Affinity at Castle Rock

Phase III Drainage Report

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HR Green Project No: 211400
Town of Castle Rock Project Number: CD22-0053

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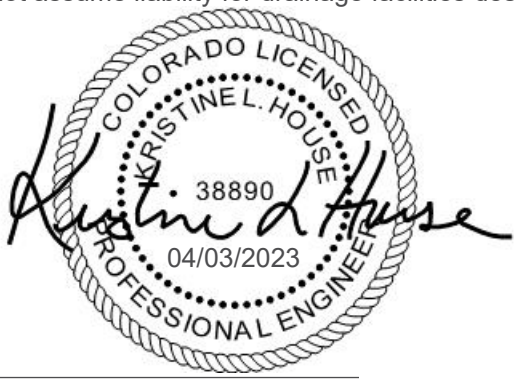
Certification Statement:

I affirm that this report and plan for the Phase III drainage design of Affinity at Castle Rock 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.



Kristine L. House, P.E. Date

State of Colorado No. 38890

For and on behalf of HR Green Development, LLC

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II. General Location and Description

A. Site Location

1. *Site Vicinity Map*

   See Vicinity Map included in Appendix A.

2. *Township, Range, Section, and ¼ Section*

   The Affinity at Castle Rock development is located primarily in the north half of Section 34, with a small portion in the south half of Section 27, Township 7 South, Range 67 West of the 6th Principal Meridian in the Town of Castle Rock, Douglas County, State of Colorado.

3. *Streets, Roadways, and Highways adjacent to the proposed development, or within the area served by the proposed drainage improvements.*

   The site is bordered to the to the northwest by Meadows Parkway, to the west by the Atchison, Topeka, & Santa Fe Railroad, the east by East Plum Creek.

4. *Names of surrounding or adjacent developments.*

   The commercial development Meadows Filing No. 17 is north, west, and south of the site.

B. Description of Property

1. *Area in Acres.*

   The Affinity at Castle Rock site is approximately 17.4 acres.

2. *Ground cover, vegetation, site topography, and slopes.*

   The site consists of undeveloped land with native grasses and stands of trees. There is an existing dirt drive that provides access to Meadows Parkway. There is a one-story brick building on the south end of the site which is the Meadows A-12 Wellhouse. At the north corner of the site, there is an existing parking facility for the East Plum Creek Trail Trailhead. A gravel maintenance access road leads from this trailhead to the existing Meadows A-12 Wellhouse.

   At the south end of the site, there is an existing detention pond facility (to remain) with side slopes at 4:1 approximately 10 feet deep. This pond was constructed with The Meadows Filing 17, and serves areas west of the Atchison, Topeka, & Santa Fe Railroad.

   In addition, there is a 10-foot tall soil stockpile on the west side of the site. The east side of the site slopes down at grades varying from 1.5% to 8% towards an existing drainageway that starts in the central portion of the site running northeast. The drainageway has side slopes as steep as 2:1. North of the drainageway bank, the site slopes down gently until reaching a sharp drop at 4:1 or steeper down to Meadows Parkway. The railroad to the southwest is set above the site, with slopes down into the site varying from 7% to 3:1. The east edge of the site has several points where drainageways into East Plum Creek begin to form, flowing offsite.

   The Preble's meadow jumping mouse (PMJM) is listed as a threatened species under the United State Endangered Species Act (ESA). The ESA prohibits the unlawful take of PMJM. A Habitat Conservation Plan is in place which preserves PMJM habitat within a conservation tract. This conservation tract is along the eastern edge of the property and defined by a 300' setback of the 100-year floodplain limit adjacent to the site. Approval from the U.S. Fish and Wildlife Service will be required for potential disturbance of the PMJM habitat. See Appendix E.

3. *Natural Resources Conservation Service (NRCS) Soils Classification Map and Discussion.*
The USDA Natural Resources Conservation Service Web Soil survey was consulted to approximate site soil conditions. The Web Soil Survey indicates the site contains soils in Hydrologic Soil Group B with areas of Bresser sandy loam (BrB, 1 to 3 percent slopes) and Newlin gravelly sandy loam (NeE, 8 to 30 percent slopes). See Appendix A for Soil Map.

4. *Major or minor drainageways.*
East Plum Creek runs south to north, east of the property. There is a minor drainageway in the central portion of the site that discharges into a storm culvert that ultimately outfalls into East Plum Creek.

5. *Floodplains delineated by Town FHAD Studies or on FEMA FIRM Maps.*
Flood Insurance Rate Map (FIRMS) covering the Affinity at Castle Rock site include:

   - FEMA Flood Insurance Rate Map 08035C0167G Revised 2.3.3.2. March 16, 2016
   - FEMA Flood Insurance Rate Map 08035C0169G Revised, March 16, 2016

   A FEMA designated 100-year floodplain with defined base flood elevations (Zone AE) associated with East Plum Creek is adjacent to the eastern property boundary. All of the Affinity at Castle Rock site is outside of the floodplain within Zone X (area of minimal flood hazard).

6. *Existing irrigation canals or ditches.*
There are no existing irrigation canals or ditches on site.

7. *Significant geologic features.*
There are no additional significant geologic features noted at this time.

8. *Proposed land use.*
Proposed land use for the Affinity at Castle Rock site includes one active adult multi-residential building, community amenities (garden, dog park, etc.), parking and private access roadway on approximately 6 acres. An additional 5 acres will be utilized for future commercial development by others. The remaining portion of the site will maintain existing land uses (detention pond, pump house, open space, etc.).

III. Drainage Basins and Sub-Basins

A. Major Drainage Basins

1. *On-site and off-site major drainage basin characteristics and flow patterns and paths.*
The site is within the East Plum Creek Watershed. The *East Plum Creek Watershed Master Plan Preliminary Design Report* describes East plum Creek as a major drainageway serving as the principal means of conveying runoff from south to north through the center of the Town of Castle Rock. The watershed originates south of Town and has a large drainage basin.

2. *Existing and proposed land uses within the basin if known.*
Development in the watershed ranges from highly urbanized clusters of single family, multi-family, and commercial land uses within the Town to agricultural land uses and forested areas in the upper reaches.

3. *Discussion of all drainageway planning or floodplain delineation studies that affect the major drainageways, such as FHAD Studies and Master Planning studies.*
There are no major drainageways within the Affinity at Castle Rock project limits.

The Master Plan noted above along with the Flood Hazard Area Delineation (FHAD) serve to establish a framework for the development of drainage and stream stability improvements that will be implemented in the future. Specifically, the Master Plan discusses how watershed runoff impacts the East Plum Creek channel and what strategies may be employed to mitigate the impacts to stormwater conveyance, floodplain management, stream stability, and stormwater quality.

4. *Discussion of the condition of any channel within or adjacent to the development, including existing conditions, need for improvements, and impact on the proposed development.*
The portions of East Plum Creek adjacent to the Affinity at Castle Rock site are noted as Reach 5 within the *East Plum Creek Watershed Master Plan Preliminary Design*. The Preliminary Design does not include any improvements (stabilization) along the bank next to the subject site or any in channel improvements. Excerpts from this report are included in Appendix E.

5. *Discussion of the impacts of the off-site flow patterns and paths, under fully developed conditions.*
Off-site basins entering the Affinity at Castle Rock site are minimal and include areas of railroad right-of-way and open space which is to remain undisturbed with site development. Because these off-site basins are not anticipated to change conditions, they have minimal impact on the on-site stormwater design.

B. Minor Drainage Basins

1. *On-site and off-site minor drainage basin characteristics and flow patterns and paths.*
The site was previously discussed within *The Meadows, Phase I Master Drainage Report*, RMC Consultants, March 2002 and *The Meadows, Phase II Drainage Report*, Filing No. 17, CVL Consultants, Inc, December 2003. The Affinity at Castle Rock site was identified as “Lot 7” with the previous reports and Preliminary Plat.

   The Phase II Report notes that historically runoff reaches East plum Creek by two general routes: runoff reaching the streets is intercepted by existing storm drain systems and routed to East Plum Creek or by utilizing existing topography to flow overland to East Plum Creek.

   The Phase II Report noted that Filing No. 17 proposed to release 4.1 acres of developed area from Lot 7 to the Meadows Parkway Drainage system. This was considered a significant reduction in area intercepted by the existing system and no further hydrologic/hydraulic analysis was completed.

2. *Existing and proposed land uses within basins.*
Development in the watershed ranges from highly urbanized clusters of single family, multi-family, and commercial land uses within the Town to agricultural land uses and forested areas in the upper reaches.

3. *Discussion of irrigation facilities that will influence or be impacted by the site drainage.*
There are no irrigation facilities that will influence or be impacted by the Affinity at Castle Rock site drainage plan.

4. *Discussion of the impacts of the off-site flow patterns and paths, under fully developed conditions.*
The minimal off site basins are not expected to change land use (railroad right-of-way) or impact the design of stormwater improvements on the Affinity at Castle Rock site.

IV. Drainage Design Criteria

A. Regulations

1. *Town criteria and optional provisions selected, when applicable*

   This Phase III Drainage Report is based on the Town of Castle Rock's *Storm Drainage Design and Technical Criteria Manual* (SDDTCM).

2. *UDFCD Manual criteria and optional provisions selected, when applicable*

   as well as the Mile High Flood District's *Urban Storm Drainage Criteria Manual* (USDCM).

B. Drainage Studies, Master Plans, Site Constraints

1. *Discuss previous drainage studies or master plans for the site or project that influence the stormwater facility design.*

   As noted above the Affinity at Castle Rock site was included in the following Drainage Studies:

   - *The Meadows, Phase I Master Drainage Report*, RMC Consultants, March 2002
   - *The Meadows, Phase II Drainage Report*, Filing No. 17, CVL Consultants, Inc, December 2003

   Stormwater improvements with the Affinity at Castle Rock will respect the drainage patterns identified within these previous reports. A portion of developed runoff will continue to follow historic patterns towards East Plum Creek and the amount of developed area from the site that is directed to the Meadows Parkway Drainage system will be decreased from previous estimates.

2. *Discuss drainage studies for adjacent developments and how those developments affect the stormwater facility design.*

   Adjacent developments have no impact on on-site stormwater improvements.

3. *Discuss Town Master Plans and how recommendations in those studies affect the design.*

   The Town of Castle Rock's stormwater Master Plans do not include any elements specific to the Affinity at Castle Rock site and will not impact the site stormwater improvements.

4. *Discuss impacts to stormwater management facility design caused by site constraints, such as streets, utilities, existing structures, downstream infrastructure, etc.*

   Several site constrains impacted the site design and therefore the stormwater management facility design as well. They include:

   - The existing detention pond and pump house. These facilities are to remain in place and take up approximately 2.6 acres of the property.
   - The site is also constrained by the elevation difference to Meadows Parkway along the north edge of the property. The site sits approximately 10-feet to 20-feet above Meadows Parkway with some tie-in slopes close to 3:1. In addition, stands of mature trees along Meadows Parkway and the large development monument are to remain with development of Affinity at Castle Rock.

   All these items along with the PMJM habitat setback reduce the area available for development or used for stormwater management improvements.

C. Hydrology

1. *Runoff calculation method(s)*

Peak storm runoff was determined using the Rational Formula: Q=CIA. The Rational Method is appropriate for urban catchments that are not complex and are generally 90 acres or less in size. Parameters for use with the Rational Method were determined as follows:

- Recommended percentage impervious values are taken from USDCM V.1 Table 6-3.
- Runoff Coefficient "C" factors are taken from USDCM V.1 Table 6-5

The Affinity at Castle Rock site includes multiple land uses including areas of multi-family, future commercial, open space, and pavement. Therefore, weighted runoff coefficients were calculated for each individual basin. See Appendix B for complete Rational Method calculations.

2. *Design storm recurrence intervals*

The 100-year storm was analyzed as the major event and the 5-year as the minor event.

3. *Design rainfall*

1-hour point rainfall values (P_1) are taken from the SDDTCM Table 6-1 (below) and are based on the National Oceanic and Atmospheric Administration Precipitation-Frequency Atlas of the Western United States, Volume III-Colorado (NOAA Atlas).

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

Rainfall intensity (I) is determined using USDCM V.1 Equation 5-1 $I = \frac{28.5\,P_1}{(10 + T_d)^{0.786}}$

4. *Detention storage calculation method(s)*

Stormwater detention storage will be provided for the Affinity at Castle Rock development. Storage volume and release rates are based on "Full-Spectrum" Detention.

The latest MHFD-Detention software has been used to design the two on-site detention facilities. This Excel-based workbook uses the Modified Pulse reservoir routing method to evaluate performance of the facility based on tributary watershed parameters and variables associated with the basin/pond geometry and outlet configuration.

5. *Detention storage release rate calculation method*

The maximum allowable 100-year release rate for a full spectrum detention facility is equal to 90 percent of the predevelopment discharge for the upstream watershed. The release rate for the Excess Urban Runoff Volume is based on a drain time of 52 to 72 hours, as specified in the UDFCD Manual.

D. Hydraulics

1. *Methods used to determine conveyance facility capacities.*

The Town allows the use of streets for drainage conveyance in the minor storm with limitations on the depth of flow in the curb and gutter and the spread of flow onto the roadway. The maximum allowable street capacity is determined by whichever limitation is more restrictive, based on the geometry of the street section.

Roadways within the Affinity at Castle Rock are private with a flowline to flowline dimension of 26-feet. However, design included with this report follows the recommendations for roadways with a Type A drainage classification. No curb overtopping in the minor storm event (flow may spread to the crown of street) and depth of water at the gutter flowline will not exceed 12-inches.

At a minimum, storm sewers are sized to pick up any minor storm runoff that exceeds the minor event capacity of the street. Inlets are located at these points to intercept excess minor event flow and direct it to the storm sewer. Hydraulic Grade Lines (HGLs) for the minor event (5-year) are kept within the pipe (no surcharge).

The storm drainage system will consist of both inlets/pipes and street flow in the major (100-year) event. Storm sewer pipes are designed to convey the storm flows that exceed the allowable street capacity. The major storm event hydraulic grade line is allowed to rise above the top of the storm sewer pipe and surcharge the system. The major storm event HGL elevation will be a minimum of 1-foot below the manhole lid, inlet grate or inlet curb opening elevation.

2. *Hydraulic grade line calculation method and discussion of loss coefficients*

To ensure that these objectives are achieved, the HGLs of the storm sewer pipe are calculated by accounting for the total hydraulic losses which include pipe friction, expansion, contraction, bend, and junction losses. In no case shall the surcharge create system velocities in excess of the 18 fps or 15 fps at a storm sewer outfall.

3. *Methods used to calculate water surface profiles.*

HGLs for minor and major events have been calculated using Hydraflow Storm Sewers Extension for Autodesk Civil 3D 2019, see Appendix C for full calculation results.

E. Storage and Water Quality Enhancement

1. *Discuss approach used for detention including regional, sub-regional or on-site facilities*

Two separate on-site Extended Detention Basins (EDBs) will be utilized to improve water quality and provide flood control for the developed parcel. MHFDs Full Spectrum detention including Excess Urban Runoff Volume (EURV) will be incorporated into the on-site detention and water quality ponds.

Pond A will treat and detain runoff from the southern half of the site including the active adult multi-residential building, community amenities (garden, dog park, etc.), and associated parking. Runoff that will overtop the spillway at the northwest corner of the pond in emergency events will outflow to the adjacent driveway and eventually Regent Circle.

Pond B will treat and detain runoff generated by the private road, relocated trail parking and the future commercial area. During an emergency event, runoff will overtop the spillway at the north of the pond and flow towards Meadows Parkway.

2. *Discuss approach for achieving the four step process including runoff volume reduction, WQCV or equivalent, stream stabilization and source control.*

The four-step approach will be applied to the site to the maximum extent practicable. See following section C for details.

The EDB's 40-hour drain time for the WQCV will promote the removal of a significant portion of total suspended solids (TSS). Soluble pollutant removal will be enhanced by providing a small wetland marsh or "micro-pool" at the outlet to promote biological uptake.

V. Stormwater Management Facility Design

A. Stormwater Conveyance Facilities

1. *Discuss general conveyance concepts.*

The proposed drainage patterns follow existing drainage patterns as closely as possible. Runoff within the proposed development will initially be carried in driveways, swales, and streets. conveyance is supplemented with storm sewer systems where street flow capacities are exceeded or at low points in the grading. This combined network conveys runoff to the on-site detention ponds.

2. *Discuss proposed drainage paths and patterns.*

The site has been delineated into 22 minor drainage basins. These minor basins have been grouped according to their ultimate outfall location. Each basin is associated with a single design point representing the culmination of runoff generated within the basin. Design points are also included in the hydrologic calculations to accumulate (route together) known flows within the pipe system. In some cases, it is assumed that future site design will capture all runoff generated by a basin.

All “A” basins are on-site, made up of paved (parking/roadway), lawn (open space), roof, and walk land uses. These basins are within the southern half of the site and are numbered A1 to A11. In general, runoff generated in these basins travels overland and then within the streets or parking areas until reaching a low point, at that time inlets intercept flows. All captured runoff is piped to pond A.

All “B” basins are on-site, made up of paved (parking/roadway), lawn (open space), future commercial, and walk land uses. These basins are within the northern half of the site and are numbered B1 to B10. In general, runoff generated in these basins travels overland and then within the streets or parking areas until reaching a low point, at that time inlets intercept flows. All captured runoff is piped to pond B.

There are four basins noted as off-site (OS) on the Drainage Plan. Runoff generated within these basins does not reach one of the sites EDBs. It is not practicable to capture runoff from these basins and direct them to the EDB’s. Basin OS1 is made up of the existing hillside, stands of mature trees along Meadows Parkway, the large Meadows development monument, and the private roadway as it ties into Meadows Parkway. Runoff generated within this basin follows historic flow patterns and does not impact the Affinity at Castle Rock site. As noted above the developed area tributary to Meadows Parkway is a reduction from initial estimates made with the Phase I Report and revised with Phase III Drainage Reports and is now only 1.46 acres, no further hydrologic/hydraulic analysis was completed.

Basins OS2, OS3 and OS4 are along the eastern and southern edges of the site and are composed of open space and the existing detention basin. The nature of the site grades and tying into the existing topography does not allow them to be directed to the EDB’s. Minor portions of these basins will be disturbed with construction, but no increase in imperviousness is expected in the final condition.

See Appendix B for hydrologic and Appendix C for hydraulic calculations.

3. *Discuss storm sewer design, including inlet and pipe locations and sizes, tributary basins and areas, peak flow rates at design points, hydraulic grade lines, etc.*

Please see Summary Runoff Tables on the Drainage Plans or the Rational Calculations for peak flow rates at design points. HGL calculation results are included in Appendix C and has been added to the storm profiles with Construction Documents.

4. *Discuss storm sewer outfall locations and design, including method of energy dissipation.*
Outfalls from both EDBs are combined and will utilize an existing 30-inch concrete pipe outfall and riprap for energy dissipation. Detained developed flows will be less than historic, and the existing outfall protection is expected to be adequate.

5. *Discuss how runoff is conveyed from all outfalls to the nearest major drainageway, including a discussion of the flow path, capacity, and stability downstream of the outfall to the nearest major drainageway.*
After the existing outfall location runoff will be conveyed overland a short distance to the northeast towards East Plum Creek. This conveyance path appears to be stable and doesn't show signs of significant erosion or degradation. Again, detained developed flows will be less than historic, and the existing conveyance is expected to be adequate.

6. *Discuss open channel and swale designs, including dimensions, alignments, tributary basins and areas, peak flow rates at design points, stabilization and grade control improvements, low flow or trickle channel capacities, water surface elevations, etc.*
Throughout the site minor grass-lines swales convey developed flows to landscape inlets for capture. These swales are triangular, with varying side-slopes and have been designed to convey the 100-year event with velocities less than what is generally considered erosive for Type B soils (5 ft/s). The lowest point of water entry (first floor or basement window) of any structure adjacent to the swale will be at least 1.0-foot above the 100-year water surface with limited exceptions, see Variances. See Appendix C for swale cross-sections and capacity calculations.

   Retaining walls are proposed around stormwater Pond A located in the center of the site. Section 13.3.14 of the SDDTCM states the following: "If retaining walls are proposed, footings shall be located above the Excess Urban Runoff Volume (EURV)."

7. *Discuss allowable street capacities.*
Street capacity calculations have been included in Appendix C. The site is relatively small and does not generate a great amount of runoff in either the minor or major storm events. Street capacity is not exceeded anywhere on the site.

   The emergency flow from Pond A will ultimately outflow at the northwest corner of the pond and onto Regent Circle. The street capacity for Regent Circle is 109.1 cfs which is adequate to provide drainage for the emergency flowrate of 22.6 cfs from Pond A. See Appendix C for street capacity and inlet capacity calculations.

   The emergency flow from pond B will outfall to the north onto Meadows Parkway. The street capacity for Meadows Parkway is 203.6 cfs which is adequate to provide drainage for the emergency flowrate of 20.0 cfs from Pond B. See Appendix C for street capacity and inlet capacity calculations.

8. *Discuss maintenance aspects of the design and easements and tracts that are required for stormwater conveyance purposes.*
Stormwater conveyance systems (pipes and manholes) have been located to facilitate future maintenance access. The grass swales have also been designed with maintenance in mind. Access to the swales is provided for mowing equipment and side-slopes are flat enough for the safe operation of equipment.

   Drainage easements are required in order to ensure the proper construction and maintenance of storm sewers and related facilities. All storm sewers for this project are less than 36-inches in diameter, therefore easements 25-feet in width will be required.

9. *Discussion of the facilities needed off-site for the conveyance of minor and major flows to the major drainageway.*

No additional facilities are required for the off-site conveyance of flows to the major drainageway (East Plum Creek).

B. Stormwater Storage Facilities

1. *Discuss detention pond designs, including release rates, storage volumes and water surface elevations for the WQCV, EURV, 100-year and emergency overflow conditions, outlet structure design, emergency spillway design, etc.*

The maximum allowable 100-year release rate the storage facilities designed with this report are equal to 90 percent of the predevelopment discharge for the upstream watershed.

POND A SUMMARY				
DETENTION STAGE	VOLUME (AC-FT)	RELEASE RATE (CFS)	MAXIMUM DEPTH (FT)	WATER SURFACE ELEVATION (FT)
WQCV	0.11	0.06	1.46	6077.96
EURV	0.37	0.11	2.84	6079.34
100-YR + ½ WQCV	0.66	8.0	4.06	6080.56
100-YR (EMERGENCY)	1.44	22.6	6.81	6083.31
TOP OF POND	N/A	N/A	7.81	6084.31

POND B SUMMARY				
DETENTION STAGE	VOLUME (AC-FT)	RELEASE RATE (CFS)	MAXIMUM DEPTH (FT)	WATER SURFACE ELEVATION (FT)
WQCV	0.13	0.1	1.40	6064.00
EURV	0.44	0.14	2.80	6065.40
100-YR + ½ WQCV	0.75	7.9	3.86	6066.46
100-YR (EMERGENCY)	N/A	20.0	4.90	6067.50
TOP OF POND	N/A	N/A	5.9	6068.50

2. *Discuss pond outfall locations and design, including method of energy dissipation.*

Outfalls from both EDBs combine into a single 30-inch concrete pipe outfall and riprap for energy dissipation. Detained developed flows will be less than historic, and the existing outfall protection is expected to be adequate.

3. *Discuss how runoff is conveyed from all pond outfalls and emergency spillways to the nearest major drainageway, including a discussion of the flow path, capacity, and stability downstream of the outfall to the nearest major drainageway.*

After the existing outfall location runoff will be conveyed overland a short distance to the northeast towards East Plum Creek. This conveyance path appears to be stable and doesn't show signs of significant erosion or degradation.

The emergency flow from Pond A will ultimately outflow at the northwest corner of the pond and onto Regent Circle. The street capacity for Regent Circle is 109.1 cfs which is adequate enough to provide drainage for the emergency flowrate of 22.6 cfs from Pond A. See Appendix C for street capacity and inlet capacity calculations.

The emergency flow from pond B will outfall to the north onto Meadows Parkway. The street capacity for Meadows Parkway is 203.6 cfs which is adequate to provide drainage for the emergency flowrate of 20.0 cfs from Pond B. See Appendix C for street capacity and inlet capacity calculations.

4. *Demonstrate compliance with water right exemption status.*

Stormwater Detention and Infiltration Design Data Sheets for both EDBs are included in Appendix D. These worksheets demonstrate compliance with Colorado Revised Statute (CRS) §37-92-602 (8).

5. *Discuss maintenance aspects of the design and easements and tracts that are required for stormwater storage purposes.*

Maintenance responsibility lies with the owner of the land. The property owner or designee will be responsible for the maintenance of all drainage facilities including inlets, pipes, culverts, channels, ditches, hydraulic structures, and detention basins located on their land unless modified by specific agreement. Additional maintenance discussion has been included in Section V.C below.

The two EDB facilities are designed to facilitate ongoing maintenance operations. Maintenance aspects specific to the stormwater storage (flood control) zone within the pond include:

- A stable access and working bench so that equipment can remove accumulated sediment and debris from the detention basin. The access path will conform to all current design criteria listed in the SDDTCM. Above the Excess Urban Runoff Volume and below the 100-year water surface: An access ramp shall be reinforced concrete as specified above or at least an 8-inch thick layer of aggregate base course or crushed gravel over compacted subgrade.
- The outlet structure trash rack, emergency spillway and other critical structures must be accessible during storm events. A working bench is provided above the 100-year water surface elevation and within 20-24 feet of the farthest point of all critical structures to allow for equipment access. Access to the working bench for these critical structures will be an all-weather surface that is also above the 100-year water elevation.

Any retaining walls have been laid out in a manner that avoids access restrictions. Any handrails or fences, likewise, will permit vehicular access. The entrance to an access drive from a roadway or parking lot shall be located so that traffic safety is not compromised.

Drainage easements for the stormwater water quality facilities shall be granted to the Town for inspection and maintenance purposes and are shown on the Drainage Plan.

C. Water Quality Enhancement Control Measures

1. *Itemize and discuss the design of all structural and non-structural water quality control measures associated with the four-step process, including type, location, tributary areas, sizing, treatment volumes, design features, etc. Each step shall be listed and discussed separately in the report.*

- Step 1: Reduce Runoff Volume to the Maximum Extent Practicable

  Reducing runoff volume is accomplished by reducing the amount of pavement and roof area that is directly connected to inlets and storm sewer, while maximizing the pervious area that receives runoff from unconnected pavement or roofs, commonly noted in Town and MHFD criteria as reducing Directly Connected Impervious Area (DCIA).

  Grass swales are designed site wide to help reduce paved/impervious areas and minimize the DCIAs on-site. Swales also serve to promote infiltration, attenuation, and water quality enhancement. At this time a reduction in the runoff coefficients (5-year) for the basins incorporating grass swales has not been employed.

- Step 2: Provide Water Quality Capture Volume and Flood Control Detention Via Full-Spectrum Detention

  For the Affinity at Castle Rock site two separate on-site Extended Detention Basins (EDBs) will be utilized to improve water quality and provide flood control for the developed parcel. MHFDs Full Spectrum detention including EURV has been incorporated into the on-site detention and water quality ponds with the total volume requirements equal to 0.5 times the WQCV plus the determined 100-year detention volume.

  These full-spectrum detention facilities control the increase in runoff rates from developed areas during frequent storm events that exacerbate stream degradation. The site EDBs will help to reduce the extent and severity of degradation in drainageways downstream of the site. Reducing degradation helps to protect stream health and water quality while cutting down on costly stream stabilization efforts.

  Detention basin outlets have been designed with sloping trash racks and safety grates. The structures are functional for controlling the design release rates, provided with oversized safety/debris grates to reduce the potential for debris plugging, easy to maintain, and designed with favorable aesthetics.

- Step 3: Utilize Stream Channel Stabilization Techniques.

  There are no streams requiring stabilization within the Affinity at Castle Rock site. The adjacent East Plum Creek initially appears to be stable, well-vegetated, and physically and biologically healthy.

- Step 4: Undertake Source Control

  Post-construction day to day site operations are expected to follow standard Good Housekeeping procedures to control the potential for illicit discharges from the site. Although portions of this site will be developed for commercial uses, there are no additional sources of pollution expected (no vehicle maintenance, heavy equipment, etc.).

  Structural measures may include covering of storage/handling areas, spill containment and control, snow storage in landscape areas, provision of proper waste receptacles and other best available technologies. In addition to structural source controls, non-structural practices to

prevent or reduce the generation of runoff or illicit discharges may include recycling programs, spill prevention and response plans, employee “awareness” education and training.

2. *Discuss how runoff is conveyed from all pond outfalls to the nearest major drainageway, including a discussion of the flow path, capacity, and stability downstream of the outfall to the nearest major drainageway.*

   As noted above, after the existing outfall location runoff will be conveyed overland a short distance to the northeast towards East Plum Creek. This conveyance path appears to be stable and doesn’t show signs of significant erosion or degradation.

3. *Discuss the operation and maintenance aspects of the design and easements and tracts that are required for stormwater quality enhancement purposes.*

   Maintenance responsibility lies with the owner of the land. The property owner or designee will be responsible for the maintenance of all drainage facilities including inlets, pipes, culverts, channels, ditches, hydraulic structures, and detention basins located on their land unless modified by specific agreement. Additional maintenance discussion has been included in Section V.B above.

   The two EDB facilities are designed to facilitate ongoing maintenance operations. Maintenance aspects specific to the stormwater quality (WQCV and EURV) zones within the pond include:

   - A stable access and working bench so that equipment can remove accumulated sediment and debris from the detention basin. The access path will conform to all current design criteria listed in the SDDTCM. Below the EURV water surface: The access ramp will be reinforced concrete or at least a twelve-inch thick layer of aggregate base course or crushed gravel over compacted subgrade.

   Drainage easements for the stormwater water quality facilities shall be granted to the Town for inspection and maintenance purposes and are shown on the Drainage Plan.

D. Floodplain Modifications

No floodplain modifications are proposed with the development of Affinity at Castle Rock.

E. Geotechnical Investigation and Sub-surface Collection System Design

1. *Discuss results of geotechnical investigations, groundwater table measurements and recommendations for groundwater mitigation measures.*

   A *Subsurface Soil Investigation* for the Affinity at Castle Rock site was completed by Entech Engineering, Inc. in July of 2022. It is not anticipated that groundwater will need to be accommodated with the development of the Affinity at Castle Rock site.

F. Operation and Maintenance

1. *Identify the responsible party for operation and maintenance of water quality enhancement control measures and stormwater management facilities.*

   The property owner shall be responsible for the maintenance of all stormwater facilities located on the property unless otherwise specified in a maintenance agreement.

2. *Discuss maintenance requirements and information to ensure the long-term operation of water quality enhancement control measures and other stormwater management facilities (see Section 4.6).*

   Routine maintenance of facilities may include removal of debris and sediment, trash rack clearing, mowing, noxious weed control, etc. Non-routine restorative maintenance activities include repairs to, or replacement of, structures and other improvements necessary to retain the effectiveness of the

system. Such tasks are necessary to preclude the facility from becoming unhealthy and to avoid reduced conveyance capability, unsightliness, and malfunction.

3. *Identify frequencies for operator inspections and routine and non-routine maintenance activities.* Routine maintenance activities for the EDBs are summarized in the following table.

Table – EDB-2
Summary of Routine Maintenance Activities

Maintenance Activity	Minimum Frequency	Look for:	Maintenance Action
Mowing	Twice annually	Excessive grass height/aesthetics	Mow grass to a height of 4" to 6"
Trash/Debris Removal	Twice annually	Trash & debris in EDB	Remove and dispose of trash and debris
Outlet Works Cleaning	As needed - after significant rain events – twice annually min.	Clogged outlet structure; ponding water	Remove and dispose of debris/trash/sediment to allow outlet to function properly
Weed control	Minimum twice annually	Noxious weeds; Unwanted vegetation	Treat w/ herbicide or hand pull; Consult the local weed specialist
Mosquito Treatment	As needed	Standing water/mosquito habitat	Treat w/ EPA approved chemicals
Algae Treatment	As needed	Standing water/ Algal growth/green color	Treat w/ EPA approved chemicals

Minor maintenance activities for the EDBs are summarized in the following table.

Table – EDB-3
Summary of Minor Maintenance Activities

Maintenance Activity	Minimum Frequency	Look for:	Maintenance Action
Sediment Removal*	As needed; typically every 1–2 years	Sediment build-up; decrease in pond volume	Remove and dispose of sediment
Erosion Repair	As needed, based upon inspection	Rills/gullies forming on side slopes, trickle channel, other areas	Repair eroded areas Revegetate; address source of erosion
Vegetation Removal/Tree Thinning	As needed, based upon inspection	Large trees/wood vegetation in lower chamber of pond	Remove vegetation; restore grade and surface
Drain Cleaning/Jet Vac	As needed, based upon inspection	Sediment build-up /non draining system	Clean drains; Jet Vac if needed

*Usually from the forebay, trickle channel, and/or micro-pool

Major maintenance activities for the EDBs are summarized in the following table.

Table – EDB-4
Summary of Major Maintenance Activities

Maintenance Activity	Minimum Frequency	Look for:	Maintenance Action
Major Sediment Removal	As needed – based upon scheduled inspections	Large quantities of sediment; reduced pond capacity	Remove and dispose of sediment. Repair vegetation as needed
Major Erosion Repair	As needed – based upon scheduled inspections	Severe erosion including gullies, excessive soil displacement, areas of settlement, holes	Repair erosion – find cause of problem and address to avoid future erosion
Structural Repair	As needed – based upon scheduled inspections	Deterioration and/or damage to structural components – broken concrete, damaged pipes, outlet works	Structural repair to restore the structure to its original design

G. Additional Permitting Requirements

1. Section 404 of the Clean Water Act

404 permitting is not anticipated with the development of Affinity at Castle Rock.

2. The Endangered Species Act

The Preble's meadow jumping mouse (PMJM) is listed as a threatened species under the United State Endangered Species Act (ESA). The ESA prohibits the unlawful take of PMJM. A Habitat Conservation Plan is in place which preserves PMJM habitat within a conservation tract. This conservation tract is along the eastern edge of the property and defined by a 300' offset of the 100-year floodplain limit adjacent to the site. Approval from the U.S. Fish and Wildlife Service may be required for potential disturbance of the PMJM habitat. See Appendix E.

3. Other local, state, or federal requirements

There are no additional permitting requirements identified at this time.

VI. Conclusions

A. Compliance with Standards

1. Town of Castle Rock Criteria

This Phase III Drainage Report for the Affinity at Castle Rock development is in compliance with Town of Castle Rock and Mile High Flood District drainage design criteria where applicable, with variances noted below.

2. Master Plans

This Phase III Drainage Report for the Affinity at Castle Rock development is in compliance with Master Plans for the area including *The Meadows, Phase I Master Drainage Report*, and the *Plum Creek, West Plum Creek, and East Plum Creek, Major Drainageway Plan.*

3. Cherry Creek Reservoir Control Regulation No. 72

This project is outside of the Cherry Creek Basin and not subject to Regulation No. 72.

A. Chatfield Reservoir Control Regulation No. 73

This Phase III Drainage Report for the Affinity at Castle Rock development is in compliance with Chatfield Reservoir Control Regulation No. 73. Water quality enhancement control measures will be

implemented to control non-point Affinity at Castle Rock pollution of stormwater runoff within the Chatfield Reservoir watershed, which includes all tributaries to Plum Creek.

B. Variances

1. *Identify provisions by section number for which a variance will be requested or has been approved by the Town (final version of Drainage Report). Additional information on variances is available in Chapter 1, General Provisions*
   TCV23-0007, Approved 04/ /2023
   SDDTCM 12.3 Table 12-3 Hydraulic Design Criteria for Grass-Lined Channels, minimum of two-feet of freeboard shall be provided to the lowest adjacent habitable structure's lowest floor.

   A variance is requested along the east side of the building to allow less than two-feet of freeboard between the 100-year swale water surface and the lowest finished floor elevation. Note Level 1 is parking / storage and all inhabited spaces are Level 2 and above.

   - Swale elevations are constrained by both the adjacent existing grades and requirements to remain outside the defined Preble's Mouse Habitat as well as maximum slopes away from the building. The elevations noted as "FG" on the plan represent the finished grade adjacent to the building and the actual finished floor may be higher or lower than this, depending on where you are at in the building. The level 1 finished floor is at an elevation of 6087.00 (noted on the architectural plan as 100'0"), and midway through the section the finished grade is above the finished floor, so the requested two-feet of freeboard is not achievable.
   - There is no adverse impact on public safety, health and welfare by allowing less than two-feet of freeboard at this location. This drainage basin (A9) has a calculated runoff of 0.9 cfs in the minor event and 3.4 cfs in the 100-year event. This results in a maximum depth of 4.8-inches at the northern-most end of the swale. There are no additional sources of water that would push the swale elevation higher and threaten the building. Runoff will spill into the street before backing up farther into the swale.

   SDDTCM 13.1.1 Full-spectrum Detention shall be provided for all New Development and Redevelopment. The Town requires that full-spectrum detention including water quality capture volume and flood control detention be provided for all new development and redevelopment.

   A variance is requested to allow a portion of the Affinity at Castle Rock site to not be directed to a full-spectrum facility.

   SDDTCM 13.1.5 Exclusions from Water Quality Enhancement and Full-Spectrum Detention: The areas of the Affinity at Castle Rock site not directed to the on-site full-spectrum EDB facilities fall into the following two excluded categories:

   - A portion of the site will be disturbed but will remain undeveloped after construction or remain wholly undisturbed and undeveloped after construction. This includes areas within basins OS1, OS2, OS3 and OS4 and totals 5.57 acres.
   - The remaining untreated impervious area is not practicable to be captured and directed to a water quality control measure. This area is within Basin OS1 and includes areas of higher elevations sloping down to meet existing grades along Meadows Parkway. Site slopes and existing elevations make it impossible to capture and convey this area to the site EDBs. Inlets have been placed along Regent Circle to maximize the developed impervious area that is treated for water quality.

This untreated impervious area totals 0.12 acres and is equivalent to 0.7% of the total site. This is within the allowable threshold of less than 20% or one acre.

See also the Permanent Water Quality Determination Worksheet in Appendix D.

TCV22-0123, Approved 03/02/2023

SDDTCM 13.3.14 Retaining Walls. Walls shall not be used on more than fifty percent of the pond circumference.

A variance is requested to allow the use of use walls around 75% of the pond instead of 50%.

- The variance is needed to obtain adequate pond volume within the limited footprint available.
- Without the variance, the pond would not meet the required volume or footings of the wall would be below the EURV.

TCV22-0122, Approved 03/02/2023

SDDTCM 9.1.2 Major Event Storm Sewer Design, specifically the following: The major storm event hydraulic grade line elevation shall be a minimum of 1-foot below the manhole lid, inlet grate or inlet curb opening elevation.

A variance is requested at curb inlet IN-A6 to allow the 100-year Hydraulic Grade Line (HGL) to be less than the required 1-foot below the inlet curb opening elevation. At this inlet current hydraulic calculations indicate that runoff will pond to approximately 5-inches at the inlet opening.

- The driving force behind the HGL elevation at inlet IN-A6 is the 100-year water surface elevation for Detention Pond A. The pond is in close proximity to the inlet and an increase in pipe size does not bring the inlet HGL down to meet criteria. An effort has been made to lower the pond (and associated 100-year water surface) as much as possible, however additional lowering results in excessively deep storm outfalling from the pond and additional retaining walls surrounding the pond. In addition, the flowline elevation of the inlet cannot be increased without adversely impacting adjacent street and driveway grading.
- A strict enforcement of this criteria would result in pushing the detention pond lower to reduce the starting HGL in the pipe system. The outcome of this would be undesirable for several reasons. The pond would not be efficiently utilizing the area/volume allotted to it, there is potential for additional retaining wall height, where an effort has been made to reduce the amount of retaining walls surrounding the detention, and the storm sewer outfall from the pond would be deeper resulting in greater construction and maintenance costs.
- There is no adverse impact on public safety, health and welfare by allowing water to pond at this inlet in the 100-year event. Peak runoff to this inlet in the major storm event is only 2 cfs. The ponding is less than the curb height and would only occur when the pond is full. For the vast majority of storm events, there will be no ponding at this inlet. In the event of a storm event in excess of the 100-year, flows will overtop the local high point at the intersection of the drive and Regent Street and flow northwest down Regent and not create additional ponding that would pose a risk to people or property.

C. Drainage Concept

1. *Discuss overall effectiveness of stormwater management design to properly convey, store and treat stormwater.*

The proposed Full Spectrum Detention facilities to be constructed throughout the development will effectively mitigate the impacts of the proposed development on downstream properties and receiving waters.

Designing a detention basin to capture Excess Urban Runoff Volume and release it slowly means that all the frequent storms smaller than approximately the two-year event will be reduced down to flows that are as near to zero as possible and typically less than the threshold value for erosion in most drainageways. In addition, by incorporating an outlet structure that limits 100-year runoff to the MHFD allowable release rate, the larger storms greater than the two-year event will be reduced down to discharges and hydrograph shapes that approximate pre-developed conditions. This reduces the likelihood that runoff hydrographs from multiple basins will combine to produce greater discharges than pre-developed conditions.

As noted above, the maximum allowable 100-year release rate for the storage facilities designed with this report are equal to 90 percent of the predevelopment discharge for the upstream watersheds. Pre-development and design release rates have been calculated with MHFD's UD-Detention worksheet and are summarized below.

	PRE-DEVELOPMENT PEAK RUNOFF	POND DESIGN RELEASE RATE
	(CFS)	(CFS)
POND A	8.7	7.9
POND B	8.5	7.9

VII. References

1. *Reference all criteria, master plans, reports, or other technical information in development of the concepts discussed in the Drainage Report.*

1. *Town of Castle Rock, Storm Drainage Design and Technical Criteria Manual*, published by Castle Rock Water Department, updated June 2019.
2. *Mile High Flood District's Urban Storm Drainage Criteria Manual* (USDCM), volumes 1, 2 and 3, current editions.
3. *Stormwater Master Plan Update 2017*, Castle Rock Water – Stormwater Division, 2017.
4. *East Plum Creek Watershed Master Plan Preliminary Design Report*,
5. *The Meadows, Phase I Master Drainage Report,* RMC Consultants, March 2002.
6. *The Meadows, Phase II Drainage Report, Filing No. 17,* CVL Consultants, Inc, December 2003.
7. *Meadows Parkway Drainage Design Report,* TST Consultants, November 1986.
8. *Meadows Boulevard Drainage Design Report,* TST Consultants, July 1986.
9. *Plum Creek, West Plum Creek, and East Plum Creek, Major Drainageway Plan*, Enginuity Engineering Solutions, September 2016.
10. *Subsurface Soil Investigation, Affinity at Castle Rock Assisted Living Facility,* Entech Engineering, Inc., July 2022.

APPENDIX A

MAPS AND EXHIBITS

HRGreen

HRGreen.com

AFFINITY AT CASTLE ROCK
PHASE III DRAINAGE REPORT
VICINITY MAP

SHEET
1

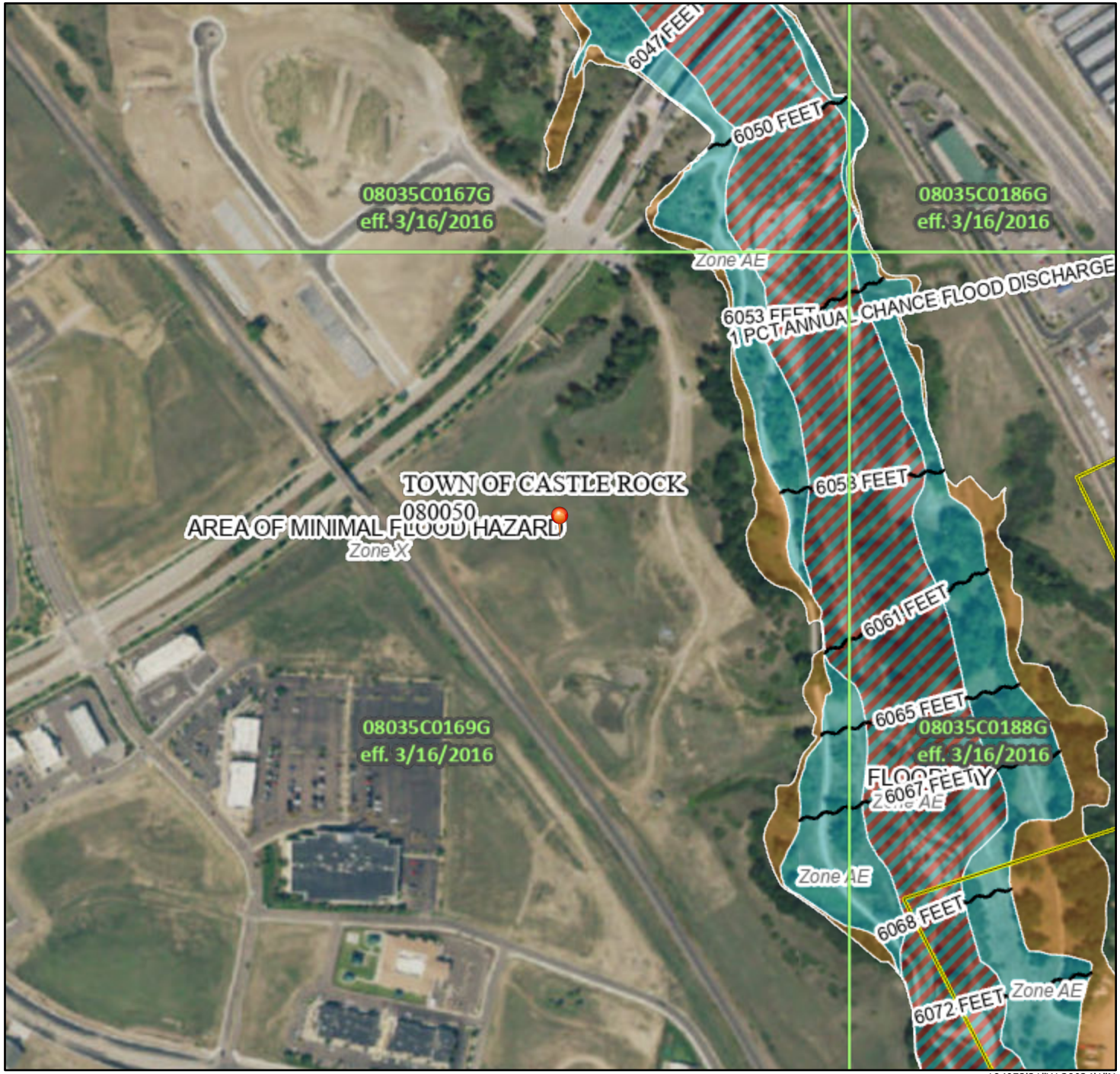
SCALE: 1"=500'
DATE: 11/2022

HR GREEN Xrefs: xx-XV-Aerial; xv-row; xc-dsgn; xv-FEMA; xv-FEMA-original

National Flood Hazard Layer FIRMette

FEMA

104°52'59"W 39°24'29"N



104°52'21"W 39°24'1"N

Feet 1:6,000

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

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

Legend

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

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

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

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

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

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

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

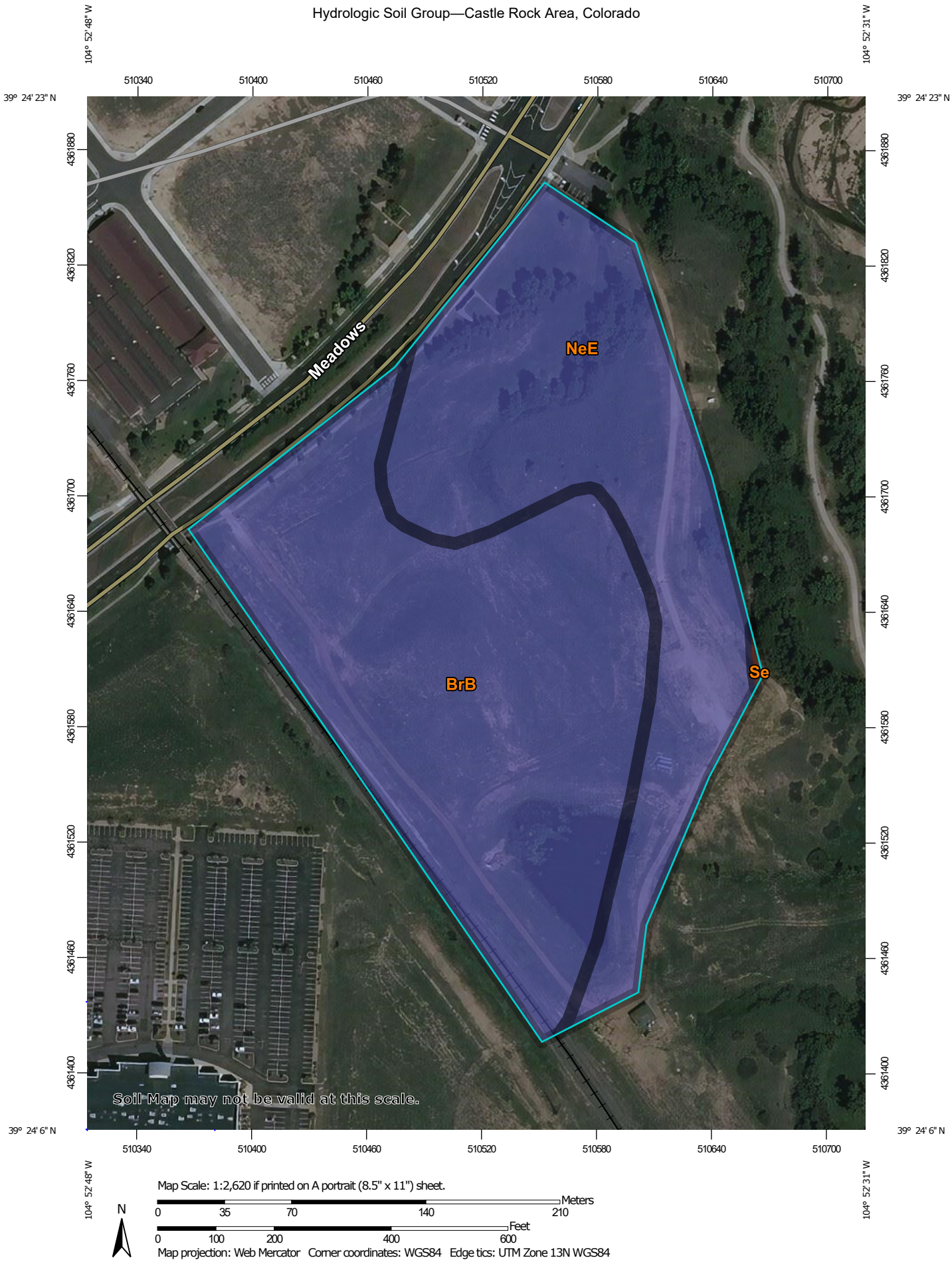
N

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

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

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 9/28/2021 at 5:38 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.



Map Scale: 1:2,620 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 35 70 140 210

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 24, 2018—Nov 19, 2018

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

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
BrB	Bresser sandy loam, cool, 1 to 3 percent slopes	B	10.1	56.6%
NeE	Newlin gravelly sandy loam, 8 to 30 percent slopes	B	7.8	43.3%
Se	Sandy wet alluvial land	D	0.0	0.1%
Totals for Area of Interest			**17.9**	**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.

APPENDIX B

HYDROLOGIC CALCULATIONS

STORM DRAINAGE SYSTEM DESIGN

Project #: 211400.00
Project: Affinity at Castle Rock

Location: Town of Castle Rock
Plan Date: Phase II Report

By: Date: 1/24/2023
Checked: Date: 1/24/2023

COMPOSITE 'C' FACTORS

BASIN	AREAS (ACRES)						SOIL	ROOF			PAVED			LANDSCAPE			WALKS			COMMERCIAL			COMP. C FACTOR		
DESIGNATION	ROOF	PAVED	LANDSCAPE	WALKS	COMMERCIAL	TOTAL	TYPE	%I	5 YR	100 YR	%I	5 YR	100 YR	%I	5 YR	100 YR	%I	5 YR	100 YR	%I	5 YR	100 YR	%I	5 YR	100 YR
A1	0.31	0.09	0.22	0.05		0.67	B	90	0.76	0.84	100	0.86	0.89	2	0.01	0.44	90	0.76	0.84	75	0.63	0.78	62.4	0.53	0.72
A2	0.24	0.08	0.28	0.07		0.67	B	90	0.76	0.84	100	0.86	0.89	2	0.01	0.44	90	0.76	0.84	75	0.63	0.78	54.4	0.46	0.68
A3	0.13	0.04	0.59			0.76	B	90	0.76	0.84	100	0.86	0.89	2	0.01	0.44	90	0.76	0.84	75	0.63	0.78	22.2	0.18	0.53
A4	0.08	0.27	0.61			0.96	B	90	0.76	0.84	100	0.86	0.89	2	0.01	0.44	90	0.76	0.84	75	0.63	0.78	36.9	0.31	0.60
A5	0.19		0.08			0.27	B	90	0.76	0.84	100	0.86	0.89	2	0.01	0.44	90	0.76	0.84	75	0.63	0.78	63.9	0.54	0.72
A5.1		0.07				0.07	B	90	0.76	0.84	100	0.86	0.89	2	0.01	0.44	90	0.76	0.84	75	0.63	0.78	100.0	0.86	0.89
A6		0.23	0.03			0.26	B	90	0.76	0.84	100	0.86	0.89	2	0.01	0.44	90	0.76	0.84	75	0.63	0.78	88.7	0.76	0.84
A7	0.12	0.20	0.02			0.34	B	90	0.76	0.84	100	0.86	0.89	2	0.01	0.44	90	0.76	0.84	75	0.63	0.78	90.7	0.77	0.85
A8	0.19	0.01	0.07			0.27	B	90	0.76	0.84	100	0.86	0.89	2	0.01	0.44	90	0.76	0.84	75	0.63	0.78	67.6	0.57	0.74
A9	0.32		0.58			0.90	B	90	0.76	0.84	100	0.86	0.89	2	0.01	0.44	90	0.76	0.84	75	0.63	0.78	33.3	0.28	0.58
A10	0.14	0.38	0.03			0.55	B	90	0.76	0.84	100	0.86	0.89	2	0.01	0.44	90	0.76	0.84	75	0.63	0.78	92.1	0.79	0.85
A11		0.36				0.36	B	90	0.76	0.84	100	0.86	0.89	2	0.01	0.44	90	0.76	0.84	75	0.63	0.78	100.0	0.86	0.89
B1					0.90	0.90	B	90	0.76	0.84	100	0.86	0.89	2	0.01	0.44	90	0.76	0.84	75	0.63	0.78	75.0	0.63	0.78
B2		0.08	0.12			0.20	B	90	0.76	0.84	100	0.86	0.89	2	0.01	0.44	90	0.76	0.84	75	0.63	0.78	41.2	0.35	0.62
B3		0.25	0.16			0.41	B	90	0.76	0.84	100	0.86	0.89	2	0.01	0.44	90	0.76	0.84	75	0.63	0.78	61.8	0.53	0.71
B4					0.88	0.88	B	90	0.76	0.84	100	0.86	0.89	2	0.01	0.44	90	0.76	0.84	75	0.63	0.78	75.0	0.63	0.78
B5					0.63	0.63	B	90	0.76	0.84	100	0.86	0.89	2	0.01	0.44	90	0.76	0.84	75	0.63	0.78	75.0	0.63	0.78
B6					1.14	1.14	B	90	0.76	0.84	100	0.86	0.89	2	0.01	0.44	90	0.76	0.84	75	0.63	0.78	75.0	0.63	0.78
B7		0.13			0.12	0.25	B	90	0.76	0.84	100	0.86	0.89	2	0.01	0.44	90	0.76	0.84	75	0.63	0.78	88.0	0.75	0.84
B8		0.21	0.29			0.50	B	90	0.76	0.84	100	0.86	0.89	2	0.01	0.44	90	0.76	0.84	75	0.63	0.78	43.2	0.37	0.63
B9		0.27	0.14			0.41	B	90	0.76	0.84	100	0.86	0.89	2	0.01	0.44	90	0.76	0.84	75	0.63	0.78	66.5	0.57	0.74
B10		0.32	0.34			0.66	B	90	0.76	0.84	100	0.86	0.89	2	0.01	0.44	90	0.76	0.84	75	0.63	0.78	49.5	0.42	0.66
OS1		0.15	1.31			1.46	B	90	0.76	0.84	100	0.86	0.89	2	0.01	0.44	90	0.76	0.84	75	0.63	0.78	12.1	0.10	0.49
OS2			0.09			0.09	B	90	0.76	0.84	100	0.86	0.89	2	0.01	0.44	90	0.76	0.84	75	0.63	0.78	2.0	0.01	0.44
OS3			1.34			1.34	B	90	0.76	0.84	100	0.86	0.89	2	0.01	0.44	90	0.76	0.84	75	0.63	0.78	2.0	0.01	0.44
OS4			2.80			2.80	B	90	0.76	0.84	100	0.86	0.89	2	0.01	0.44	90	0.76	0.84	75	0.63	0.78	2.0	0.01	0.44
SUMMARY																									
Total Pond A	1.72	1.73	2.51	0.12	0.00	6.08	B	90	0.76	0.84	100	0.86	0.89	2	0.01	0.44	90	0.76	0.84	75	0.63	0.78	56.5	0.48	0.69
Forebay A1	1.07	0.98	1.83	0.12	0.00	4.00	B	90	0.76	0.84	100	0.86	0.89	2	0.01	0.44	90	0.76	0.84	75	0.63	0.78	52.2	0.44	0.67
Forebay A2	0.65	0.39	0.68	0.00	0.00	1.72	B	90	0.76	0.84	100	0.86	0.89	2	0.01	0.44	90	0.76	0.84	75	0.63	0.78	57.5	0.49	0.69
Total Pond B	0.00	1.26	1.05	0.00	3.67	5.98	B	90	0.76	0.84	100	0.86	0.89	2	0.01	0.44	90	0.76	0.84	75	0.63	0.78	67.4	0.57	0.74
Forebay B1	0.00	0.46	0.28	0.00	3.67	4.41	B	90	0.76	0.84	100	0.86	0.89	2	0.01	0.44	90	0.76	0.84	75	0.63	0.78	73.0	0.61	0.77
Forebay B2	0.00	0.48	0.43	0.00	0.00	0.91	B	90	0.76	0.84	100	0.86	0.89	2	0.01	0.44	90	0.76	0.84	75	0.63	0.78	53.7	0.46	0.68

STORM DRAINAGE SYSTEM DESIGN

HRGreen

Project #: 211400 | Location: Town of Castle Rock | By: K House | Date: 1/24/2023
Project: Affinity at Castle Rock | Plan Date: Phase II Report | Checked: R Littleton | Date: 1/24/2023

TIME OF CONCENTRATION

BASIN DATA			INITIAL/OVERLAND TIME (Ti)			TRAVEL TIME (Tt)					TOTAL	Tc Check (Urbanized Basins)		FINAL Tc	REMARKS
DESIGNATION	C5	AREA (AC)	LENGTH (FT)	SLOPE %	Ti (Min.)*	GRASS/ PAVED	LENGTH (FT)	SLOPE %	VEL. (FPS)**	Tt(Min.)	Ti+Tt(Min.)	LGTH. (FT)	Tc = (L/180) + 10	(minutes)	
A1	0.53	0.67	45	2.0	5.6	GRASS	110	2.0	2.1	0.9	6.5	155	10.9	6.5	
A2	0.46	0.67	65	2.0	7.5	GRASS	120	2.0	2.1	0.9	8.5	185	11.0	8.5	
A3	0.18	0.76	120	5.7	10.3	GRASS	190	4.6	3.2	1.0	11.3	310	11.7	11.3	
A4	0.31	0.96	125	17.0	6.3	PAVED	95	4.4	4.2	0.4	6.7	220	11.2	6.7	
A5	0.54	0.27	45	2.0	5.5	GRASS	60	2.1	2.2	0.5	5.9	105	10.6	5.9	
A5.1	0.86	0.07	45	1.0	3.0	PAVED	45	3.6	3.8	0.2	3.1	90	10.5	5.0	
A6	0.76	0.26	40	4.0	2.5	PAVED	100	4.0	4.0	0.4	2.9	140	10.8	5.0	
A7	0.77	0.34	45	2.0	3.2	PAVED	130	4.0	4.0	0.5	3.7	175	11.0	5.0	
A8	0.57	0.27	45	2.0	5.2	GRASS	65	6.0	3.7	0.3	5.5	110	10.6	5.5	
A9	0.28	0.90	70	0.8	13.6	GRASS	385	2.0	2.1	3.0	16.6	455	12.5	12.5	
A10	0.79	0.55	45	2.0	3.0	PAVED	155	0.8	1.8	1.5	4.5	200	11.1	5.0	
A11	0.86	0.36	20	10.0	0.9	PAVED	77	2.2	3.0	0.4	1.3	97	10.5	5.0	
B1	0.63	0.90	50	20.0	2.2	PAVED	220	1.4	2.4	1.5	3.8	270	11.5	5.0	
B2	0.35	0.20	25	20.0	2.5	PAVED	190	6.0	4.9	0.6	3.2	215	11.2	5.0	
B3	0.53	0.41	30	5.0	3.4	PAVED	440	3.8	3.9	1.9	5.2	470	12.6	5.2	
B4	0.63	0.88	20	2.0	3.1	PAVED	280	2.0	2.8	1.6	4.7	300	11.7	5.0	
B5	0.63	0.63	20	2.0	3.1	PAVED	225	2.0	2.8	1.3	4.4	245	11.4	5.0	
B6	0.63	1.14	20	2.0	3.1	PAVED	240	2.0	2.8	1.4	4.5	260	11.4	5.0	
B7	0.75	0.25	40	2.0	3.2	PAVED	240	5.5	4.7	0.9	4.1	280	11.6	5.0	
B8	0.37	0.50	70	8.0	5.6	PAVED	660	2.6	3.2	3.4	9.0	730	14.1	9.0	
B9	0.57	0.41	20	2.0	3.5	PAVED	470	2.6	3.2	2.4	5.9	490	12.7	5.9	
B10	0.42	0.66	80	20.0	4.1	GRASS	30	2.0	2.1	0.2	4.3	110	10.6	5.0	

STORM DRAINAGE SYSTEM DESIGN

Project #: 211400 | Location: Town of Castle Rock | By: K House | Date: 1/24/2023
Project: Affinity at Castle Rock | Plan Date: Phase II Report | Checked: R Littleton | Date: 1/24/2023

TIME OF CONCENTRATION

BASIN DATA			INITIAL/OVERLAND TIME (Ti)			TRAVEL TIME (Tt)					TOTAL	Tc Check (Urbanized Basins)		FINAL Tc	REMARKS
DESIGNATION	C5	AREA (AC)	LENGTH (FT)	SLOPE %	Ti (Min.)*	GRASS/ PAVED	LENGTH (FT)	SLOPE %	VEL. (FPS)**	Tt(Min.)	Ti+Tt(Min.)	LGTH. (FT)	Tc = (L/180) + 10	(minutes)	
OS1	0.10	1.46	70	8.0	7.7	GRASS	50	20.0	6.7	0.1	7.8	120	10.7	7.8	

STORM DRAINAGE SYSTEM DESIGN

HRGreen

Project #: 211400.00 | Location: Town of Castle Rock | By: K House 1/24/2023

Project: Affinity at Castle Rock | Plan Date: Phase II Report | Checked: R Littleton 1/24/2023

RATIONAL METHOD PROCEDURE ~ 5-YEAR DEVELOPED (P1 = 1.43)

			DIRECT RUNOFF						TOTAL RUNOFF					REMARKS
STRUCTURE	DESIGN POINT	BASIN	AREA (AC)	COEFF. (C)	Tc (MINUTES)	C*A	I (IN/HR)	Q (CFS)	SUM AREA (AC)	SUM Tc (MINUTES)	I (IN/HR)	SUM CA	TOTAL Q (CFS)	
LS-A1	1	A1	0.67	0.53	6.5	0.35	4.51	**1.6**						A1
LS-A2	2	A2	0.67	0.46	8.5	0.31	4.12	**1.3**	1.34	8.47	4.12	0.66	2.7	A1 + A2 (total in pipe)
LS-A3	3	A3	0.76	0.18	11.3	0.14	3.68	**0.5**	2.10	11.29	3.68	0.80	2.9	A1 - A3 (total in pipe)
IN-A4	4	A4	0.96	0.31	6.7	0.30	4.47	**1.3**	3.06	11.29	3.68	1.10	4.0	A1 - A4 (total in pipe)
LS-A5	5	A5	0.27	0.54	5.9	0.15	4.62	**0.7**						A5
IN-A5.1	6	A5.1	0.07	0.86	5.0	0.06	4.85	**0.3**	0.34	5.95	4.62	0.21	0.9	A5 - A5.1 (total in pipe)
IN-A6	7	A6	0.26	0.76	5.0	0.20	4.85	**1.0**						
	7.1	A6							3.32	11.29	3.68	1.30	4.8	A5 + A7 (total in pipe)
IN-A7	8	A7	0.34	0.77	5.0	0.26	4.85	**1.3**	4.00	11.29	3.68	1.77	6.5	A1 - A7 (total in pipe)
LS-A8.1/8.2	9	A8	0.27	0.57	5.5	0.15	4.73	**0.7**						A8
LS-A9	10	A9	0.90	0.28	12.5	0.25	3.52	**0.9**						A9
IN-A10	11	A10	0.55	0.79	5.0	0.43	4.85	**2.1**	1.72	12.53	3.52	0.84	2.9	A8 - A10 (total in pipe)
OS-1	12	A11	0.36	0.86	5.0	0.31	4.85	**1.5**	6.08	12.53	3.52	2.91	10.3	A1 - A11 (total to pond)
								0.6						Pond A Release
MH-12	13	B1	0.90	0.63	5.0	0.57	4.85	**2.8**						B1
IN-B2	14	B2	0.20	0.35	5.0	0.07	4.85	**0.3**	1.10	5.00	4.85	0.64	3.1	B1 + B2 (total in pipe)
IN-B3	15	B3	0.41	0.53	5.2	0.22	4.79	**1.0**	1.51	5.25	4.79	0.85	4.1	B1 - B3 (total in pipe)
MH-15	16	B4	0.88	0.63	5.0	0.55	4.85	**2.7**	2.39	5.25	4.79	1.41	6.7	B1 - B4 (total in pipe)
MH-16	17	B5	0.63	0.63	5.0	0.40	4.85	**1.9**	3.02	5.25	4.79	1.80	8.6	B1 - B5 (total in pipe)
MH-17	18	B6	1.14	0.63	5.0	0.72	4.85	**3.5**	4.16	5.25	4.79	2.52	12.1	B1 - B6 (total in pipe)
IN-B7	19	B7	0.25	0.75	5.0	0.19	4.85	**0.9**						B7
IN-B8	20	B8	0.50	0.37	9.0	0.18	4.03	**0.7**						B8
IN-B9	21	B9	0.41	0.57	5.9	0.23	4.64	**1.1**	0.91	9.01	4.03	0.42	1.7	B8 + B9 (total in pipe)
OS-2	22	B10	0.66	0.42	5.0	0.28	4.85	**1.4**	5.98	9.01	4.03	3.41	13.7	B1 - B10 (total to pond)
MH-11	22.1							**0.3**					**0.9**	Pond A + B Release
N/A	23	OS1	1.46	0.10	7.8	0.14	4.24	**0.6**						OS1

FORMULAS:

$I=28.5*P1/(10+Tc)^{0.786}$

STORM DRAINAGE SYSTEM DESIGN

HRGreen

Project #: 211400.00 | Location: Town of Castle Rock | By: K House 1/24/2023
Project: Affinity at Castle Rock | Plan Date: Phase II Report | Checked: R Littleton 1/24/2023

RATIONAL METHOD PROCEDURE ~ 100-YEAR DEVELOPED (P1 = 2.60)

			DIRECT RUNOFF						TOTAL RUNOFF					REMARKS
STRUCTURE	DESIGN POINT	BASIN	AREA (AC)	COEFF. (C)	Tc (MINUTES)	C*A	I (IN/HR)	Q (CFS)	SUM AREA (AC)	SUM Tc (MINUTES)	I (IN/HR)	SUM CA	TOTAL Q (CFS)	
LS-A1	1	A1	0.67	0.72	6.5	0.48	8.20	**3.9**						A1
LS-A2	2	A2	0.67	0.68	8.5	0.45	7.49	**3.4**	1.34	8.47	7.49	0.93	7.0	A1 + A2 (total in pipe)
LS-A3	3	A3	0.76	0.53	11.3	0.40	6.70	**2.7**	2.10	11.29	6.70	1.34	9.0	A1 - A3 (total in pipe)
IN-A4	4	A4	0.96	0.60	6.7	0.58	8.12	**4.7**	3.06	11.29	6.70	1.91	12.8	A1 - A4 (total in pipe)
LS-A5	5	A5	0.27	0.72	5.9	0.19	8.40	**1.6**						A5
IN-A5.1	6	A5.1	0.07	0.89	5.0	0.06	8.82	**0.5**	0.34	10.95	6.78	0.26	1.7	A5 - A5.1 (total in pipe)
IN-A6	7	A6	0.26	0.84	5.0	0.22	8.82	**1.9**						0.0
	7.1	A6							3.32	11.29	6.70	2.13	14.3	A5 + A7 (total in pipe)
IN-A7	8	A7	0.34	0.85	5.0	0.29	8.82	**2.5**	4.00	11.29	6.70	2.68	17.9	A1 - A7 (total in pipe)
LS-A8.1/8.2	9	A8	0.27	0.74	5.5	0.20	8.61	**1.7**						A8
LS-A9	10	A9	0.90	0.58	12.5	0.52	6.41	**3.4**						A9
IN-A10	11	A10	0.55	0.85	5.0	0.47	8.82	**4.1**	1.72	12.53	6.41	1.19	7.6	A8 - A10 (total in pipe)
OS-1	12	A11	0.36	0.89	5.0	0.32	8.82	**2.8**	6.08	12.53	6.41	4.19	26.8	A1 - A11 (total to pond)
								8.0						Pond A Release
MH-12	13	B1	0.90	0.78	5.0	0.70	8.82	**6.2**						B1
IN-B2	14	B2	0.20	0.62	5.0	0.12	8.82	**1.1**	1.10	5.00	8.82	0.83	7.3	B1 + B2 (total in pipe)
IN-B3	15	B3	0.41	0.71	5.2	0.29	8.71	**2.6**	1.51	5.25	8.71	1.12	9.7	B1 - B3 (total in pipe)
MH-15	16	B4	0.88	0.78	5.0	0.69	8.82	**6.1**	2.39	5.25	8.71	1.81	15.7	B1 - B4 (total in pipe)
MH-16	17	B5	0.63	0.78	5.0	0.49	8.82	**4.3**	3.02	5.25	8.71	2.30	20.0	B1 - B5 (total in pipe)
MH-17	18	B6	1.14	0.78	5.0	0.89	8.82	**7.8**	4.16	5.25	8.71	3.19	27.7	B1 - B6 (total in pipe)
IN-B7	19	B7	0.25	0.84	5.0	0.21	8.82	**1.8**						B7
IN-B8	20	B8	0.50	0.63	9.0	0.31	7.32	**2.3**						B8
IN-B9	21	B9	0.41	0.74	5.9	0.30	8.43	**2.5**	0.91	9.01	7.32	0.62	4.5	B8 + B9 (total in pipe)
OS-2	22	B10	0.66	0.66	5.0	0.43	8.82	**3.8**	5.98	9.01	7.32	4.45	32.5	B1 - B10 (total to pond)
MH-11	22.1							**7.9**					**15.9**	Pond A + B Release
N/A	23	OS1	1.46	0.49	7.8	0.71	7.70	**5.5**						OS1

FORMULAS:
I=28.5*P1/(10+Tc)^0.786

Table 6-3. Recommended percentage imperviousness values

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

Table 6-4. Runoff coefficient equations based on NRCS soil group and storm return period

NRCS Soil Group		Storm Return Period					
	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year	500-Year
A	$C_A = 0.84i^{1.302}$	$C_A = 0.86i^{1.276}$	$C_A = 0.87i^{1.232}$	$C_A = 0.88i^{1.124}$	$C_A = 0.85i + 0.025$	$C_A = 0.78i + 0.110$	$C_A = 0.65i + 0.254$
B	$C_B = 0.84i^{1.169}$	$C_B = 0.86i^{1.088}$	$C_B = 0.81i + 0.057$	$C_B = 0.63i + 0.249$	$C_B = 0.56i + 0.328$	$C_B = 0.47i + 0.426$	$C_B = 0.37i + 0.536$
C/D	$C_{C/D} = 0.83i^{1.122}$	$C_{C/D} = 0.82i + 0.035$	$C_{C/D} = 0.74i + 0.132$	$C_{C/D} = 0.56i + 0.319$	$C_{C/D} = 0.49i + 0.393$	$C_{C/D} = 0.41i + 0.484$	$C_{C/D} = 0.32i + 0.588$

Where:

i = % imperviousness (expressed as a decimal)

C_A = Runoff coefficient for Natural Resources Conservation Service (NRCS) HSG A soils

C_B = Runoff coefficient for NRCS HSG B soils

$C_{C/D}$ = Runoff coefficient for NRCS HSG C and D soils.

The values for various catchment imperviousness and storm return periods are presented graphically in Figures 6-1 through 6-3, and are tabulated in Table 6-5. These coefficients were developed for the Denver region to work in conjunction with the time of concentration recommendations in Section 2.4. Use of these coefficients and this procedure outside of the semi-arid climate found in the Denver region may not be valid. The UD-Rational Excel workbook performs all the needed calculations to find the runoff coefficient given the soil type and imperviousness and the reader may want to take advantage of this macro-enabled Excel workbook that is available for download from the UDFCD's website www.udfcd.org.

See Examples 7.1 and 7.2 that illustrate the Rational Method.

Table 6-5. Runoff coefficients, *c*

Total or Effective % Impervious	NRCS Hydrologic Soil Group A						
	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year	500-Year
2%	0.01	0.01	0.01	0.01	0.04	0.13	0.27
5%	0.02	0.02	0.02	0.03	0.07	0.15	0.29
10%	0.04	0.05	0.05	0.07	0.11	0.19	0.32
15%	0.07	0.08	0.08	0.1	0.15	0.23	0.35
20%	0.1	0.11	0.12	0.14	0.2	0.27	0.38
25%	0.14	0.15	0.16	0.19	0.24	0.3	0.42
30%	0.18	0.19	0.2	0.23	0.28	0.34	0.45
35%	0.21	0.23	0.24	0.27	0.32	0.38	0.48
40%	0.25	0.27	0.28	0.32	0.37	0.42	0.51
45%	0.3	0.31	0.33	0.36	0.41	0.46	0.54
50%	0.34	0.36	0.37	0.41	0.45	0.5	0.58
55%	0.39	0.4	0.42	0.45	0.49	0.54	0.61
60%	0.43	0.45	0.47	0.5	0.54	0.58	0.64
65%	0.48	0.5	0.51	0.54	0.58	0.62	0.67
70%	0.53	0.55	0.56	0.59	0.62	0.65	0.71
75%	0.58	0.6	0.61	0.64	0.66	0.69	0.74
80%	0.63	0.65	0.66	0.69	0.71	0.73	0.77
85%	0.68	0.7	0.71	0.74	0.75	0.77	0.8
90%	0.73	0.75	0.77	0.79	0.79	0.81	0.84
95%	0.79	0.81	0.82	0.83	0.84	0.85	0.87
100%	0.84	0.86	0.87	0.88	0.88	0.89	0.9
Total or Effective % Impervious	**NRCS Hydrologic Soil Group B**						
	2-Year	**5-Year**	**10-Year**	**25-Year**	**50-Year**	**100-Year**	**500-Year**
2%	0.01	0.01	0.07	0.26	0.34	0.44	0.54
5%	0.03	0.03	0.1	0.28	0.36	0.45	0.55
10%	0.06	0.07	0.14	0.31	0.38	0.47	0.57
15%	0.09	0.11	0.18	0.34	0.41	0.5	0.59
20%	0.13	0.15	0.22	0.38	0.44	0.52	0.61
25%	0.17	0.19	0.26	0.41	0.47	0.54	0.63
30%	0.2	0.23	0.3	0.44	0.49	0.57	0.65
35%	0.24	0.27	0.34	0.47	0.52	0.59	0.66
40%	0.29	0.32	0.38	0.5	0.55	0.61	0.68
45%	0.33	0.36	0.42	0.53	0.58	0.64	0.7
50%	0.37	0.4	0.46	0.56	0.61	0.66	0.72
55%	0.42	0.45	0.5	0.6	0.63	0.68	0.74
60%	0.46	0.49	0.54	0.63	0.66	0.71	0.76
65%	0.5	0.54	0.58	0.66	0.69	0.73	0.77
70%	0.55	0.58	0.62	0.69	0.72	0.75	0.79
75%	0.6	0.63	0.66	0.72	0.75	0.78	0.81
80%	0.64	0.67	0.7	0.75	0.77	0.8	0.83
85%	0.69	0.72	0.74	0.78	0.8	0.82	0.85
90%	0.74	0.76	0.78	0.81	0.83	0.84	0.87
95%	0.79	0.81	0.82	0.85	0.86	0.87	0.88
100%	0.84	0.86	0.86	0.88	0.89	0.89	0.9

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.

APPENDIX C

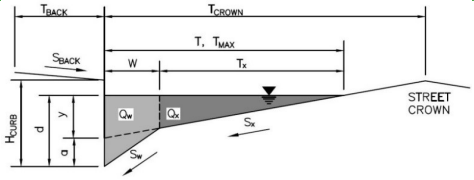
HYDRAULIC CALCULATIONS

STREET CAPACITIES

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

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

Project: **Affinity at Castle Rock**
Inlet ID: **Private Roadway Capacity**



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	10.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.018	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	13.0	ft
Gutter Width	W =	1.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.011	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	13.0	13.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	12.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☑	

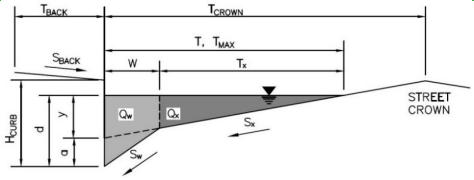
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Spread Criterion MAJOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	**5.3**	**109.1**	**cfs**

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

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

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

Project: **Affinity at Castle Rock**
Inlet ID: **Private Roadway Capacity**



Gutter Geometry:			
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	10.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.018	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	13.0	ft
Gutter Width	W =	1.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.017	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	13.0	13.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	12.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☑	

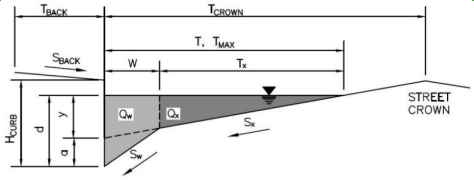
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Spread Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	**6.6**	**128.8**	**cfs**

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

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

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

Project: **Affinity at Castle Rock**
Inlet ID: **Private Roadway Capacity**



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	10.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.018	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	13.0	ft
Gutter Width	W =	1.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.018	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	13.0	13.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	12.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☑	

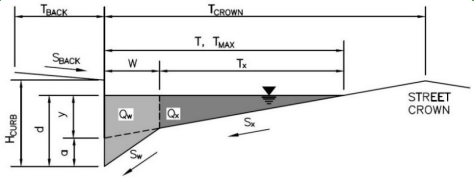
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Spread Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	**6.7**	**126.6**	**cfs**

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

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

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

Project: **Affinity at Castle Rock**
Inlet ID: **Private Roadway Capacity**



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	10.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.018	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	13.0	ft
Gutter Width	W =	1.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.028	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	13.0	13.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	12.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☑	

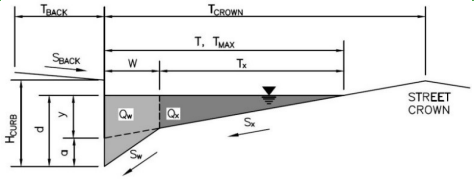
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Spread Criterion MAJOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	**8.4**	**110.9**	**cfs**

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

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

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

Project: **Affinity at Castle Rock**
Inlet ID: **Private Roadway Capacity**



Gutter Geometry:			
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	10.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.018	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	13.0	ft
Gutter Width	W =	1.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.031	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	13.0	13.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	12.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☑	

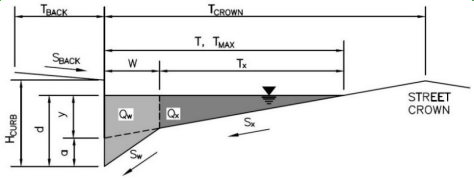
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Spread Criterion MAJOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	**8.8**	**107.6**	**cfs**

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

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

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

Project: **Affinity at Castle Rock**
Inlet ID: **Private Roadway Capacity**



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	10.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.018	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	13.0	ft
Gutter Width	W =	1.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.037	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	13.0	13.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	12.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☑	

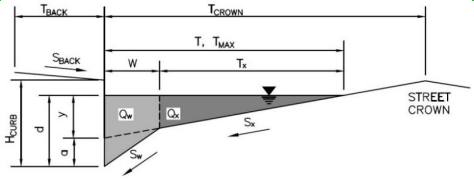
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Spread Criterion MAJOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	**9.7**	**102.0**	**cfs**

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

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

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

Project: **Affinity at Castle Rock**
Inlet ID: **Private Roadway Capacity**



Gutter Geometry:			
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	10.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.018	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	13.0	ft
Gutter Width	W =	1.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.060	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	13.0	13.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	12.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☑	

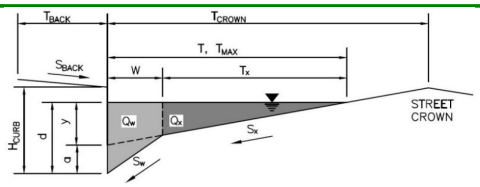
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Spread Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	**12.3**	**88.2**	**cfs**

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

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

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

Project: **Affinity at Castle Rock**
Inlet ID: **Meadows Parkway**



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	10.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.018	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	38.5	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.010	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.010	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	20.0	38.5	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	12.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☑	

MINOR STORM Allowable Capacity is based on Spread Criterion
MAJOR STORM Allowable Capacity is based on Depth Criterion

	Minor Storm	Major Storm	
Q_{allow} =	**5.7**	**203.6**	**cfs**

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

INLET CAPACITIES

STORM DRAINAGE SYSTEM DESIGN

HRGreen

Project #: 211400 | Location: Town of Castle Rock | By: K House | Date: 1/25/2023
Project: Affinity at Castle Rock | Plan Date: Phase II Report | Checked: R Littleton | Date: 1/25/2023

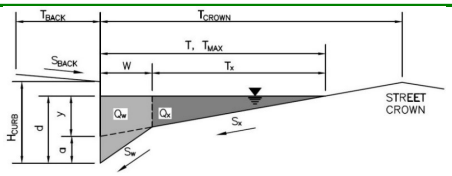
INLET SIZING SUMMARY

		MINOR STORM EVENT (5YR)				MAJOR STORM EVENT (100YR)								
DESIGN POINT	BASIN	ROUTED Q_5 (CFS)	Q_5 + CO (CFS)	CAPTURED Q_5 (CFS)	Q_5 FLOW CO (CFS)	ROUTED Q_{100} (CFS)	Q_{100} + CO (CFS)	CAPTURED Q_{100} (CFS)	Q_{100} FLOW CO (CFS)	STRUCTURE	INLET SIZE	INLET TYPE	DESIGN EVENT	COMMENTS
1	A1	1.6	1.6	**1.6**	-	3.9	3.9	**3.9**	-	LS-A1.0/1.1/1.2	15"	Landscape	100-Year	A1
2	A2	1.3	1.3	**1.3**	-	3.4	3.4	**3.4**	-	LS-A2.1/2.2	15"	Landscape	100-Year	A1 + A2 (total in pipe)
3	A3	0.5	0.5	**0.5**	-	2.7	2.7	**2.7**	-	LS-A3	18"	Landscape	100-Year	A1 - A3 (total in pipe)
4	A4	1.3	1.3	**1.3**	-	4.7	4.7	**4.7**	-	IN-A4	Single	No. 16	100-Year	A1 - A4 (total in pipe)
5	A5	0.7	0.7	**0.7**	-	1.6	1.6	**1.6**	-	LS-A5	15"	Landscape	100-Year	A5
6	A5.1	0.3	0.3	**0.3**	-	0.5	0.5	**0.5**	-	IN-A5.1	Single	No. 16	100-Year	A5 - A5.1 (total in pipe)
7	A6	1.0	1.0	**1.0**	-	1.9	1.9	**1.9**	-	IN-A6	10'	Type-R	100-Year	
8	A7	1.3	1.3	**1.3**	-	2.5	2.5	**2.5**	-	IN-A7	5'	Type-R	100-Year	A1 - A7 (total in pipe)
9	A8	0.7	0.7	**0.7**	-	1.7	1.7	**1.7**	-	LS-A8.1/8.2	12"	Landscape	100-Year	A8
10	A9	0.9	0.9	**0.9**	-	3.4	3.4	**3.4**	-	LS-A9.1	24"	Landscape	100-Year	A9
11	A10	2.1	2.1	**2.1**	-	4.1	4.1	**4.1**	-	IN-A10	Single	No. 16	100-Year	A8 - A10 (total in pipe)
14	B2	0.3	0.3	**0.3**	-	1.1	1.1	**1.1**	-	IN-B2	5'	Type-R	100-Year	B1 + B2 (total in pipe)
15	B3	1.0	1.0	**1.0**	-	2.6	2.6	**2.6**	-	IN-B3	10'	Type-R	100-Year	B1 - B3 (total in pipe)
19	B7	0.9	0.9	**0.9**	-	1.8	1.8	**1.8**	-	IN-B7	Single	No. 16	100-Year	B7
20	B8	0.7	0.7	**0.7**	-	2.3	2.3	**2.3**	-	IN-B8	10'	Type-R	100-Year	B8
21	B9	1.1	1.1	**1.1**	-	2.5	2.5	**2.5**	-	IN-B9	10'	Type-R	100-Year	B8 + B9 (total in pipe)

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

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

Project: **Affinity at Castle Rock**
Inlet ID: **BASIN A4**



Gutter Geometry:

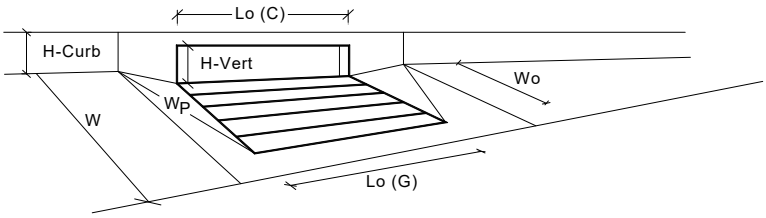
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	9.0		ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.090		ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.013		
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00		inches
Distance from Curb Face to Street Crown	T_{CROWN} =	28.0		ft
Gutter Width	W =	1.00		ft
Street Transverse Slope	S_X =	0.050		ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083		ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000		ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016		

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	28.0	28.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	8.0	inches
Check boxes are not applicable in SUMP conditions		☐	☐	

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	**Q_{allow} =**	**SUMP**	**SUMP**	**cfs**

INLET IN A SUMP OR SAG LOCATION

MHFD-Inlet, Version 5.01 (April 2021)



Design Information (Input)

		MINOR	MAJOR	
Type of Inlet	Type =	Denver No. 16 Combination		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	2.00	2.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1	1	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	6.0	8.0	inches

Grate Information (☐ Override Depths)

		MINOR	MAJOR	
Length of a Unit Grate	L_o (G) =	3.00	3.00	feet
Warning 5 Width of a Unit Grate	W_o =	1.73	1.73	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	0.31	0.31	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	0.50	0.50	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	3.60	3.60	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	0.60	0.60	

Curb Opening Information

		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	3.00	3.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.50	6.50	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	5.25	5.25	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	0.00	0.00	degrees
Warning 1 Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	1.50	1.50	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.70	3.70	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.66	0.66	

Low Head Performance Reduction (Calculated)

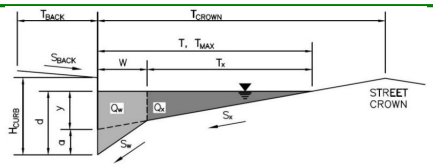
		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	0.451	0.617	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.42	0.58	ft
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	0.94	1.00	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	1.00	1.00	
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	0.94	1.00	

		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	**Q_a =**	**4.1**	**6.4**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	1.3	4.7	cfs

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

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

Project: **Affinity at Castle Rock**
Inlet ID: **Basin A5.1**



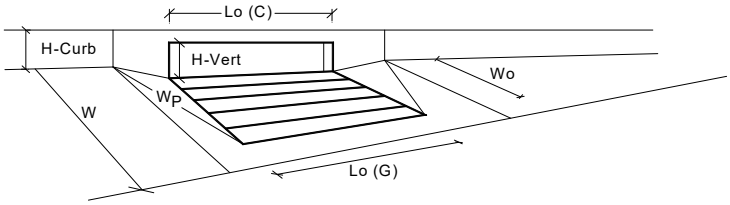
Gutter Geometry:			
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	3.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.002	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.013	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	31.5	ft
Gutter Width	W =	1.00	ft
Street Transverse Slope	S_X =	0.030	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	31.5	31.5	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	6.0	inches
Check boxes are not applicable in SUMP conditions		☐	☐	

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	**Q_{allow} =**	**SUMP**	**SUMP**	**cfs**

INLET IN A SUMP OR SAG LOCATION

MHFD-Inlet, Version 5.01 (April 2021)

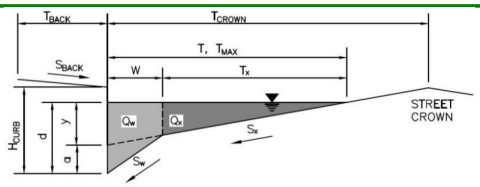


Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	Denver No. 16 Combination		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	2.00	2.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1	1	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	6.0	6.0	inches
Grate Information		MINOR	MAJOR	☐ Override Depths
Length of a Unit Grate	L_o (G) =	3.00	3.00	feet
Warning 5 Width of a Unit Grate	W_o =	1.73	1.73	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	0.31	0.31	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	0.50	0.50	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	3.60	3.60	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	0.60	0.60	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	3.00	3.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.50	6.50	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	5.25	5.25	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	0.00	0.00	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	1.00	1.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.70	3.70	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.66	0.66	
Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	0.451	0.451	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.42	0.42	ft
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	0.94	0.94	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	1.00	1.00	
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	0.94	0.94	
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	**Q_a =**	**4.1**	**4.1**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	0.3	0.5	cfs

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

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

Project: **Affinity at Castle Rock**
Inlet ID: **Basin A6**



Gutter Geometry:			
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	9.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.005	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.018	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	13.5	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.045	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.030	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

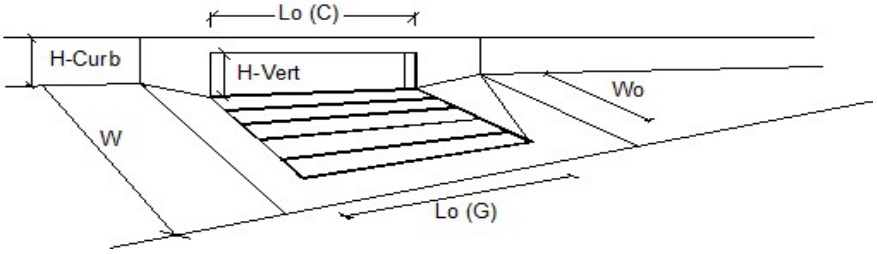
		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	13.5	13.5	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	12.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**11.0**	**43.3**	**cfs**

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

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.01 (April 2021)



Design Information (Input)		MINOR	MAJOR	
Type of Inlet (CDOT Type R Curb Opening)	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	2	2	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	5.00	5.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)	W_o =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	C_f-G =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_f-C =	0.10	0.10	

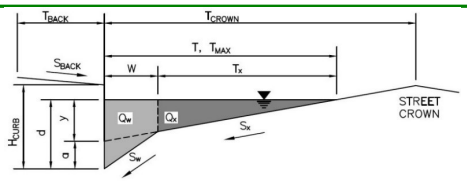
Street Hydraulics: OK - Q < Allowable Street Capacity'		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**1.0**	**1.9**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.0**	**0.0**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**100**	**100**	**%**

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

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

Project: **Affinity at Castle Rock**

Inlet ID: **Basin A7**



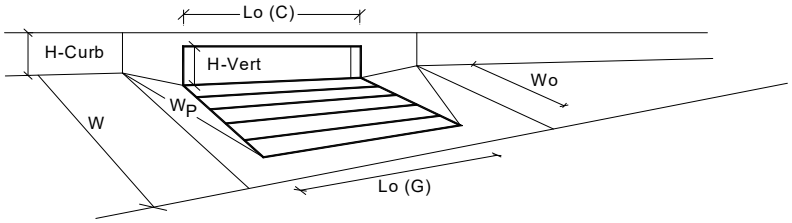
Gutter Geometry:			
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	5.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =		ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.013	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	13.5	ft
Gutter Width	W =	1.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	13.5	13.5	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	12.0	inches
Check boxes are not applicable in SUMP conditions		☐	☐	

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	**Q_{allow} =**	**SUMP**	**SUMP**	**cfs**

INLET IN A SUMP OR SAG LOCATION

MHFD-Inlet, Version 5.01 (April 2021)



Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1	1	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	4.0	4.1	inches

Grate Information		MINOR	MAJOR	☑ Override Depths
Length of a Unit Grate	L_o (G) =	N/A	N/A	feet
Width of a Unit Grate	W_o =	N/A	N/A	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	N/A	N/A	

Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	5.00	5.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	1.00	1.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.67	0.67	

Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	N/A	N/A	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.25	0.26	ft
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	0.51	0.52	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	1.00	1.00	
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	N/A	N/A	

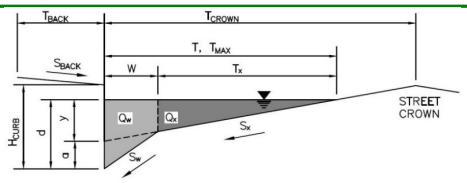
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	**Q_a =**	**2.8**	**2.9**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	1.3	2.5	cfs

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

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

Project: **Affinity at Castle Rock**

Inlet ID: **Basin A10**



Gutter Geometry:

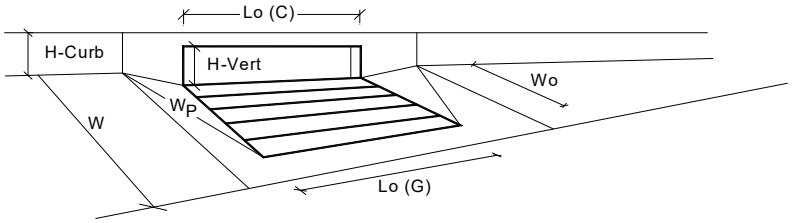
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	5.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.013	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	29.5	ft
Gutter Width	W =	1.00	ft
Street Transverse Slope	S_X =	0.038	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	29.5	29.5	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	8.0	inches
Check boxes are not applicable in SUMP conditions		☐	☐	

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	**Q_{allow} =**	**SUMP**	**SUMP**	**cfs**

INLET IN A SUMP OR SAG LOCATION

MHFD-Inlet, Version 5.01 (April 2021)



Design Information (Input)

		MINOR	MAJOR	
Type of Inlet	Type =	Denver No. 16 Combination		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	2.00	2.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1	1	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	6.0	8.0	inches

Grate Information

		MINOR	MAJOR	Override Depths
Length of a Unit Grate	L_o (G) =	3.00	3.00	feet
Warning 5 Width of a Unit Grate	W_o =	1.73	1.73	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	0.31	0.31	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	0.50	0.50	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	3.60	3.60	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	0.60	0.60	

Curb Opening Information

		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	3.00	3.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.50	6.50	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	5.25	5.25	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	0.00	0.00	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	1.00	1.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.70	3.70	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.66	0.66	

Low Head Performance Reduction (Calculated)

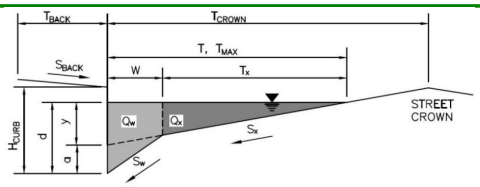
		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	0.451	0.617	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.42	0.58	ft
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	0.94	1.00	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	1.00	1.00	
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	0.94	1.00	

		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	**Q_a =**	**4.1**	**6.4**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	2.1	4.1	cfs

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

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

Project: **Affinity at Castle Rock**
Inlet ID: **Basin B2**



Gutter Geometry:			
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	35.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.013	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	18.5	ft
Gutter Width	W =	1.00	ft
Street Transverse Slope	S_X =	0.050	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.045	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

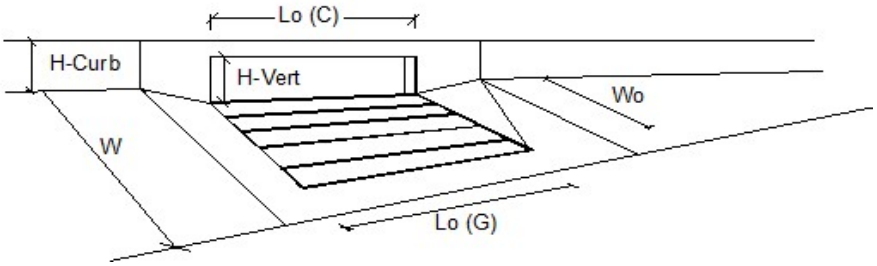
		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	18.5	18.5	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	12.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	**10.7**	**90.8**	**cfs**

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

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.01 (April 2021)



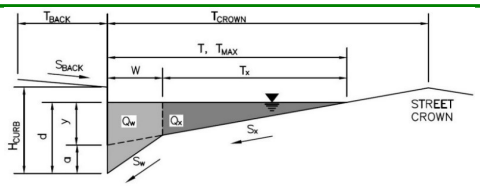
Design Information (Input)		MINOR	MAJOR	
Type of Inlet (CDOT Type R Curb Opening)	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	5.00	5.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)	W_o =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	C_f-G =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_f-C =	0.10	0.10	

Street Hydraulics: OK - Q < Allowable Street Capacity'		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**0.3**	**1.1**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.0**	**0.0**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**100**	**100**	**%**

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

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

Project: **Affinity at Castle Rock**
Inlet ID: **Basin B3**



Gutter Geometry:			
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	10.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.018	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	13.0	ft
Gutter Width	W =	1.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.045	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

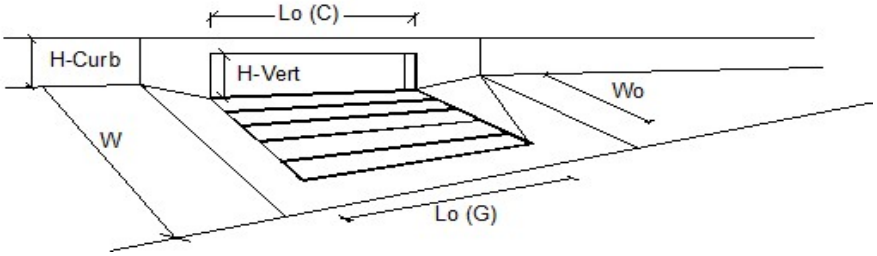
		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	13.0	13.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	12.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☑	

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Spread Criterion MAJOR STORM Allowable Capacity is based on Depth Criterion	**Q_{allow} =**	**10.7**	**96.2**	**cfs**

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

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.01 (April 2021)



Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	2	2	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	5.00	5.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)	W_o =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	C_f-G =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_f-C =	0.10	0.10	

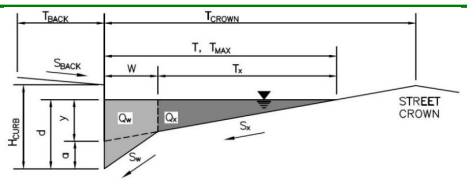
Street Hydraulics: OK - Q < Allowable Street Capacity'		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**1.0**	**2.6**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.0**	**0.0**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**100**	**100**	**%**

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

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

Project: **Affinity at Castle Rock**

Inlet ID: **Basin B7**



Gutter Geometry:

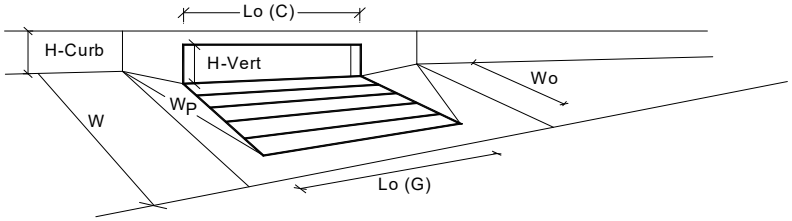
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	9.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.013	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	28.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.035	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	28.0	28.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	6.0	inches
Check boxes are not applicable in SUMP conditions		☐	☐	

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	**Q_{allow} =**	**SUMP**	**SUMP**	**cfs**

INLET IN A SUMP OR SAG LOCATION

MHFD-Inlet, Version 5.01 (April 2021)



Design Information (Input) — Type of Inlet: Denver No. 16 Combination

		MINOR	MAJOR	
Type of Inlet	Type =	Denver No. 16 Combination		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	2.00	2.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1	1	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	6.0	6.0	inches

Grate Information — ☐ Override Depths

		MINOR	MAJOR	
Length of a Unit Grate	L_o (G) =	3.00	3.00	feet
Width of a Unit Grate	W_o =	1.73	1.73	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	0.31	0.31	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	0.50	0.50	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	3.60	3.60	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	0.60	0.60	

Curb Opening Information

		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	3.00	3.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.50	6.50	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	5.25	5.25	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	0.00	0.00	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.70	3.70	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.66	0.66	

Low Head Performance Reduction (Calculated)

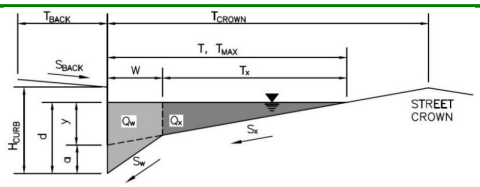
		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	0.523	0.523	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.33	0.33	ft
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	0.94	0.94	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	1.00	1.00	
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	0.94	0.94	

		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	**Q_a =**	**3.9**	**3.9**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	0.9	1.8	cfs

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

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

Project: **Affinity at Castle Rock**
Inlet ID: **Basin B8**



Gutter Geometry:			
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	10.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =		ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.018	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	13.5	ft
Gutter Width	W =	1.00	ft
Street Transverse Slope	S_X =	0.025	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.015	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

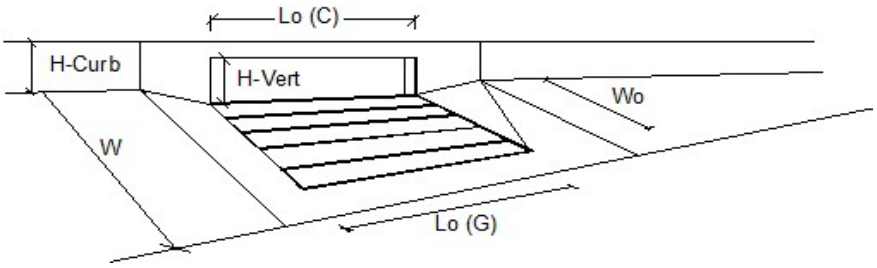
		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	13.5	13.5	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	12.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Spread Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**9.7**	**9.7**	**cfs**

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

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.01 (April 2021)



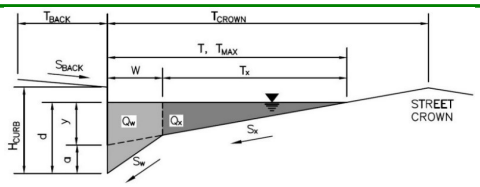
Design Information (Input)		MINOR	MAJOR	
Type of Inlet (CDOT Type R Curb Opening)	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	2	2	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	5.00	5.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)	W_o =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	C_f-G =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_f-C =	0.10	0.10	

Street Hydraulics: OK - Q < Allowable Street Capacity'		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**0.7**	**2.3**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.0**	**0.0**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**100**	**100**	**%**

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

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

Project: **Affinity at Castle Rock**
Inlet ID: **Basin B9**



Gutter Geometry:			
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	10.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.018	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	13.0	ft
Gutter Width	W =	1.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.015	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

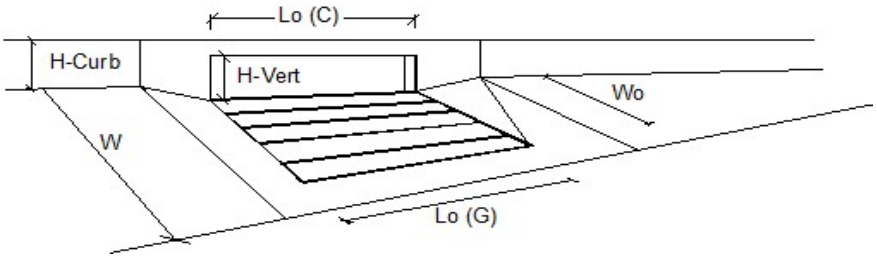
		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	13.0	13.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	12.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☑	

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Spread Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	**Q_{allow} =**	**6.2**	**127.4**	**cfs**

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

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.01 (April 2021)



Design Information (Input)		MINOR	MAJOR	
Type of Inlet (CDOT Type R Curb Opening)	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	2	2	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	5.00	5.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)	W_o =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	C_f-G =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_f-C =	0.10	0.10	

Street Hydraulics: OK - Q < Allowable Street Capacity'		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**1.1**	**2.5**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.0**	**0.0**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**100**	**100**	**%**

Basin A1 - LS-A1.0, A1.1, A1.2

Nyloplast Inlet Capacity Table

DISCLAIMER: SAFETY FACTORS ARE NOT INCLUDED IN THESE CALCULATIONS. ACTUAL CALCULATIONS SHOULD BE CARRIED OUT AND VERIFIED BY THE DESIGN ENGINEER TAKING INTO ACCOUNT ALL LOCAL CONDITIONS. NYLOPLAST RECOMMENDS USING A MINIMUM SAFETY FACTOR OF 1.25 FOR PAVED AREAS AND 2.0 FOR TURF AREAS. ADS/NYLOPLAST IS NOT RESPONSIBLE FOR MISUSE OF THIS TOOL.

Input	
Type of Grate	15" Standard
Head (ft)	0.2

Properties	
Orifice Flow Area (in)	**92.70**
Orifice Flow Area (ft)	**0.64**
Weir Flow Perimeter (in)	**54.81**
Weir Flow Perimeter (ft)	**4.57**

Solution	
Capacity (cfs)	**1.36**
Capacity (gpm)	**610.56**

Required
1.3

$Q_{weir} = CLH^{3/2}$

$C = 3.33\ Weir\ Discharge\ Coefficient$

$L = Perimeter\ of\ Grate\ Opening\ (ft)$

$H = Flow\ Height\ of\ Water\ Surface\ Above\ Weir\ (ft)$

$Q_{orifice} = CA\sqrt{2gh}$

$C = 0.60\ Orifice\ Discharge\ Coefficient$

$A = Area\ of\ the\ Orifice\ (ft^2)$

$g = Gravitational\ Constant\ \left(32.2\frac{ft}{s^2}\right)$

$H = Depth\ of\ Water\ Above\ Center\ of\ Orifice\ (ft)$

REV 2.1.21

Basin A2 - LS-A2.1, A2.2

Nyloplast Inlet Capacity Table

DISCLAIMER: SAFETY FACTORS ARE NOT INCLUDED IN THESE CALCULATIONS. ACTUAL CALCULATIONS SHOULD BE CARRIED OUT AND VERIFIED BY THE DESIGN ENGINEER TAKING INTO ACCOUNT ALL LOCAL CONDITIONS. NYLOPLAST RECOMMENDS USING A MINIMUM SAFETY FACTOR OF 1.25 FOR PAVED AREAS AND 2.0 FOR TURF AREAS. ADS/NYLOPLAST IS NOT RESPONSIBLE FOR MISUSE OF THIS TOOL.

Input	
Type of Grate	15" Standard
Head (ft)	0.31

Properties	
Orifice Flow Area (in)	**92.70**
Orifice Flow Area (ft)	**0.64**
Weir Flow Perimeter (in)	**54.81**
Weir Flow Perimeter (ft)	**4.57**

Solution	
Capacity (cfs)	**1.71**
Capacity (gpm)	**769.27**

Required
1.7

$$Q_{weir} = CLH^{3/2}$$

$C = 3.33$ *Weir Discharge Coefficient*

$L =$ *Perimeter of Grate Opening* (ft)

$H =$ *Flow Height of Water Surface Above Weir* (ft)

$$Q_{orifice} = CA\sqrt{2gh}$$

$C = 0.60$ *Orifice Discharge Coefficient*

$A =$ *Area of the Orifice* (ft^2)

$g =$ *Gravitational Constant* $\left(32.2\frac{ft}{s^2}\right)$

$H =$ *Depth of Water Above Center of Orifice* (ft)

REV 2.1.21

Basin A3 - LS-A3

Nyloplast Inlet Capacity Table

DISCLAIMER: SAFETY FACTORS ARE NOT INCLUDED IN THESE CALCULATIONS. ACTUAL CALCULATIONS SHOULD BE CARRIED OUT AND VERIFIED BY THE DESIGN ENGINEER TAKING INTO ACCOUNT ALL LOCAL CONDITIONS. NYLOPLAST RECOMMENDS USING A MINIMUM SAFETY FACTOR OF 1.25 FOR PAVED AREAS AND 2.0 FOR TURF AREAS. ADS/NYLOPLAST IS NOT RESPONSIBLE FOR MISUSE OF THIS TOOL.

Input	
Type of Grate	18" Standard
Head (ft)	0.5

Properties	
Orifice Flow Area (in)	**116.72**
Orifice Flow Area (ft)	**0.81**
Weir Flow Perimeter (in)	**52.04**
Weir Flow Perimeter (ft)	**4.34**

Solution		Required
Capacity (cfs)	**2.74**	2.7
Capacity (gpm)	**1230.13**	

$$Q_{weir} = CLH^{3/2}$$

$C = 3.33$ *Weir Discharge Coefficient*

$L =$ *Perimeter of Grate Opening* (ft)

$H =$ *Flow Height of Water Surface Above Weir* (ft)

$$Q_{orifice} = CA\sqrt{2gh}$$

$C = 0.60$ *Orifice Discharge Coefficient*

$A =$ *Area of the Orifice* (ft^2)

$g =$ *Gravitational Constant* $\left(32.2\frac{ft}{s^2}\right)$

$H =$ *Depth of Water Above Center of Orifice* (ft)

REV 2.1.21

Basin A5 - LS-A5

Nyloplast Inlet Capacity Table

DISCLAIMER: SAFETY FACTORS ARE NOT INCLUDED IN THESE CALCULATIONS. ACTUAL CALCULATIONS SHOULD BE CARRIED OUT AND VERIFIED BY THE DESIGN ENGINEER TAKING INTO ACCOUNT ALL LOCAL CONDITIONS. NYLOPLAST RECOMMENDS USING A MINIMUM SAFETY FACTOR OF 1.25 FOR PAVED AREAS AND 2.0 FOR TURF AREAS. ADS/NYLOPLAST IS NOT RESPONSIBLE FOR MISUSE OF THIS TOOL.

Input	
Type of Grate	15" Standard
Head (ft)	0.3

Properties	
Orifice Flow Area (in)	**92.70**
Orifice Flow Area (ft)	**0.64**
Weir Flow Perimeter (in)	**54.81**
Weir Flow Perimeter (ft)	**4.57**

Solution	
Capacity (cfs)	**1.69**
Capacity (gpm)	**756.77**

Required
1.6

$Q_{weir} = CLH^{3/2}$

$C = 3.33\ Weir\ Discharge\ Coefficient$

$L = Perimeter\ of\ Grate\ Opening\ (ft)$

$H = Flow\ Height\ of\ Water\ Surface\ Above\ Weir\ (ft)$

$Q_{orifice} = CA\sqrt{2gh}$

$C = 0.60\ Orifice\ Discharge\ Coefficient$

$A = Area\ of\ the\ Orifice\ (ft^2)$

$g = Gravitational\ Constant\ \left(32.2\frac{ft}{s^2}\right)$

$H = Depth\ of\ Water\ Above\ Center\ of\ Orifice\ (ft)$

REV 2.1.21

Basin A8 - LS-A8.1, A8.2

Nyloplast Inlet Capacity Table

DISCLAIMER: SAFETY FACTORS ARE NOT INCLUDED IN THESE CALCULATIONS. ACTUAL CALCULATIONS SHOULD BE CARRIED OUT AND VERIFIED BY THE DESIGN ENGINEER TAKING INTO ACCOUNT ALL LOCAL CONDITIONS. NYLOPLAST RECOMMENDS USING A MINIMUM SAFETY FACTOR OF 1.25 FOR PAVED AREAS AND 2.0 FOR TURF AREAS. ADS/NYLOPLAST IS NOT RESPONSIBLE FOR MISUSE OF THIS TOOL.

Input	
Type of Grate	12" Standard
Head (ft)	0.2

Properties	
Orifice Flow Area (in)	**60.62**
Orifice Flow Area (ft)	**0.42**
Weir Flow Perimeter (in)	**43.75**
Weir Flow Perimeter (ft)	**3.65**

Solution		Required
Capacity (cfs)	**0.90**	0.9
Capacity (gpm)	**404.07**	

$$Q_{weir} = CLH^{3/2}$$

$C = 3.33$ *Weir Discharge Coefficient*

$L =$ *Perimeter of Grate Opening* (ft)

$H =$ *Flow Height of Water Surface Above Weir* (ft)

$$Q_{orifice} = CA\sqrt{2gh}$$

$C = 0.60$ *Orifice Discharge Coefficient*

$A =$ *Area of the Orifice* (ft^2)

$g =$ *Gravitational Constant* $\left(32.2\frac{ft}{s^2}\right)$

$H =$ *Depth of Water Above Center of Orifice* (ft)

REV 2.1.21

Basin A9 - LS-A9.1

Nyloplast Inlet Capacity Table

DISCLAIMER: SAFETY FACTORS ARE NOT INCLUDED IN THESE CALCULATIONS. ACTUAL CALCULATIONS SHOULD BE CARRIED OUT AND VERIFIED BY THE DESIGN ENGINEER TAKING INTO ACCOUNT ALL LOCAL CONDITIONS. NYLOPLAST RECOMMENDS USING A MINIMUM SAFETY FACTOR OF 1.25 FOR PAVED AREAS AND 2.0 FOR TURF AREAS. ADS/NYLOPLAST IS NOT RESPONSIBLE FOR MISUSE OF THIS TOOL.

Input	
Type of Grate	24" Standard
Head (ft)	0.3

Properties	
Orifice Flow Area (in)	**194.60**
Orifice Flow Area (ft)	**1.34**
Weir Flow Perimeter (in)	**77.04**
Weir Flow Perimeter (ft)	**6.42**

Solution	
Capacity (cfs)	**3.51**
Capacity (gpm)	**1576.57**

Required
3.4

$Q_{weir} = CLH^{3/2}$

$C = 3.33\ Weir\ Discharge\ Coefficient$

$L = Perimeter\ of\ Grate\ Opening\ (ft)$

$H = Flow\ Height\ of\ Water\ Surface\ Above\ Weir\ (ft)$

$Q_{orifice} = CA\sqrt{2gh}$

$C = 0.60\ Orifice\ Discharge\ Coefficient$

$A = Area\ of\ the\ Orifice\ (ft^2)$

$g = Gravitational\ Constant\ \left(32.2\frac{ft}{s^2}\right)$

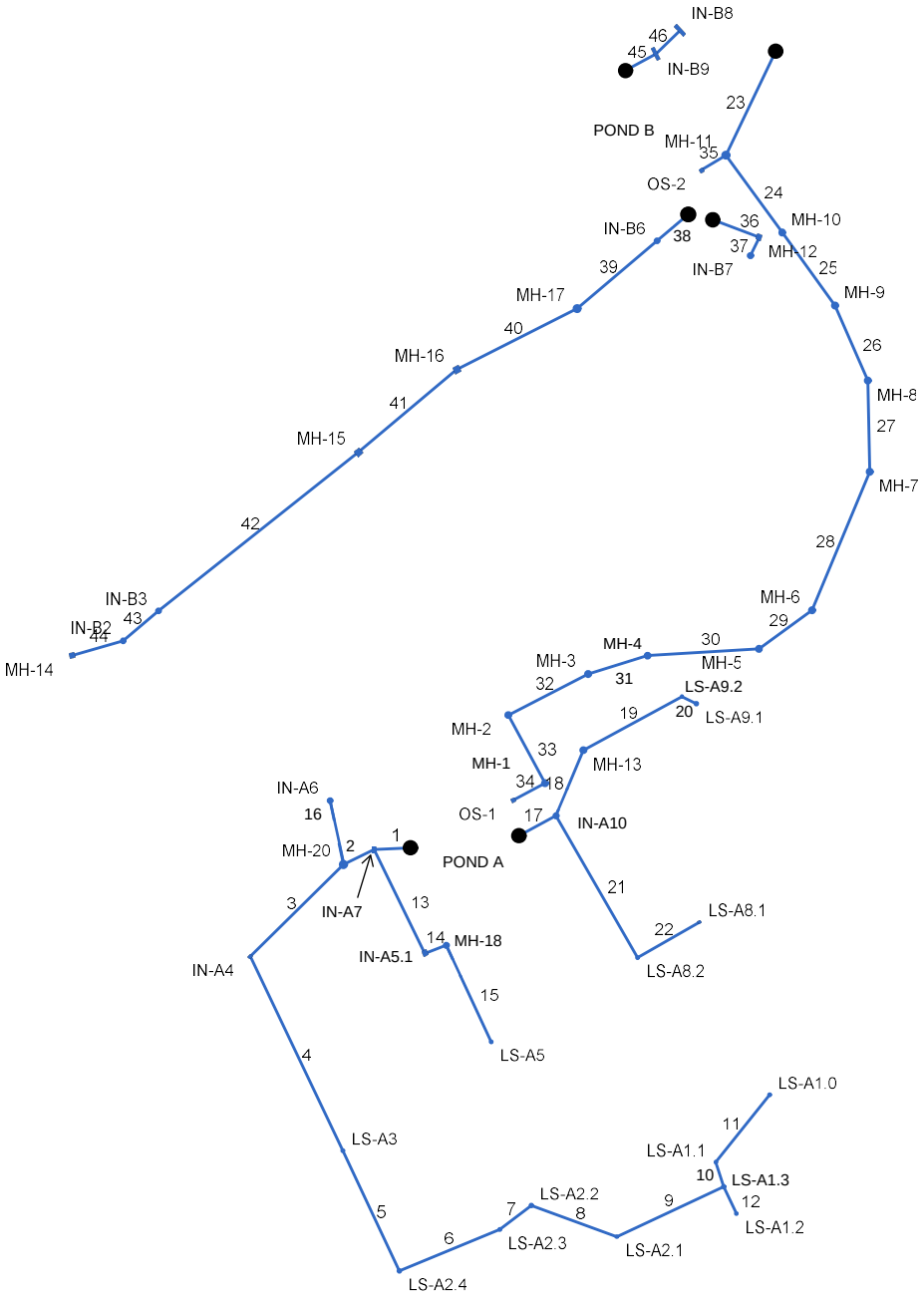
$H = Depth\ of\ Water\ Above\ Center\ of\ Orifice\ (ft)$

REV 2.1.21

STORM SEWER CAPACITIES AND HYDRAULIC GRADE LINES

HRGreen

Hydraflow Storm Sewers Extension for Autodesk® Civil 3D® Plan



Project File: Storm_100_KLH.stm	Number of lines: 46	Date: 3/28/2023

Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line Size (in)	Line shape	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line Slope (%)	HGL Down (ft)	HGL Up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns Line No.	Junction Type
1	P-26	6.50	24	Cir	28.561	6076.93	6077.86	3.255	6077.96	6078.40	n/a	6078.40 j	End	Curb-Horiz
2	P-(13)	4.80	24	Cir	27.403	6078.06	6078.53	1.714	6078.60	6079.07	n/a	6079.07	1	Manhole
3	P-25	4.00	18	Cir	104.169	6079.03	6081.09	1.978	6079.56	6081.62	n/a	6081.62	2	Combination
4	P-24	2.90	18	Cir	171.472	6081.29	6088.70	4.321	6081.66	6089.07	n/a	6089.07	3	DropGrate
5	P-23	2.70	15	Cir	106.101	6088.95	6089.90	0.895	6089.48	6090.43	n/a	6090.43	4	DropGrate
6	P-21	2.70	15	Cir	86.247	6090.10	6090.53	0.498	6090.73	6091.16	n/a	6091.16	5	DropGrate
7	P-(19)	2.70	15	Cir	31.498	6090.73	6090.88	0.476	6091.36	6091.51	n/a	6091.51	6	DropGrate
8	P-20	2.70	15	Cir	72.351	6091.08	6091.45	0.512	6091.70	6092.07	n/a	6092.07	7	DropGrate
9	P-43 (1)	1.60	12	Cir	93.897	6091.65	6092.13	0.511	6092.17	6092.65	n/a	6092.65	8	DropGrate
10	P-43	0.55	12	Cir	20.427	6092.33	6092.54	1.028	6092.65	6092.78	n/a	6092.78 j	9	DropGrate
11	P-(22)	0.55	12	Cir	68.726	6092.54	6092.87	0.480	6092.83	6093.17	n/a	6093.17	10	DropGrate
12	P-(16)	0.55	12	Cir	23.749	6092.33	6092.79	1.937	6092.65	6093.00	n/a	6093.00 j	9	DropGrate
13	P-28	0.90	12	Cir	91.988	6078.39	6080.29	2.065	6078.67	6080.57	n/a	6080.57	1	Manhole
14	P-(15)	0.90	12	Cir	18.191	6080.48	6080.67	1.044	6080.82	6081.01	n/a	6081.01	13	Combination
15	P-(14)	0.70	12	Cir	84.737	6080.87	6082.29	1.676	6081.11	6082.53	n/a	6082.53	14	DropGrate
16	P-27	1.00	18	Cir	52.035	6078.43	6078.69	0.499	6079.07	6079.06	n/a	6079.06	2	Curb-Horiz
17	P-31	2.90	18	Cir	33.442	6076.77	6078.42	4.934	6077.96	6078.78	n/a	6078.78 j	End	Combination
18	P-30 (3) (2) (1)	0.90	12	Cir	56.713	6078.92	6080.34	2.504	6079.17	6080.59	n/a	6080.59	17	Manhole
19	P-30	0.90	12	Cir	89.174	6080.54	6082.94	2.691	6080.78	6083.18	n/a	6083.18	18	DropGrate
20	P-29	0.90	12	Cir	12.792	6083.14	6083.40	2.031	6083.40	6083.66	n/a	6083.66	19	DropGrate
21	P-32	0.70	12	Cir	130.382	6080.02	6080.97	0.729	6080.32	6081.27	n/a	6081.27	17	DropGrate
22	P-(21)	0.70	12	Cir	56.764	6081.17	6082.56	2.449	6081.39	6082.78	n/a	6082.78	21	DropGrate
23	P-(1)	0.90	30	Cir	91.850	6058.80	6061.51	2.950	6059.00	6061.71	n/a	6061.71	End	Manhole
24	P-39 (1)	0.60	18	Cir	76.303	6062.51	6065.70	4.181	6062.68	6065.87	n/a	6065.87	23	Manhole

Project File: Storm_5.stm | Number of lines: 46 | Run Date: 3/29/2023

NOTES: Return period = 5 Yrs. ; j - Line contains hyd. jump.

Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line Size (in)	Line shape	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line Slope (%)	HGL Down (ft)	HGL Up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns Line No.	Junction Type
25	P-39	0.60	18	Cir	71.690	6066.10	6069.09	4.170	6066.27	6069.26	n/a	6069.26	24	Manhole
26	P-37	0.60	18	Cir	65.299	6069.29	6070.52	1.884	6069.50	6070.73	n/a	6070.73	25	Manhole
27	P-35	0.60	18	Cir	72.745	6070.72	6071.09	0.508	6071.01	6071.38	0.04	6071.43	26	Manhole
28	P-18	0.60	18	Cir	119.522	6071.29	6071.88	0.494	6071.58	6072.17	n/a	6072.23 j	27	Manhole
29	P-5	0.60	18	Cir	52.388	6072.08	6072.34	0.496	6072.37	6072.63	n/a	6072.69 j	28	Manhole
30	P-3	0.60	18	Cir	88.678	6072.54	6072.99	0.508	6072.83	6073.28	0.03	6073.31	29	Manhole
31	P-(9)	0.60	18	Cir	49.264	6073.19	6073.43	0.488	6073.48	6073.72	n/a	6073.74 j	30	Manhole
32	P-1	0.60	18	Cir	71.428	6073.63	6073.99	0.504	6073.92	6074.28	n/a	6074.38 j	31	Manhole
33	P-7 (1)	0.60	18	Cir	61.773	6074.19	6074.50	0.502	6074.48	6074.79	n/a	6074.89 j	32	Manhole
34	P-7	0.60	18	Cir	28.950	6074.70	6074.86	0.552	6074.98	6075.14	n/a	6075.14	33	Grate
35	P-(2)	0.30	18	Cir	22.805	6061.89	6062.00	0.482	6062.10	6062.21	0.06	6062.27	23	Grate
36	P-(12)	0.90	18	Cir	39.367	6062.83	6065.77	7.468	6064.00	6065.95	n/a	6065.95 j	End	Manhole
37	P-(11)	0.90	18	Cir	16.043	6067.77	6068.30	3.302	6067.99	6068.52	n/a	6068.52	36	Combination
38	P-(8) (2)	12.10	24	Cir	32.536	6062.79	6063.00	0.645	6064.00	6064.19	n/a	6064.19	End	Grate
39	P-(8)	8.60	24	Cir	83.192	6063.20	6063.62	0.505	6064.24	6064.66	n/a	6064.66	38	Manhole
40	P-(7)	8.60	24	Cir	107.619	6063.81	6064.35	0.502	6064.85	6065.39	n/a	6065.39	39	Manhole
41	P-(6)	6.70	24	Cir	102.145	6064.55	6065.06	0.500	6065.45	6065.96	n/a	6065.96	40	Manhole
42	P-(5)	4.10	24	Cir	203.268	6065.26	6066.27	0.497	6065.96	6066.96	n/a	6066.96	41	Curb-Horiz
43	P-(4)	3.10	24	Cir	36.662	6066.47	6066.65	0.490	6067.07	6067.25	n/a	6067.25	42	Curb-Horiz
44	P-(3)	2.80	18	Cir	42.332	6067.35	6071.38	9.519	6067.65	6071.68	n/a	6071.68	43	Manhole
45	P-42	1.70	18	Cir	27.579	6063.17	6063.72	1.995	6064.00	6064.06	n/a	6064.06 j	End	Curb-Horiz
46	P-41	0.70	18	Cir	26.667	6063.92	6064.45	1.989	6064.14	6064.67	n/a	6064.67	45	Curb-Horiz

Project File: Storm_5.stm | Number of lines: 46 | Run Date: 3/29/2023

NOTES: Return period = 5 Yrs. ; j - Line contains hyd. jump.

Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line Size (in)	Line shape	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line Slope (%)	HGL Down (ft)	HGL Up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns Line No.	Junction Type
1	P-26	17.90	24	Cir	28.561	6076.93	6077.86	3.255	6080.56*	6080.74*	0.76	6081.50	End	Curb-Horiz
2	P-(13)	14.30	24	Cir	27.403	6078.06	6078.53	1.714	6081.50*	6081.61*	0.32	6081.93	1	Manhole
3	P-25	12.80	18	Cir	104.169	6079.03	6081.09	1.978	6081.93*	6083.48*	1.17	6084.64	2	Combination
4	P-24	9.00	18	Cir	171.472	6081.29	6088.70	4.321	6084.64	6089.86	n/a	6089.86 j	3	DropGrate
5	P-23	7.00	15	Cir	106.101	6088.95	6089.90	0.895	6089.94	6090.89	n/a	6090.89	4	DropGrate
6	P-21	7.00	15	Cir	86.247	6090.10	6090.53	0.498	6091.35*	6092.08*	0.25	6092.33	5	DropGrate
7	P-(19)	7.00	15	Cir	31.498	6090.73	6090.88	0.476	6092.33*	6092.59*	0.66	6093.25	6	DropGrate
8	P-20	5.60	15	Cir	72.351	6091.08	6091.45	0.512	6093.25*	6093.64*	0.37	6094.01	7	DropGrate
9	P-43 (1)	3.90	12	Cir	93.897	6091.65	6092.13	0.511	6094.01*	6094.81*	0.58	6095.39	8	DropGrate
10	P-43	2.60	12	Cir	20.427	6092.33	6092.54	1.028	6095.39*	6095.47*	0.22	6095.69	9	DropGrate
11	P-(22)	1.30	12	Cir	68.726	6092.54	6092.87	0.480	6095.69*	6095.75*	0.04	6095.79	10	DropGrate
12	P-(16)	1.30	12	Cir	23.749	6092.33	6092.79	1.937	6095.39*	6095.41*	0.04	6095.45	9	DropGrate
13	P-28	1.70	12	Cir	91.988	6078.39	6080.29	2.065	6081.50*	6081.71*	0.07	6081.78	1	Manhole
14	P-(15)	1.70	12	Cir	18.191	6080.48	6080.67	1.044	6081.78*	6081.82*	0.11	6081.93	13	Combination
15	P-(14)	1.60	12	Cir	84.737	6080.87	6082.29	1.676	6081.93	6082.83	n/a	6082.83 j	14	DropGrate
16	P-27	1.90	18	Cir	52.035	6078.43	6078.69	0.499	6081.93*	6081.95*	0.02	6081.96	2	Curb-Horiz
17	P-31	7.60	18	Cir	33.442	6076.77	6078.42	4.934	6080.56*	6080.74*	0.43	6081.17	End	Combination
18	P-30 (3) (2) (1)	3.40	12	Cir	56.713	6078.92	6080.34	2.504	6081.17*	6081.54*	0.20	6081.73	17	Manhole
19	P-30	3.40	12	Cir	89.174	6080.54	6082.94	2.691	6081.73	6083.73	n/a	6083.73 j	18	DropGrate
20	P-29	3.40	12	Cir	12.792	6083.14	6083.40	2.031	6083.73	6083.94	n/a	6083.94	19	DropGrate
21	P-32	1.70	12	Cir	130.382	6080.02	6080.97	0.729	6081.17	6081.52	n/a	6081.52 j	17	DropGrate
22	P-(21)	1.70	12	Cir	56.764	6081.17	6082.56	2.449	6081.52	6082.91	n/a	6082.91	21	DropGrate
23	P-(1)	15.90	30	Cir	91.850	6058.80	6061.51	2.950	6059.61	6062.32	n/a	6062.32	End	Manhole
24	P-39 (1)	8.00	18	Cir	76.303	6062.51	6065.70	4.181	6063.14	6066.33	n/a	6066.33	23	Manhole

Project File: Storm_100_KLH.stm | Number of lines: 46 | Run Date: 3/28/2023

NOTES: Return period = 100 Yrs. ; *Surcharged (HGL above crown). ; j - Line contains hyd. jump.

Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line Size (in)	Line shape	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line Slope (%)	HGL Down (ft)	HGL Up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns Line No.	Junction Type
25	P-39	8.00	18	Cir	71.690	6066.10	6069.09	4.170	6066.74	6069.73	n/a	6069.73	24	Manhole
26	P-37	8.00	18	Cir	65.299	6069.29	6070.52	1.884	6070.09	6071.32	n/a	6071.32	25	Manhole
27	P-35	8.00	18	Cir	72.745	6070.72	6071.09	0.508	6072.08	6072.45	0.16	6072.61	26	Manhole
28	P-18	8.00	18	Cir	119.522	6071.29	6071.88	0.494	6072.79*	6073.48*	0.18	6073.67	27	Manhole
29	P-5	8.00	18	Cir	52.388	6072.08	6072.34	0.496	6073.67*	6073.97*	0.19	6074.16	28	Manhole
30	P-3	8.00	18	Cir	88.678	6072.54	6072.99	0.508	6074.16*	6074.68*	0.09	6074.77	29	Manhole
31	P-(9)	8.00	18	Cir	49.264	6073.19	6073.43	0.488	6074.77*	6075.05*	0.07	6075.12	30	Manhole
32	P-1	8.00	18	Cir	71.428	6073.63	6073.99	0.504	6075.12	6075.49	0.32	6075.81	31	Manhole
33	P-7 (1)	8.00	18	Cir	61.773	6074.19	6074.50	0.502	6075.81*	6076.16*	0.32	6076.48	32	Manhole
34	P-7	8.00	18	Cir	28.950	6074.70	6074.86	0.552	6076.48*	6076.65*	0.32	6076.97	33	Grate
35	P-(2)	7.90	18	Cir	22.805	6061.89	6062.00	0.482	6063.39	6063.50	0.31	6063.81	23	Grate
36	P-(12)	1.80	18	Cir	39.367	6062.83	6065.77	7.468	6066.46	6066.43	0.09	6066.52	End	Manhole
37	P-(11)	1.80	18	Cir	16.043	6067.77	6068.30	3.302	6068.08	6068.61	n/a	6068.61	36	Combination
38	P-(8) (2)	27.70	24	Cir	32.536	6062.79	6063.00	0.645	6066.46*	6066.95*	0.60	6067.55	End	Grate
39	P-(8)	20.00	24	Cir	83.192	6063.20	6063.62	0.505	6067.55*	6068.21*	0.18	6068.38	38	Manhole
40	P-(7)	20.00	24	Cir	107.619	6063.81	6064.35	0.502	6068.38*	6069.22*	0.17	6069.39	39	Manhole
41	P-(6)	15.70	24	Cir	102.145	6064.55	6065.06	0.500	6069.39*	6069.89*	0.06	6069.94	40	Manhole
42	P-(5)	9.70	24	Cir	203.268	6065.26	6066.27	0.497	6069.94*	6070.32*	0.07	6070.39	41	Curb-Horiz
43	P-(4)	7.30	24	Cir	36.662	6066.47	6066.65	0.490	6070.39*	6070.43*	0.06	6070.49	42	Curb-Horiz
44	P-(3)	6.20	18	Cir	42.332	6067.35	6071.38	9.519	6070.49	6072.34	n/a	6072.34 j	43	Manhole
45	P-42	4.50	18	Cir	27.579	6063.17	6063.72	1.995	6066.46*	6066.51*	0.05	6066.56	End	Curb-Horiz
46	P-41	2.30	18	Cir	26.667	6063.92	6064.45	1.989	6066.56*	6066.57*	0.03	6066.60	45	Curb-Horiz

Project File: Storm_100_KLH.stm | Number of lines: 46 | Run Date: 3/28/2023

NOTES: Return period = 100 Yrs. ; *Surcharged (HGL above crown). ; j - Line contains hyd. jump.

OPEN CHANNEL AND SWALE CAPACITIES

Worksheet for Swale A3

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.035	
Channel Slope	3.40	%
Left Side Slope	18.00	ft/ft (H:V)
Right Side Slope	18.00	ft/ft (H:V)
Discharge	2.70	cfs

Results

Normal Depth	0.27	ft
Flow Area	1.31	ft²
Wetted Perimeter	9.73	ft
Hydraulic Radius	0.13	ft
Top Width	9.72	ft
Critical Depth	0.27	ft
Critical Slope	3.49	%
Velocity	2.06	ft/s
Velocity Head	0.07	ft
Specific Energy	0.34	ft
Froude Number	0.99	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.27	ft
Critical Depth	0.27	ft
Channel Slope	3.40	%
Critical Slope	3.49	%

Cross Section for Swale A3

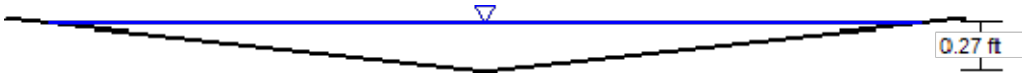
Project Description

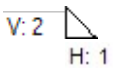
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.035	
Channel Slope	3.40	%
Normal Depth	0.27	ft
Left Side Slope	18.00	ft/ft (H:V)
Right Side Slope	18.00	ft/ft (H:V)
Discharge	2.70	cfs

Cross Section Image





Worksheet for Swale A9

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.035	
Channel Slope	2.00	%
Left Side Slope	20.00	ft/ft (H:V)
Right Side Slope	20.00	ft/ft (H:V)
Discharge	3.40	cfs

Results

Normal Depth	0.31	ft
Flow Area	1.95	ft²
Wetted Perimeter	12.52	ft
Hydraulic Radius	0.16	ft
Top Width	12.50	ft
Critical Depth	0.28	ft
Critical Slope	3.43	%
Velocity	1.74	ft/s
Velocity Head	0.05	ft
Specific Energy	0.36	ft
Froude Number	0.78	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.31	ft
Critical Depth	0.28	ft
Channel Slope	2.00	%
Critical Slope	3.43	%

Cross Section for Swale A9

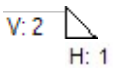
Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

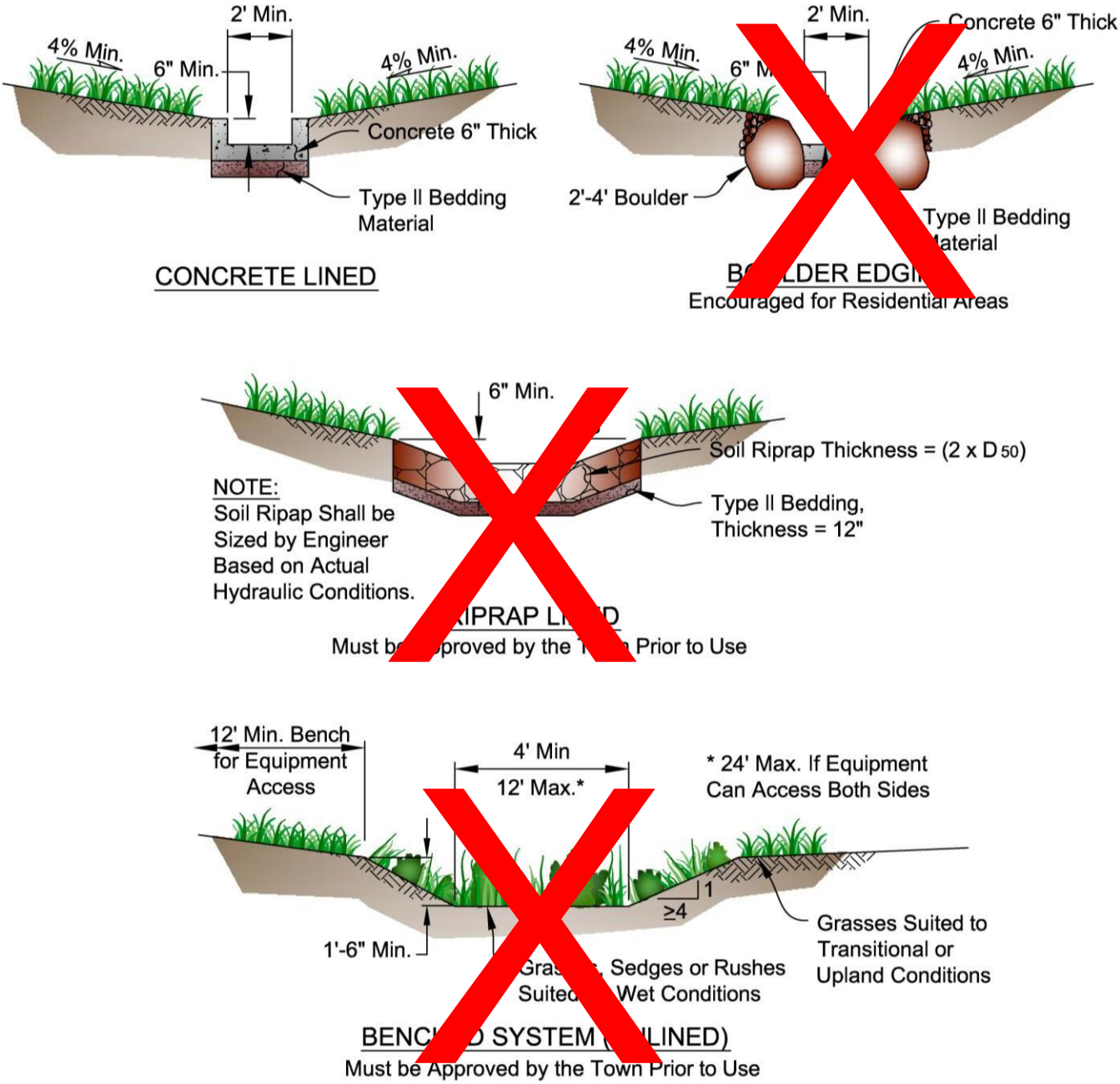
Roughness Coefficient	0.035	
Channel Slope	2.00	%
Normal Depth	0.31	ft
Left Side Slope	20.00	ft/ft (H:V)
Right Side Slope	20.00	ft/ft (H:V)
Discharge	3.40	cfs

Cross Section Image



LOW FLOW AND TRICKLE CHANNELS

FIGURE 13-6
TYPICAL LOW FLOW CHANNEL DETAILS



Worksheet for Trickle Channel Capacity

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.50	%
Normal Depth	0.50	ft
Bottom Width	2.00	ft

Results

Discharge	3.89	cfs
Flow Area	1.00	ft²
Wetted Perimeter	3.00	ft
Hydraulic Radius	0.33	ft
Top Width	2.00	ft
Critical Depth	0.49	ft
Critical Slope	0.53	%
Velocity	3.89	ft/s
Velocity Head	0.23	ft
Specific Energy	0.73	ft
Froude Number	0.97	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.50	ft
Critical Depth	0.49	ft
Channel Slope	0.50	%
Critical Slope	0.53	%

Cross Section for Trickle Channel Capacity

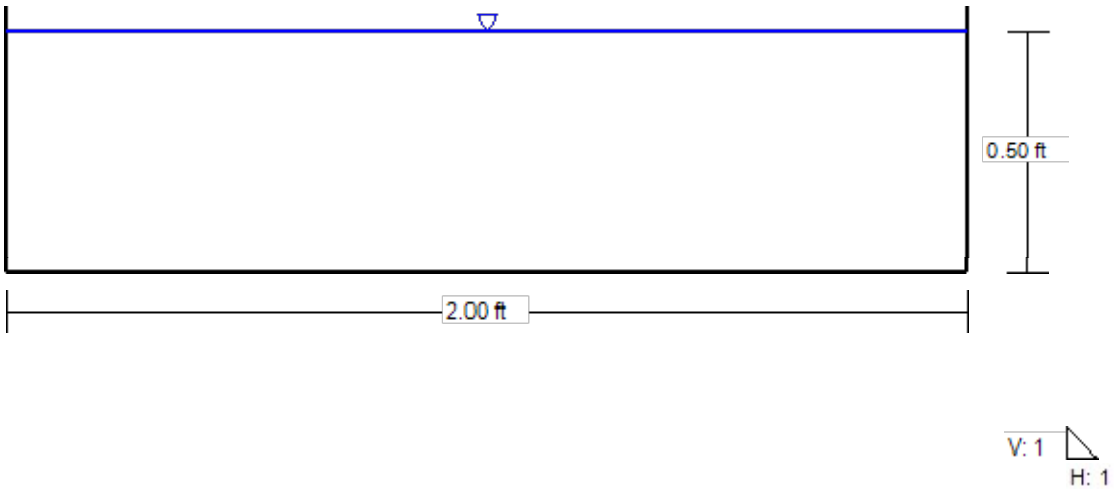
Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.50	%
Normal Depth	0.50	ft
Bottom Width	2.00	ft
Discharge	3.89	cfs

Cross Section Image



APPENDIX D

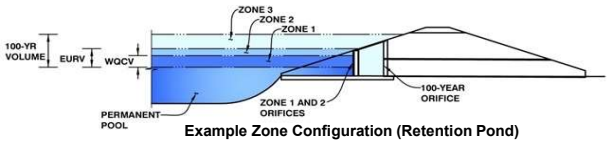
DETENTION AND WATER QUALITY CALCULATIONS

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.05 (January 2022)

Project: **Affinity at Castle Rock**

Basin ID: **Pond A**



Example Zone Configuration (Retention Pond)

Pond Bottom = **6076.50**

Depth Increment = 0.50 ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft²)	Optional Override Area (ft²)	Area (acre)	Volume (ft³)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	3	0.000		
6,077.00	--	0.50	--	--	--	1,921	0.044	481	0.011
6,077.50	--	1.00	--	--	--	5,093	0.117	2,234	0.051
6,078.00	--	1.50	--	--	--	7,058	0.162	5,272	0.121
6,078.50	--	2.00	--	--	--	7,948	0.182	9,024	0.207
6,079.00	--	2.50	--	--	--	8,711	0.200	13,189	0.303
6,079.50	--	3.00	--	--	--	9,513	0.218	17,745	0.407
6,080.00	--	3.50	--	--	--	10,351	0.238	22,711	0.521
6,080.50	--	4.00	--	--	--	11,215	0.257	28,102	0.645
6,081.00	--	4.50	--	--	--	11,592	0.266	33,804	0.776
6,081.50	--	5.00	--	--	--	11,977	0.275	39,696	0.911
6,082.00	--	5.50	--	--	--	12,430	0.285	45,798	1.051
6,082.50	--	6.00	--	--	--	12,822	0.294	52,111	1.196
6,083.00	--	6.50	--	--	--	13,241	0.304	58,627	1.346
6,083.50	--	7.00	--	--	--	13,789	0.317	65,384	1.501
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Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	6.08	acres
Watershed Length =	670	ft
Watershed Length to Centroid =	350	ft
Watershed Slope =	0.020	ft/ft
Watershed Imperviousness =	56.50%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	100.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	Denver - Capitol Building	

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

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.114	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.371	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.06 in.) =	0.277	acre-feet	1.06	inches
5-yr Runoff Volume (P1 = 1.43 in.) =	0.432	acre-feet	1.43	inches
10-yr Runoff Volume (P1 = 1.66 in.) =	0.533	acre-feet	1.66	inches
25-yr Runoff Volume (P1 = 1.69 in.) =	0.575	acre-feet		inches
50-yr Runoff Volume (P1 = 2.26 in.) =	0.852	acre-feet	2.26	inches
100-yr Runoff Volume (P1 = 2.6 in.) =	1.039	acre-feet	2.60	inches
500-yr Runoff Volume (P1 = 3.14 in.) =	1.313	acre-feet		inches
Approximate 2-yr Detention Volume =	0.252	acre-feet		
Approximate 5-yr Detention Volume =	0.367	acre-feet		
Approximate 10-yr Detention Volume =	0.474	acre-feet		
Approximate 25-yr Detention Volume =	0.458	acre-feet		
Approximate 50-yr Detention Volume =	0.568	acre-feet		
Approximate 100-yr Detention Volume =	0.642	acre-feet		

Define Zones and Basin Geometry

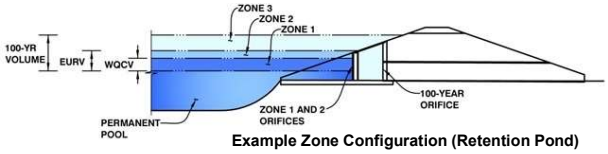
Zone 1 Volume (WQCV) =	0.11	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.26	acre-feet
Zone 3 (100yr + 1 / 2 WQCV - Zones 1 & 2) =	0.33	acre-feet
Total Detention Basin Volume =	0.70	acre-feet

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.05 (January 2022)

Project: **Affinity at Castle Rock**

Basin ID: **Pond A**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.46	0.114	Orifice Plate
Zone 2 (EURV)	2.84	0.257	Circular Orifice
3 (100+1/2WQCV)	4.21	0.328	Weir&Pipe (Restrict)
Total (all zones)		0.699	

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

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

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

			Calculated Parameters for Plate		
Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	4.583E-03	ft^2
Depth at top of Zone using Orifice Plate =	1.46	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	5.84	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	0.66	sq. inches (diameter = 7/8 inch)	Elliptical Slot Area =	N/A	ft^2

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.50	1.00					
Orifice Area (sq. inches)	0.66	0.66	0.66					

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

User Input: Vertical Orifice (Circular or Rectangular)

	Zone 2 Circular	Not Selected		Calculated Parameters for Vertical Orifice	Zone 2 Circular	Not Selected	
Invert of Vertical Orifice =	1.46	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =	0.00	N/A	ft^2
Depth at top of Zone using Vertical Orifice =	2.84	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	0.03	N/A	feet
Vertical Orifice Diameter =	0.63	N/A	inches				

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

	Zone 3 Weir	Not Selected		Calculated Parameters for Overflow Weir	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	2.85	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	3.60	N/A	feet
Overflow Weir Front Edge Length =	3.00	N/A	feet	Overflow Weir Slope Length =	3.09	N/A	feet
Overflow Weir Grate Slope =	4.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	8.80	N/A	
Horiz. Length of Weir Sides =	3.00	N/A	feet	Overflow Grate Open Area w/o Debris =	6.46	N/A	ft^2
Overflow Grate Type =	Type C Grate	N/A		Overflow Grate Open Area w/ Debris =	6.46	N/A	ft^2
Debris Clogging % =	0%	N/A	%				

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

	Zone 3 Restrictor	Not Selected		Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	1.64	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	0.73	N/A	ft^2
Outlet Pipe Diameter =	18.00	N/A	inches	Outlet Orifice Centroid =	0.38	N/A	feet
Restrictor Plate Height Above Pipe Invert =	7.80		inches	Half-Central Angle of Restrictor Plate on Pipe =	1.44	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

			Calculated Parameters for Spillway		
Spillway Invert Stage=	5.12	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.72	feet
Spillway Crest Length =	10.00	feet	Stage at Top of Freeboard =	6.84	feet
Spillway End Slopes =	0.00	H:V	Basin Area at Top of Freeboard =	0.31	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	1.45	acre-ft

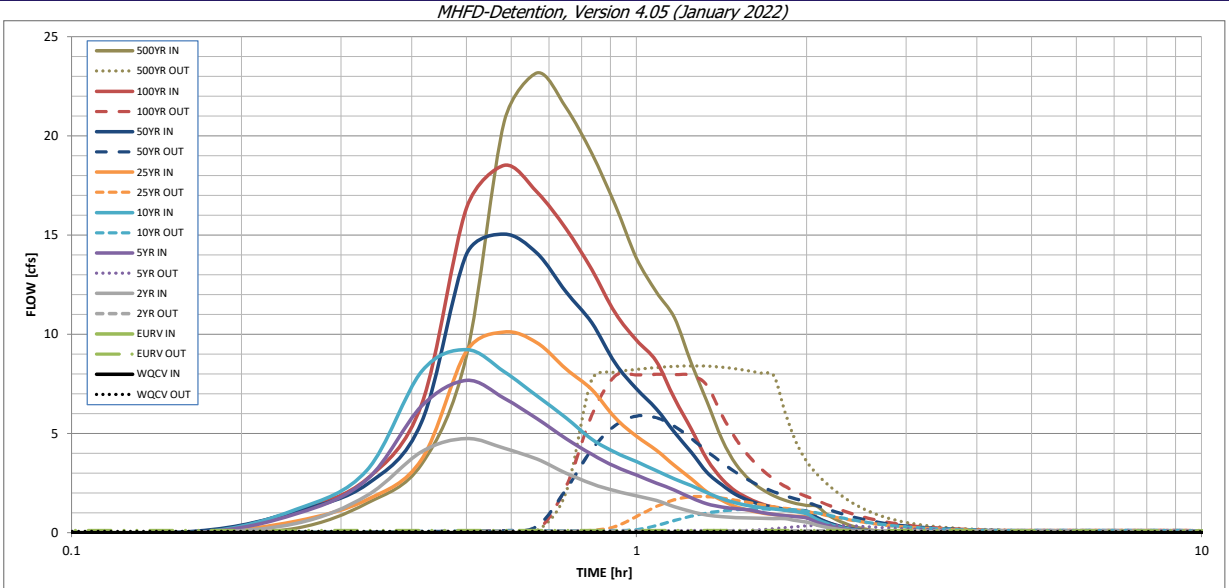
Routed Hydrograph Results — *The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).*

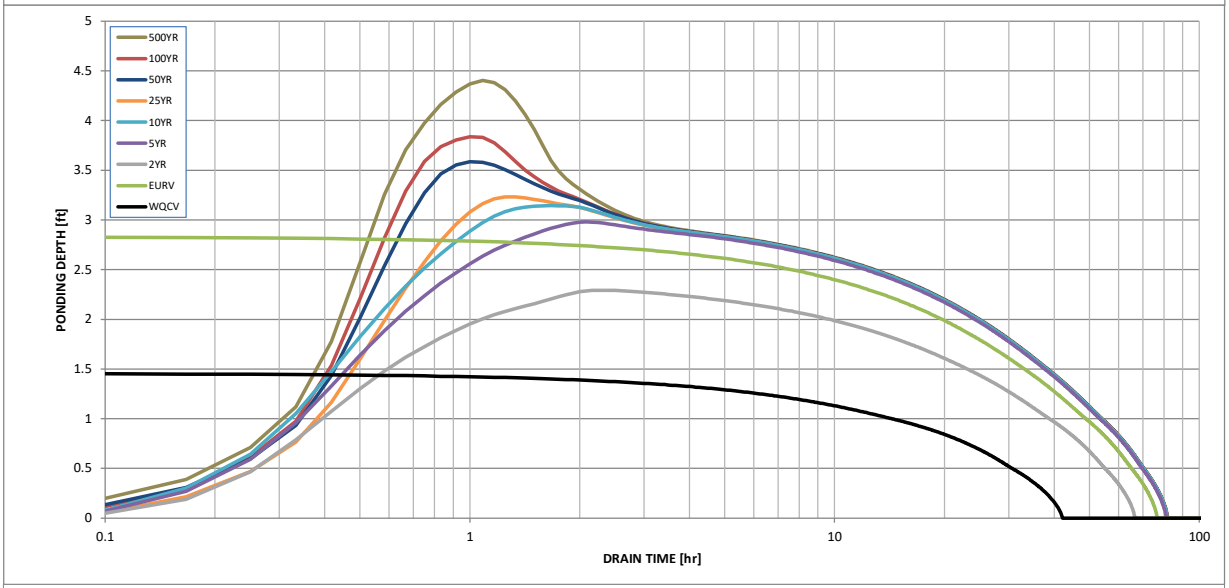
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.06	1.43	1.66	1.69	2.26	2.60	3.14
CUHP Runoff Volume (acre-ft) =	0.114	0.371	0.277	0.432	0.533	0.575	0.852	1.039	1.313
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.277	0.432	0.533	0.575	0.852	1.039	1.313
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.1	1.7	2.5	3.6	6.7	8.7	11.6
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.02	0.27	0.42	0.60	1.10	1.44	1.91
Peak Inflow Q (cfs) =	N/A	N/A	4.8	7.7	9.2	10.1	15.0	18.5	23.2
Peak Outflow Q (cfs) =	0.06	0.11	0.10	0.39	1.19	1.82	5.88	8.0	8.41
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.2	0.5	0.5	0.9	0.9	0.7
Structure Controlling Flow =	Plate	Vertical Orifice 1	Vertical Orifice 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Outlet Plate 1
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	0.0	0.2	0.3	0.9	1.2	1.3
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	37	65	57	69	67	67	63	61	58
Time to Drain 99% of Inflow Volume (hours) =	**40**	72	63	76	75	75	72	71	69
Maximum Ponding Depth (ft) =	1.46	2.84	2.29	2.98	3.14	3.23	3.58	3.84	4.40
Area at Maximum Ponding Depth (acres) =	0.16	0.21	0.19	0.22	0.22	0.23	0.24	0.25	0.26
Maximum Volume Stored (acre-ft) =	0.11	0.37	0.26	0.40	0.44	0.46	0.54	0.60	0.75
Elevation (ft) =	6077.96	6079.34							

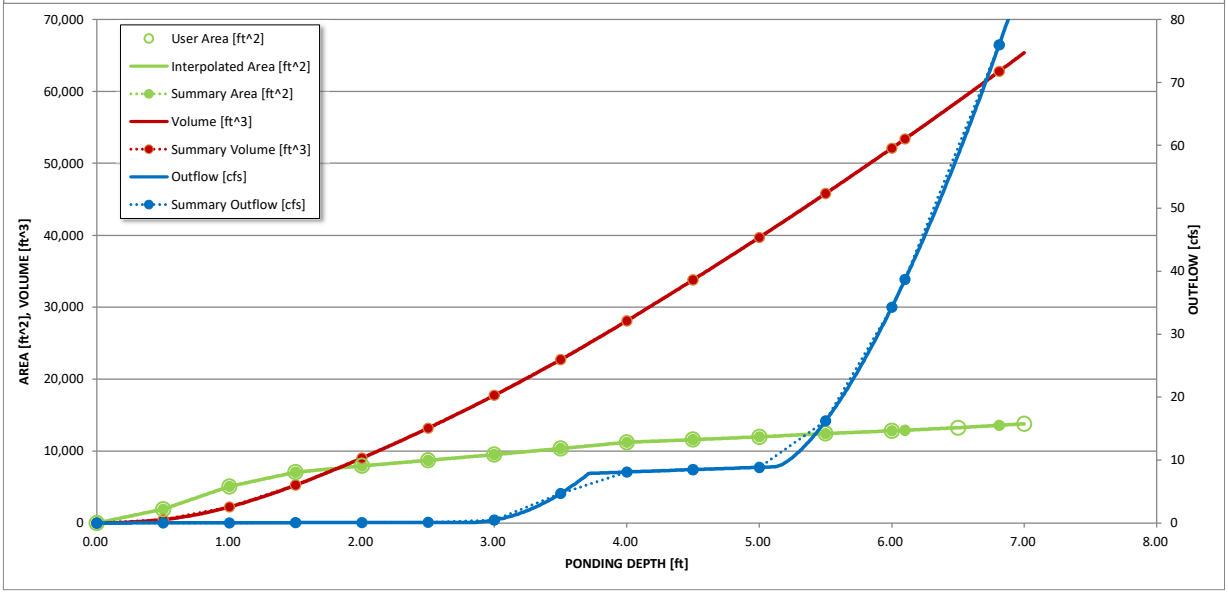
100-Year Volume + 1/2 WQCV =	0.66
Maximum Ponding Depth (ft) =	4.06
Elevation (ft) =	6080.56

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.05 (January 2022)







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

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename:

Inflow Hydrographs

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

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.04	0.23
	0:15:00	0.00	0.00	0.47	0.95	1.18	0.59	1.08	1.11	1.48
	0:20:00	0.00	0.00	1.87	2.68	3.15	1.66	2.44	2.72	3.46
	0:25:00	0.00	0.00	4.09	6.39	8.12	3.69	5.58	6.47	8.91
	0:30:00	0.00	0.00	4.75	7.67	9.23	9.15	14.03	16.36	20.71
	0:35:00	0.00	0.00	4.26	6.78	8.12	10.12	15.05	18.51	23.17
	0:40:00	0.00	0.00	3.71	5.74	6.89	9.57	14.08	17.17	21.44
	0:45:00	0.00	0.00	3.01	4.75	5.79	8.26	12.14	15.33	19.12
	0:50:00	0.00	0.00	2.46	3.95	4.72	7.21	10.58	13.26	16.52
	0:55:00	0.00	0.00	2.11	3.33	4.06	5.79	8.55	11.08	13.85
	1:00:00	0.00	0.00	1.86	2.90	3.58	4.86	7.25	9.70	12.14
	1:05:00	0.00	0.00	1.63	2.51	3.13	4.16	6.25	8.65	10.84
	1:10:00	0.00	0.00	1.32	2.15	2.72	3.39	5.07	6.77	8.53
	1:15:00	0.00	0.00	1.06	1.75	2.37	2.71	4.04	5.21	6.60
	1:20:00	0.00	0.00	0.90	1.46	2.02	2.05	3.03	3.69	4.69
	1:25:00	0.00	0.00	0.81	1.30	1.71	1.62	2.40	2.70	3.45
	1:30:00	0.00	0.00	0.77	1.21	1.50	1.31	1.92	2.09	2.68
	1:35:00	0.00	0.00	0.74	1.15	1.36	1.12	1.62	1.71	2.20
	1:40:00	0.00	0.00	0.73	1.02	1.26	1.00	1.41	1.45	1.86
	1:45:00	0.00	0.00	0.72	0.93	1.19	0.92	1.28	1.28	1.64
	1:50:00	0.00	0.00	0.71	0.86	1.14	0.86	1.18	1.15	1.48
	1:55:00	0.00	0.00	0.61	0.81	1.07	0.83	1.12	1.08	1.38
	2:00:00	0.00	0.00	0.54	0.75	0.96	0.81	1.09	1.05	1.34
	2:05:00	0.00	0.00	0.39	0.54	0.68	0.58	0.78	0.75	0.96
	2:10:00	0.00	0.00	0.28	0.38	0.48	0.41	0.55	0.54	0.68
	2:15:00	0.00	0.00	0.19	0.27	0.34	0.29	0.39	0.38	0.48
	2:20:00	0.00	0.00	0.13	0.18	0.23	0.20	0.27	0.26	0.33
	2:25:00	0.00	0.00	0.09	0.12	0.16	0.13	0.18	0.17	0.22
	2:30:00	0.00	0.00	0.06	0.08	0.10	0.09	0.12	0.12	0.15
	2:35:00	0.00	0.00	0.03	0.05	0.06	0.06	0.08	0.07	0.09
	2:40:00	0.00	0.00	0.02	0.03	0.03	0.03	0.04	0.04	0.05
	2:45:00	0.00	0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.02
	2:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
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	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.05 (January 2022)

Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.

The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

Stage - Storage Description	Stage [ft]	Area [ft^2]	Area [acres]	Volume [ft^3]	Volume [ac-ft]	Total Outflow [cfs]
6076.5	0.00	3	0.000	0	0.000	0.00
6077.0	0.50	1,921	0.044	481	0.011	0.02
6077.5	1.00	5,093	0.117	2,234	0.051	0.04
6078.0	1.50	7,058	0.162	5,272	0.121	0.07
6078.5	2.00	7,948	0.182	9,024	0.207	0.09
6079.0	2.50	8,711	0.200	13,189	0.303	0.10
6079.5	3.00	9,513	0.218	17,745	0.407	0.46
6080.0	3.50	10,351	0.238	22,711	0.521	4.69
6080.5	4.00	11,215	0.257	28,102	0.645	8.11
6081.0	4.50	11,592	0.266	33,804	0.776	8.48
6081.5	5.00	11,977	0.275	39,696	0.911	8.84
6082.0	5.50	12,430	0.285	45,798	1.051	16.22
6082.5	6.00	12,822	0.294	52,111	1.196	34.29
SPILLWAY	6.10	12,906	0.296	53,397	1.226	38.69
EMERGENCY	6.81	13,581	0.312	62,784	1.441	75.95

For best results, include the stages of all grade slope changes (e.g. ISV and Floor) from the S-A-V table on Sheet 'Basin'.

Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

Worksheet for Pond A Emergency Overflow (V-Notch Weir)

Project Description

Solve For	Headwater Elevation

Input Data

Discharge	26.80	cfs
Crest Elevation	6082.60	ft
Tailwater Elevation	6082.00	ft
Coefficient of Discharge	0.57	
Angle	175.60	degrees

Results

Headwater Elevation	6083.31	ft
Headwater Height Above Crest	0.71	ft
Tailwater Height Above Crest	-0.60	ft
Flow Area	13.06	ft²
Velocity	2.05	ft/s
Wetted Perimeter	36.90	ft
Top Width	36.87	ft

Cross Section for Pond A Emergency Overflow (V-Notch Weir)

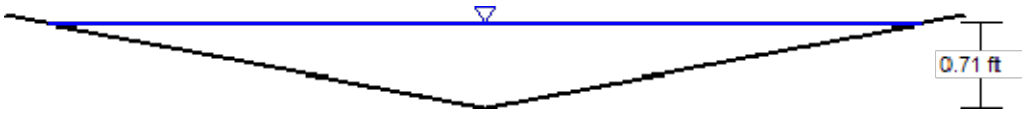
Project Description

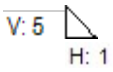
Solve For	Headwater Elevation

Input Data

Discharge	26.80	cfs
Headwater Elevation	6083.31	ft
Crest Elevation	6082.60	ft
Tailwater Elevation	6082.00	ft
Coefficient of Discharge	0.57	
Angle	175.60	degrees

Cross Section Image





Stormwater Detention and Infiltration Design Data Sheet

SDI-Design Data v2.00, Released January 2020

Stormwater Facility Name: **Affinity at Castle Rock - Pond A**

Facility Location & Jurisdiction: **Southwest of Meadows Parkway & Sante Fe Drive, Town of Castle Rock**

User Input: Watershed Characteristics

Extended Detention Basin (EDB)	EDB	
Watershed Area =	6.08	acres
Watershed Length =	670	ft
Watershed Length to Centroid =	350	ft
Watershed Slope =	0.020	ft/ft
Watershed Imperviousness =	56.5%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	100.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours

Location for 1-hr Rainfall Depths (use dropdown):

Douglas County - Zone 1

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

Once CUHP has been run and the Stage-Area-Discharge information has been provided, click 'Process Data' to interpolate the Stage-Area-Volume-Discharge data and generate summary results in the table below. Once this is complete, click 'Print to PDF'.

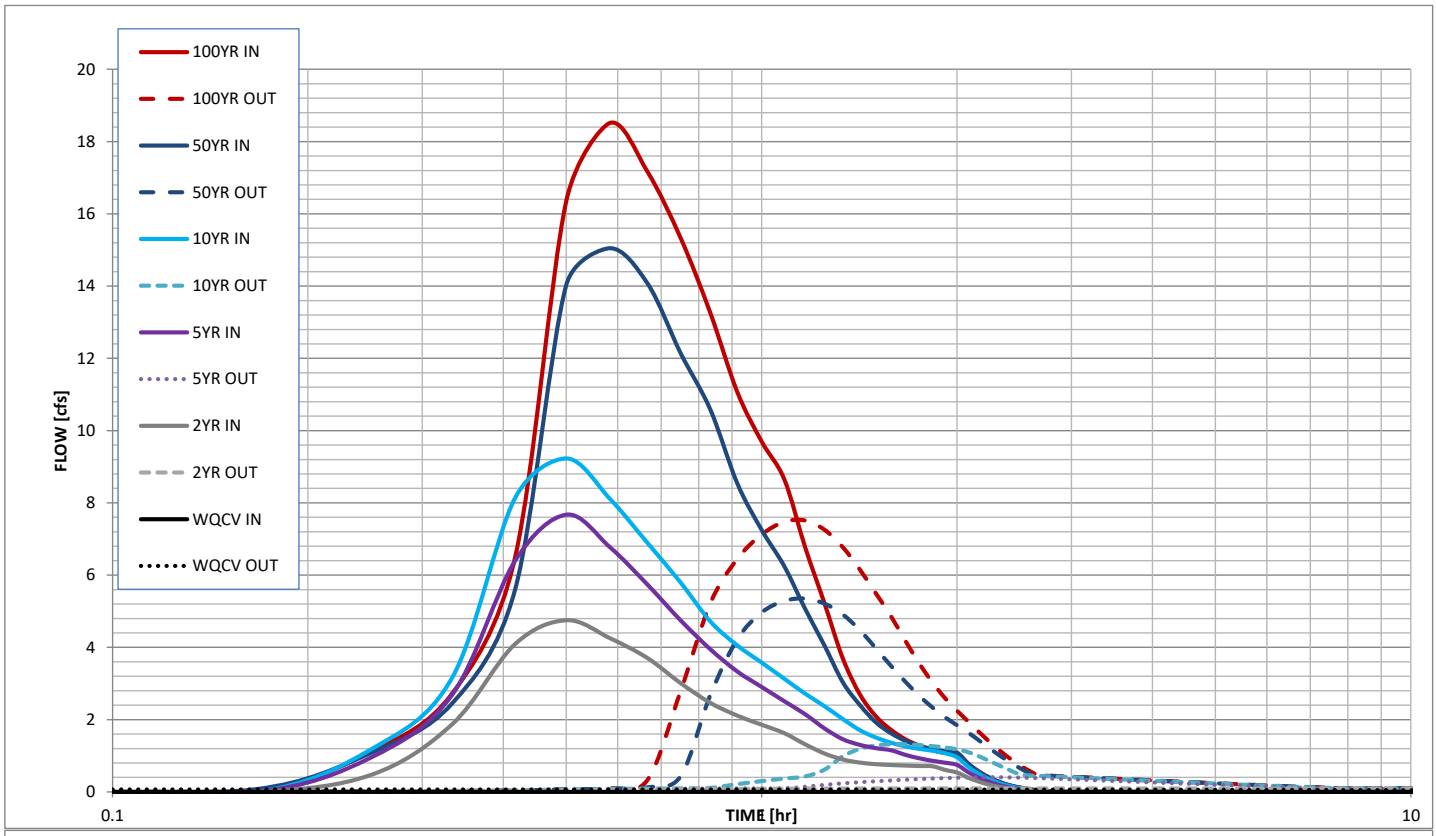
User Defined Stage [ft]	User Defined Area [ft^2]	User Defined Stage [ft]	User Defined Discharge [cfs]
0.00	3	0.00	0.00
0.50	1,921	0.50	0.02
1.00	5,093	1.00	0.04
1.50	7,058	1.50	0.07
2.00	7,948	2.00	0.09
2.50	8,711	2.50	0.10
3.00	9,513	3.00	0.46
3.50	10,351	3.50	4.69
4.00	11,215	4.00	8.11
4.50	11,592	4.50	8.48
5.00	11,977	5.00	8.84
5.50	12,430	5.50	16.22
6.00	12,822	6.00	34.29
6.10	12,906	6.10	38.69
6.81	13,581	6.81	75.95

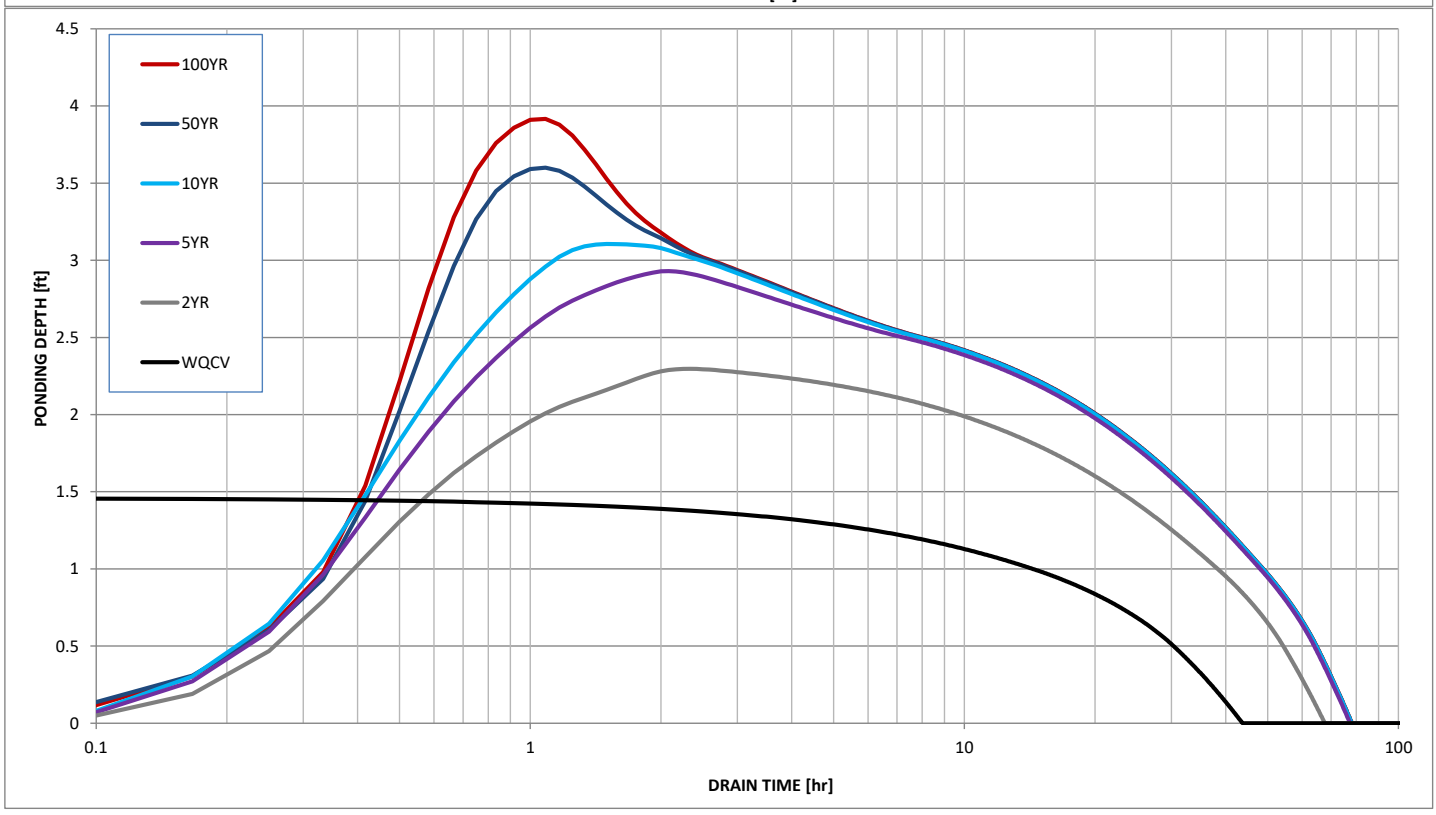
After completing and printing this worksheet to a pdf, go to:
https://maperture.digitaldataservices.com/gvh/?viewer=cswdif
Create a new stormwater facility, and attach the PDF of this worksheet to that record.

Routed Hydrograph Results

Design Storm Return Period =	WQCV	2 Year	5 Year	10 Year	50 Year	100 Year	
One-Hour Rainfall Depth =	N/A	1.06	1.43	1.66	2.26	2.60	in
CUHP Runoff Volume =	0.114	0.277	0.432	0.533	0.852	1.039	acre-ft
Inflow Hydrograph Volume =	N/A	0.277	0.432	0.533	0.852	1.039	acre-ft
Time to Drain 97% of Inflow Volume =	36.3	56.0	**62.8**	61.8	57.6	55.4	hours
Time to Drain 99% of Inflow Volume =	39.4	61.0	69.0	68.7	66.3	**65.2**	hours
Maximum Ponding Depth =	1.46	2.30	2.93	3.11	3.60	3.92	ft
Maximum Ponded Area =	0.16	0.19	0.22	0.22	0.24	**0.25**	acres
Maximum Volume Stored =	0.115	0.262	0.391	0.429	0.543	0.621	acre-ft

Stormwater Detention and Infiltration Design Data Sheet





Design Procedure Form: Extended Detention Basin (EDB)

UD-BMP (Version 3.07, March 2018)

Designer:
Company: HR Green
Date: December 21, 2022
Project: Affinity at Castle Rock
Location: Forebay A1 (west)

1. Basin Storage Volume

A) Effective Imperviousness of Tributary Area, I_a — I_a = 52.2 %

B) Tributary Area's Imperviousness Ratio ($i = I_a / 100$) — i = 0.522

C) Contributing Watershed Area — Area = 4.00 ac

D) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm — d_6 = ____ in

E) Design Concept (Select EURV when also designing for flood control)

Choose One
- ○ Water Quality Capture Volume (WQCV)
- ◉ Excess Urban Runoff Volume (EURV)

F) Design Volume (WQCV) Based on 40-hour Drain Time
($V_{DESIGN} = (1.0 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i) / 12 * Area$)
V_{DESIGN} = 0.071 ac-ft

G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume
($V_{WQCV\ OTHER} = (d_6 * (V_{DESIGN}/0.43))$)
$V_{DESIGN\ OTHER}$ = ____ ac-ft

H) User Input of Water Quality Capture Volume (WQCV) Design Volume (Only if a different WQCV Design Volume is desired)
$V_{DESIGN\ USER}$ = ____ ac-ft

I) NRCS Hydrologic Soil Groups of Tributary Watershed
i) Percentage of Watershed consisting of Type A Soils — HSG_A = 0 %
ii) Percentage of Watershed consisting of Type B Soils — HSG_B = 100 %
iii) Percentage of Watershed consisting of Type C/D Soils — $HSG_{C/D}$ = 0 %

J) Excess Urban Runoff Volume (EURV) Design Volume
For HSG A: $EURV_A = 1.68 * i^{1.28}$
For HSG B: $EURV_B = 1.36 * i^{1.08}$
For HSG C/D: $EURV_{C/D} = 1.20 * i^{1.08}$
$EURV_{DESIGN}$ = 0.225 ac-f t

K) User Input of Excess Urban Runoff Volume (EURV) Design Volume (Only if a different EURV Design Volume is desired)
$EURV_{DESIGN\ USER}$ = ____ ac-f t

2. Basin Shape: Length to Width Ratio
(A basin length to width ratio of at least 2:1 will improve TSS reduction.)
L : W = 2.0 : 1

3. Basin Side Slopes

A) Basin Maximum Side Slopes
(Horizontal distance per unit vertical, 4:1 or flatter preferred)
Z = 4.00 ft / ft

4. Inlet

A) Describe means of providing energy dissipation at concentrated inflow locations:

5. Forebay

A) Minimum Forebay Volume
(V_{FMIN} = 2% of the WQCV)
V_{FMIN} = 0.001 ac-ft

B) Actual Forebay Volume
V_F = 0.001 ac-ft

C) Forebay Depth
(D_F = 18 inch maximum)
D_F = 6.0 in

D) Forebay Discharge

i) Undetained 100-year Peak Discharge
Q_{100} = 17.90 cfs

ii) Forebay Discharge Design Flow
($Q_F = 0.02 * Q_{100}$)
Q_F = 0.36 cfs

E) Forebay Discharge Design

Choose One
- ○ Berm With Pipe
- ◉ Wall with Rect. Notch
- ○ Wall with V-Notch Weir

Flow too small for berm w/ pipe

F) Discharge Pipe Size (minimum 8-inches)
Calculated D_P = ____ in

G) Rectangular Notch Width
Calculated W_N = 4.8 in

Design Procedure Form: Extended Detention Basin (EDB)

UD-BMP (Version 3.07, March 2018)

Designer:
Company: HR Green
Date: December 21, 2022
Project: Affinity at Castle Rock
Location: Forebay A2 (east)

1. Basin Storage Volume

A) Effective Imperviousness of Tributary Area, I_a — I_a = 57.5 %

B) Tributary Area's Imperviousness Ratio ($i = I_a / 100$) — i = 0.575

C) Contributing Watershed Area — Area = 1.720 ac

D) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm — d_6 = in

E) Design Concept (Select EURV when also designing for flood control)

Choose One
- ○ Water Quality Capture Volume (WQCV)
- ◉ Excess Urban Runoff Volume (EURV)

F) Design Volume (WQCV) Based on 40-hour Drain Time ($V_{DESIGN} = (1.0 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i) / 12 * Area$) — V_{DESIGN} = 0.033 ac-ft

G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume ($V_{WQCV\ OTHER} = d_6 * (V_{DESIGN}/0.43)$) — $V_{DESIGN\ OTHER}$ = ac-ft

H) User Input of Water Quality Capture Volume (WQCV) Design Volume (Only if a different WQCV Design Volume is desired) — $V_{DESIGN\ USER}$ = ac-ft

I) NRCS Hydrologic Soil Groups of Tributary Watershed
- i) Percentage of Watershed consisting of Type A Soils — HSG_A = 0 %
- ii) Percentage of Watershed consisting of Type B Soils — HSG_B = 100 %
- iii) Percentage of Watershed consisting of Type C/D Soils — $HSG_{C/D}$ = 0 %

J) Excess Urban Runoff Volume (EURV) Design Volume
For HSG A: $EURV_A = 1.68 * i^{1.28}$
For HSG B: $EURV_B = 1.36 * i^{1.08}$
For HSG C/D: $EURV_{C/D} = 1.20 * i^{1.08}$
— $EURV_{DESIGN}$ = 0.107 ac-f t

K) User Input of Excess Urban Runoff Volume (EURV) Design Volume (Only if a different EURV Design Volume is desired) — $EURV_{DESIGN\ USER}$ = ac-f t

2. Basin Shape: Length to Width Ratio (A basin length to width ratio of at least 2:1 will improve TSS reduction.) — L : W = 2.0 : 1

3. Basin Side Slopes

A) Basin Maximum Side Slopes (Horizontal distance per unit vertical, 4:1 or flatter preferred) — Z = 4.00 ft / ft

4. Inlet

A) Describe means of providing energy dissipation at concentrated inflow locations:

5. Forebay

A) Minimum Forebay Volume (V_{FMIN} = 0% of the WQCV) — V_{FMIN} = 0.000 ac-ft — **A FOREBAY MAY NOT BE NECESSARY FOR THIS SIZE SITE**

B) Actual Forebay Volume — V_F = 0.0005 ac-ft

C) Forebay Depth (D_F = 12 inch maximum) — D_F = 6.0 in

D) Forebay Discharge

i) Undetained 100-year Peak Discharge — Q_{100} = 7.60 cfs

ii) Forebay Discharge Design Flow ($Q_F = 0.02 * Q_{100}$) — Q_F = 0.15 cfs

E) Forebay Discharge Design

Choose One
- ○ Berm With Pipe
- ◉ Wall with Rect. Notch
- ○ Wall with V-Notch Weir

Flow too small for berm w/ pipe

F) Discharge Pipe Size (minimum 8-inches) — Calculated D_P = in

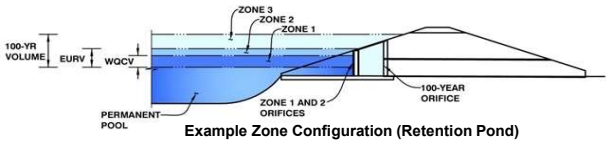
G) Rectangular Notch Width — Calculated W_N = 2.7 in

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.05 (January 2022)

Project: **Affinity at Castle Rock**

Basin ID: **Pond B**



Example Zone Configuration (Retention Pond)

Pond Bottom = **6062.60**

Depth Increment = 0.50 ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft²)	Optional Override Area (ft²)	Area (acre)	Volume (ft³)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	3	0.000		
6,063.00	--	0.40	--	--	--	1,617	0.037	324	0.007
6,063.50	--	0.90	--	--	--	6,020	0.138	2,233	0.051
6,064.00	--	1.40	--	--	--	8,137	0.187	5,773	0.133
6,064.50	--	1.90	--	--	--	9,222	0.212	10,112	0.232
6,065.00	--	2.40	--	--	--	10,336	0.237	15,002	0.344
6,065.50	--	2.90	--	--	--	11,478	0.263	20,455	0.470
6,066.00	--	3.40	--	--	--	12,648	0.290	26,486	0.608
6,066.50	--	3.90	--	--	--	13,847	0.318	33,110	0.760
6,067.00	--	4.40	--	--	--	15,075	0.346	40,341	0.926
6,067.50	--	4.90	--	--	--	16,436	0.377	48,219	1.107
6,068.00	--	5.40	--	--	--	17,859	0.410	56,793	1.304
6,068.50	--	5.90	--	--	--	19,034	0.437	66,016	1.516
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Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	5.98	acres
Watershed Length =	830	ft
Watershed Length to Centroid =	415	ft
Watershed Slope =	0.042	ft/ft
Watershed Imperviousness =	67.40%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	100.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	Denver - Capitol Building	

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

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.131	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.441	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.06 in.) =	0.328	acre-feet	1.06	inches
5-yr Runoff Volume (P1 = 1.43 in.) =	0.490	acre-feet	1.43	inches
10-yr Runoff Volume (P1 = 1.66 in.) =	0.594	acre-feet	1.66	inches
25-yr Runoff Volume (P1 = 1.69 in.) =	0.628	acre-feet		inches
50-yr Runoff Volume (P1 = 2.26 in.) =	0.905	acre-feet	2.26	inches
100-yr Runoff Volume (P1 = 2.6 in.) =	1.087	acre-feet	2.60	inches
500-yr Runoff Volume (P1 = 3.14 in.) =	1.358	acre-feet		inches
Approximate 2-yr Detention Volume =	0.306	acre-feet		
Approximate 5-yr Detention Volume =	0.438	acre-feet		
Approximate 10-yr Detention Volume =	0.552	acre-feet		
Approximate 25-yr Detention Volume =	0.529	acre-feet		
Approximate 50-yr Detention Volume =	0.655	acre-feet		
Approximate 100-yr Detention Volume =	0.724	acre-feet		

Define Zones and Basin Geometry

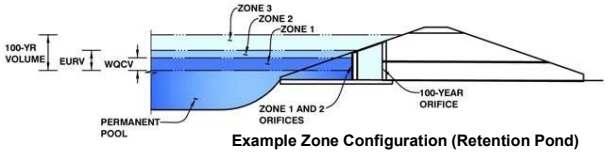
Zone 1 Volume (WQCV) =	0.13	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.31	acre-feet
Zone 3 Volume (User Defined - Zones 1 & 2) =	0.31	acre-feet
Total Detention Basin Volume =	0.75	acre-feet

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.05 (January 2022)

Project: **Affinity at Castle Rock**

Basin ID: **Pond B**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.40	0.131	Orifice Plate
Zone 2 (EURV)	2.80	0.310	Circular Orifice
Zone 3 (User)	3.87	0.309	Weir&Pipe (Restrict)
Total (all zones)		0.750	

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

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)	Underdrain Orifice Area =	N/A	ft²
Underdrain Orifice Diameter =	N/A	inches	Underdrain Orifice Centroid =	N/A	feet

Calculated Parameters for Underdrain

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

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	5.208E-03	ft²
Depth at top of Zone using Orifice Plate =	1.40	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	5.60	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	0.75	sq. inches (diameter = 15/16 inch)	Elliptical Slot Area =	N/A	ft²

Calculated Parameters for Plate

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.47	0.93					
Orifice Area (sq. inches)	0.75	0.75	0.75					

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

User Input: Vertical Orifice (Circular or Rectangular)

	Zone 2 Circular	Not Selected			Zone 2 Circular	Not Selected	
Invert of Vertical Orifice =	1.40	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =	0.00	N/A	ft²
Depth at top of Zone using Vertical Orifice =	2.80	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	0.04	N/A	feet
Vertical Orifice Diameter =	0.94	N/A	inches				

Calculated Parameters for Vertical Orifice

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

	Zone 3 Weir	Not Selected			Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	2.80	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	3.55	N/A	feet
Overflow Weir Front Edge Length =	3.00	N/A	feet	Overflow Weir Slope Length =	3.09	N/A	feet
Overflow Weir Grate Slope =	4.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	7.75	N/A	
Horiz. Length of Weir Sides =	3.00	N/A	feet	Overflow Grate Open Area w/o Debris =	6.46	N/A	ft²
Overflow Grate Type =	Type C Grate	N/A		Overflow Grate Open Area w/ Debris =	6.46	N/A	ft²
Debris Clogging % =	0%	N/A	%				

Calculated Parameters for Overflow Weir

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

	Zone 3 Restrictor	Not Selected			Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.60	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	0.83	N/A	ft²
Outlet Pipe Diameter =	18.00	N/A	inches	Outlet Orifice Centroid =	0.41	N/A	feet
Restrictor Plate Height Above Pipe Invert =	8.60		inches	Half-Central Angle of Restrictor Plate on Pipe =	1.53	N/A	radians

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	3.90	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.67	feet
Spillway Crest Length =	10.00	feet	Stage at Top of Freeboard =	5.57	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	0.42	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	1.37	acre-ft

Calculated Parameters for Spillway

Routed Hydrograph Results

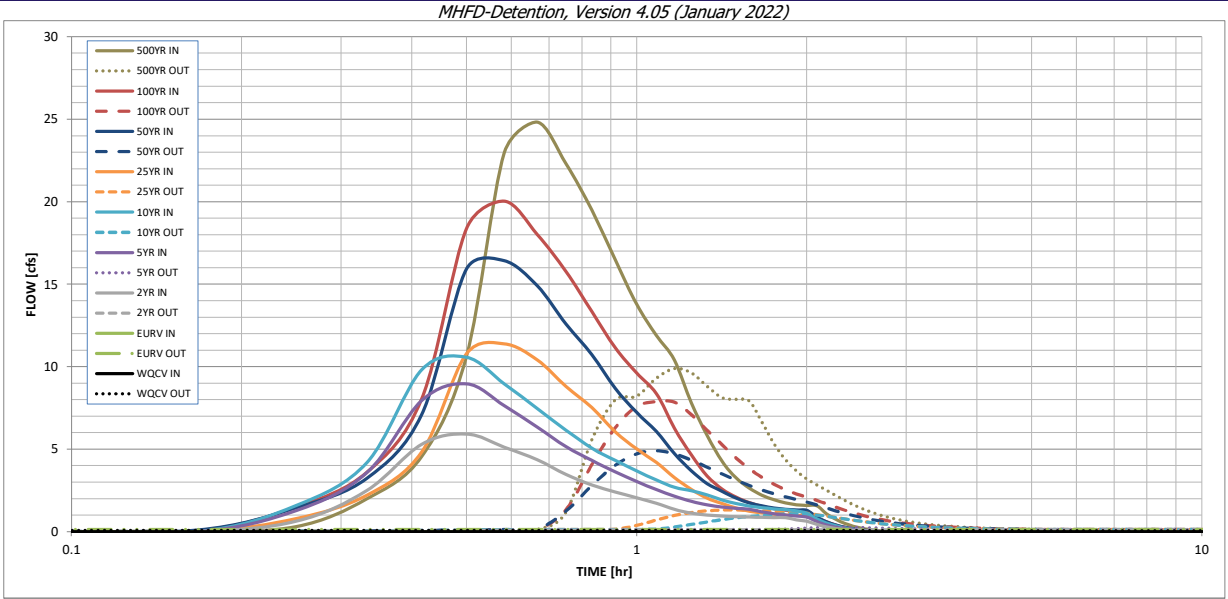
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

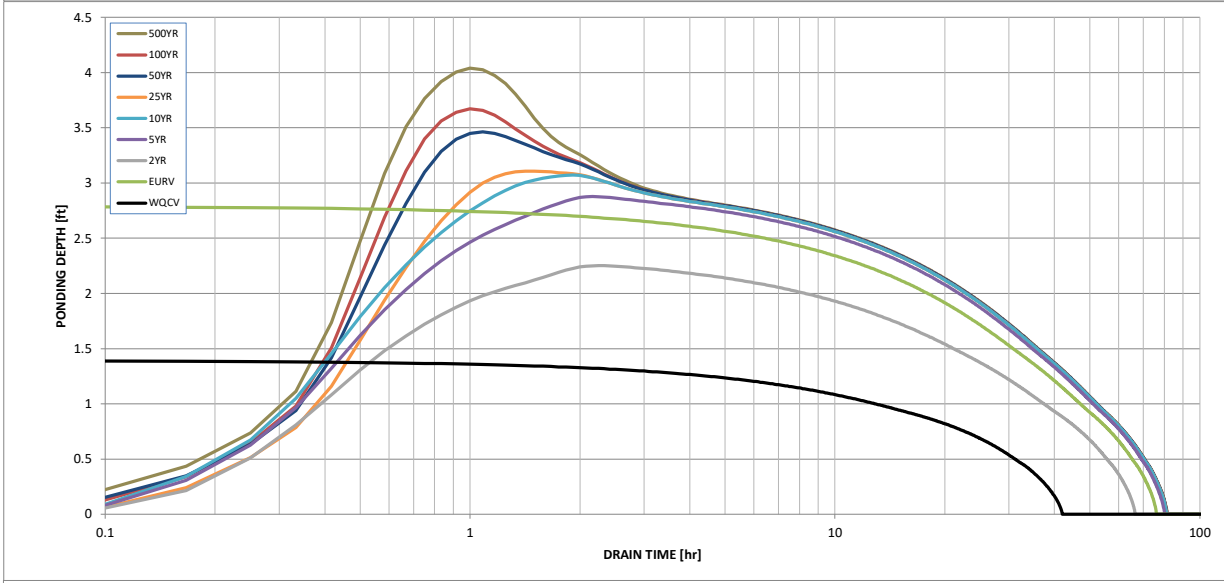
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.06	1.43	1.66	1.69	2.26	2.60	3.14
CUHP Runoff Volume (acre-ft) =	0.131	0.441	0.328	0.490	0.594	0.628	0.905	1.087	1.358
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.328	0.490	0.594	0.628	0.905	1.087	1.358
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.1	1.6	2.5	3.5	6.5	8.5	11.3
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.02	0.27	0.41	0.59	1.09	1.42	1.89
Peak Inflow Q (cfs) =	N/A	N/A	5.9	9.0	10.6	11.4	16.4	20.0	24.8
Peak Outflow Q (cfs) =	0.07	0.14	0.1	0.3	1.1	1.3	4.9	7.9	9.9
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.2	0.4	0.4	0.8	0.9	0.9
Structure Controlling Flow =	Vertical Orifice 1	Overflow Weir 1	Vertical Orifice 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	0.0	0.1	0.2	0.7	1.2	1.3
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	37	65	57	68	68	67	64	62	60
Time to Drain 99% of Inflow Volume (hours) =	**40**	71	62	75	75	74	73	71	70
Maximum Ponding Depth (ft) =	1.40	2.80	2.25	2.88	3.07	3.11	3.46	3.67	4.04
Area at Maximum Ponding Depth (acres) =	0.19	0.26	0.23	0.26	0.27	0.27	0.29	0.31	0.33
Maximum Volume Stored (acre-ft) =	0.13	0.44	0.31	0.46	0.52	0.52	0.63	0.69	0.80
Elevation (ft) =	6064.00	6065.40							

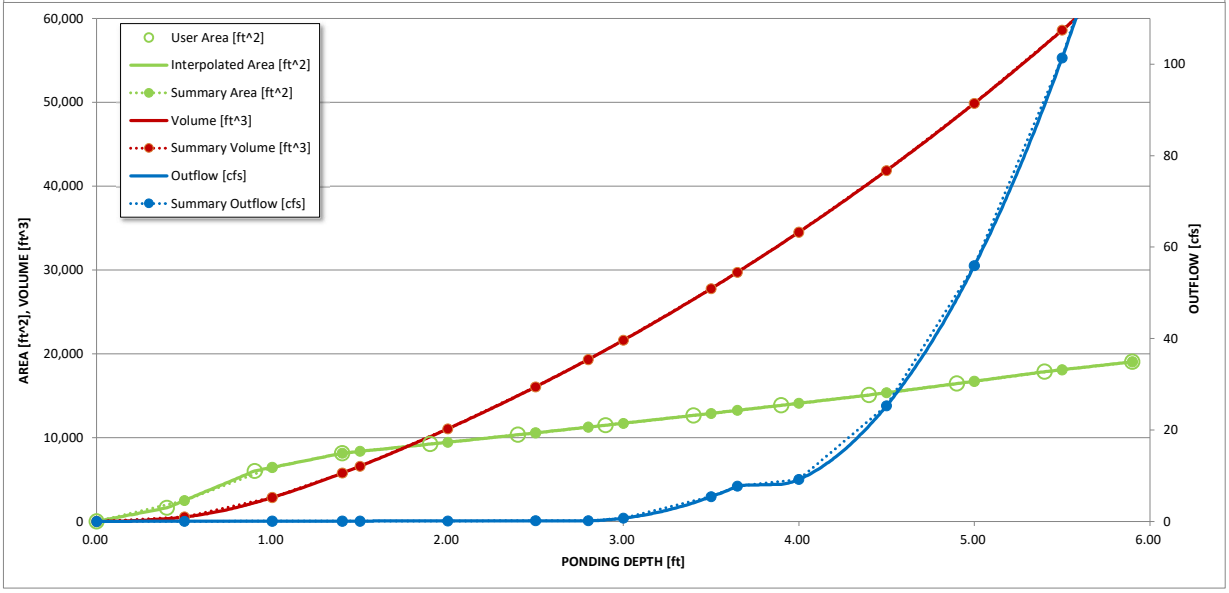
100-Year Volume + 1/2 WQCV =	0.75
Maximum Pond Depth (ft) =	3.88
Elevation (ft) =	6066.48

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.05 (January 2022)







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

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename:

Inflow Hydrographs

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

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.05	0.31
	0:15:00	0.00	0.00	0.64	1.28	1.59	0.80	1.45	1.49	1.99
	0:20:00	0.00	0.00	2.51	3.58	4.19	2.22	3.24	3.61	4.56
	0:25:00	0.00	0.00	5.30	7.94	9.80	4.82	7.09	8.04	10.63
	0:30:00	0.00	0.00	5.92	8.97	10.57	10.79	15.92	18.37	22.95
	0:35:00	0.00	0.00	5.13	7.64	8.97	11.38	16.42	20.04	24.82
	0:40:00	0.00	0.00	4.36	6.34	7.47	10.41	14.90	18.02	22.30
	0:45:00	0.00	0.00	3.46	5.15	6.15	8.80	12.58	15.77	19.48
	0:50:00	0.00	0.00	2.83	4.31	5.06	7.52	10.73	13.33	16.47
	0:55:00	0.00	0.00	2.41	3.62	4.31	6.05	8.68	11.14	13.79
	1:00:00	0.00	0.00	2.05	3.05	3.69	5.01	7.22	9.61	11.91
	1:05:00	0.00	0.00	1.72	2.55	3.13	4.20	6.08	8.38	10.39
	1:10:00	0.00	0.00	1.34	2.15	2.69	3.27	4.73	6.26	7.79
	1:15:00	0.00	0.00	1.12	1.84	2.49	2.56	3.69	4.64	5.83
	1:20:00	0.00	0.00	1.01	1.63	2.23	2.02	2.91	3.38	4.25
	1:25:00	0.00	0.00	0.94	1.50	1.92	1.70	2.44	2.58	3.25
	1:30:00	0.00	0.00	0.91	1.41	1.70	1.43	2.02	2.08	2.63
	1:35:00	0.00	0.00	0.89	1.35	1.56	1.25	1.74	1.76	2.21
	1:40:00	0.00	0.00	0.87	1.20	1.45	1.13	1.56	1.54	1.94
	1:45:00	0.00	0.00	0.86	1.08	1.38	1.06	1.44	1.39	1.75
	1:50:00	0.00	0.00	0.85	1.00	1.33	1.01	1.36	1.30	1.63
	1:55:00	0.00	0.00	0.72	0.95	1.25	0.98	1.32	1.26	1.59
	2:00:00	0.00	0.00	0.63	0.88	1.12	0.96	1.29	1.25	1.57
	2:05:00	0.00	0.00	0.44	0.61	0.77	0.66	0.89	0.87	1.09
	2:10:00	0.00	0.00	0.30	0.41	0.53	0.45	0.60	0.60	0.75
	2:15:00	0.00	0.00	0.20	0.27	0.36	0.31	0.41	0.40	0.51
	2:20:00	0.00	0.00	0.13	0.17	0.23	0.20	0.27	0.26	0.33
	2:25:00	0.00	0.00	0.08	0.11	0.15	0.13	0.17	0.17	0.21
	2:30:00	0.00	0.00	0.04	0.07	0.09	0.08	0.10	0.10	0.13
	2:35:00	0.00	0.00	0.02	0.03	0.04	0.04	0.05	0.05	0.07
	2:40:00	0.00	0.00	0.01	0.01	0.01	0.02	0.02	0.02	0.02
	2:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
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	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
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	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.05 (January 2022)

Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.

The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

Stage - Storage Description	Stage [ft]	Area [ft^2]	Area [acres]	Volume [ft^3]	Volume [ac-ft]	Total Outflow [cfs]
	0.00	3	0.000	0	0.000	0.00
	0.50	2,498	0.057	530	0.012	0.02
	1.00	6,444	0.148	2,856	0.066	0.05
WQCV	1.40	8,137	0.187	5,773	0.133	0.07
	1.50	8,354	0.192	6,597	0.151	0.08
	2.00	9,445	0.217	11,046	0.254	0.11
	2.50	10,564	0.243	16,047	0.368	0.13
EURV	2.80	11,249	0.258	19,319	0.443	0.14
	3.00	11,712	0.269	21,614	0.496	0.71
	3.50	12,888	0.296	27,763	0.637	5.42
100-YEAR	3.65	13,248	0.304	29,723	0.682	7.71
	4.00	14,093	0.324	34,507	0.792	9.19
	4.50	15,347	0.352	41,862	0.961	25.31
	5.00	16,721	0.384	49,877	1.145	55.93
	5.50	18,094	0.415	58,590	1.345	101.37
	5.90	19,034	0.437	66,016	1.516	149.06

For best results, include the stages of all grade slope changes (e.g. ISV and Floor) from the S-A-V table on Sheet 'Basin'.

Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

Stormwater Detention and Infiltration Design Data Sheet

SDI-Design Data v2.00, Released January 2020

Stormwater Facility Name: **Affinity at Castle Rock - Pond B**

Facility Location & Jurisdiction: **Southwest of Meadows Parkway & Sante Fe Drive, Town of Castle Rock**

User Input: Watershed Characteristics

Extended Detention Basin (EDB)	EDB	
Watershed Area =	5.98	acres
Watershed Length =	830	ft
Watershed Length to Centroid =	415	ft
Watershed Slope =	0.042	ft/ft
Watershed Imperviousness =	67.4%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	100.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours

Location for 1-hr Rainfall Depths (use dropdown):

Douglas County - Zone 1

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

Once CUHP has been run and the Stage-Area-Discharge information has been provided, click 'Process Data' to interpolate the Stage-Area-Volume-Discharge data and generate summary results in the table below. Once this is complete, click 'Print to PDF'.

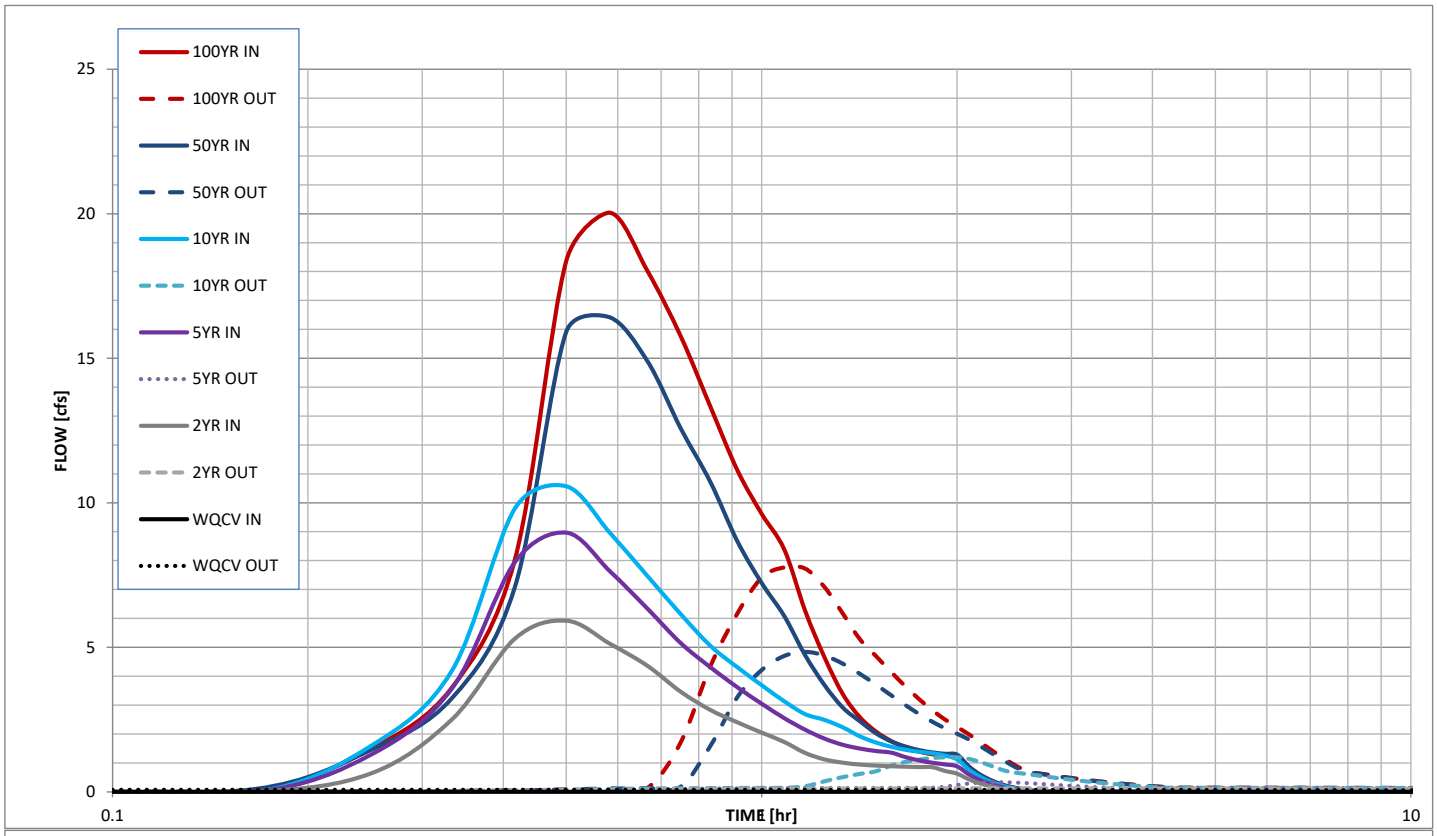
User Defined Stage [ft]	User Defined Area [ft^2]	User Defined Stage [ft]	User Defined Discharge [cfs]
0.00	3	0.00	0.00
0.50	2,498	0.50	0.02
1.00	6,444	1.00	0.05
1.40	8,137	1.40	0.07
1.50	8,354	1.50	0.08
2.00	9,445	2.00	0.11
2.50	10,564	2.50	0.13
2.80	11,249	2.80	0.14
3.00	11,712	3.00	0.70
3.50	12,888	3.50	5.41
3.65	13,248	3.65	7.71
4.00	14,093	4.00	9.22
4.50	15,347	4.50	25.37
5.00	16,721	5.00	56.02
5.50	18,094	5.50	101.48
5.90	19,034	5.90	149.18

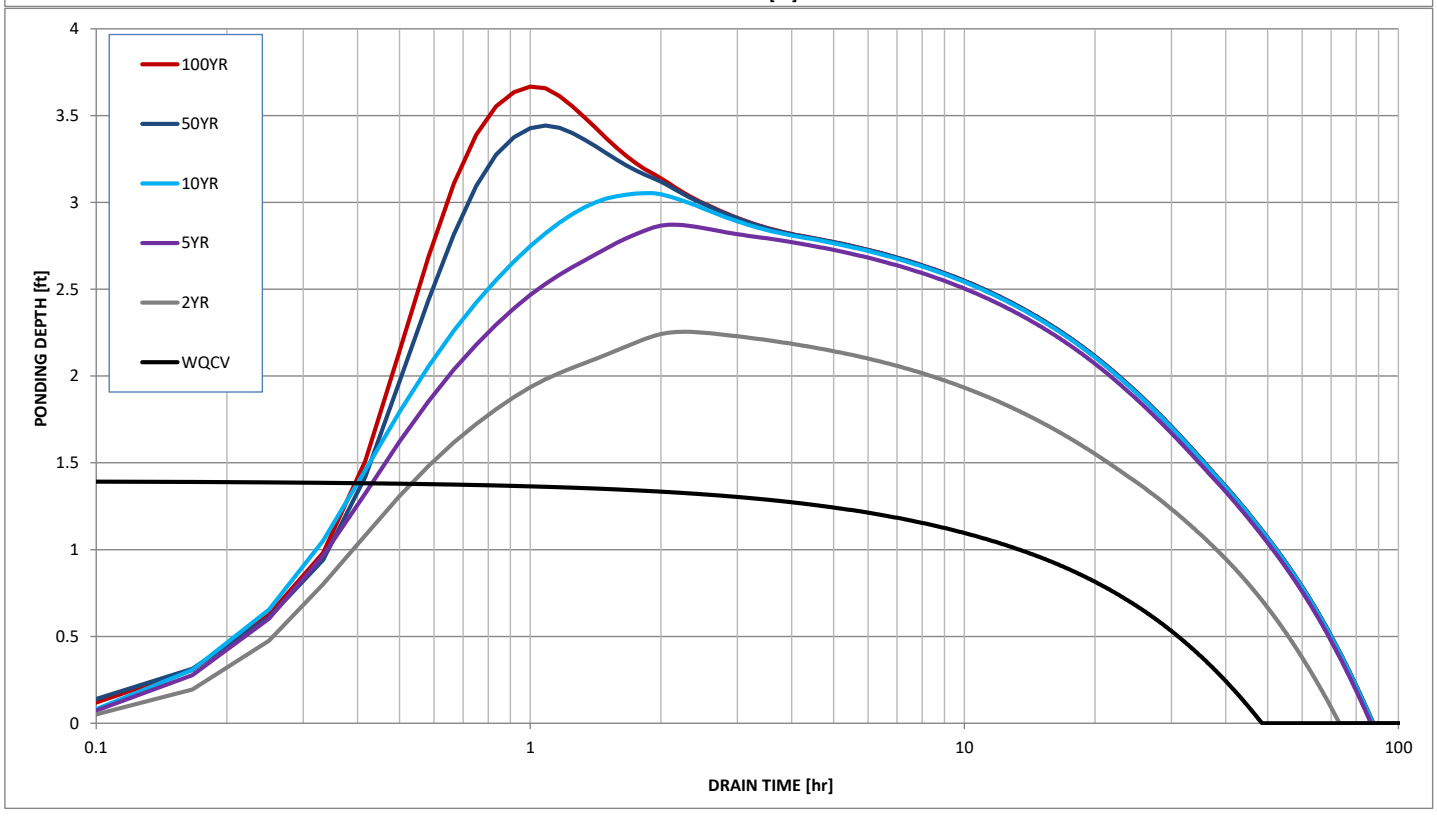
After completing and printing this worksheet to a pdf, go to:
https://maperture.digitaldataservices.com/gvh/?viewer=cswdif
Create a new stormwater facility, and attach the PDF of this worksheet to that record.

Routed Hydrograph Results

Design Storm Return Period =	WQCV	2 Year	5 Year	10 Year	50 Year	100 Year	
One-Hour Rainfall Depth =	N/A	1.06	1.43	1.66	2.26	2.60	in
CUHP Runoff Volume =	0.131	0.328	0.490	0.594	0.905	1.087	acre-ft
Inflow Hydrograph Volume =	N/A	0.328	0.490	0.594	0.905	1.087	acre-ft
Time to Drain 97% of Inflow Volume =	39.3	58.8	**68.8**	68.0	63.9	61.9	hours
Time to Drain 99% of Inflow Volume =	43.3	64.8	76.3	76.2	73.7	**72.3**	hours
Maximum Ponding Depth =	1.40	2.25	2.87	3.05	3.44	3.67	ft
Maximum Ponded Area =	0.19	0.23	0.26	0.27	0.29	**0.30**	acres
Maximum Volume Stored =	0.132	0.309	0.461	0.509	0.619	0.686	acre-ft

Stormwater Detention and Infiltration Design Data Sheet





Design Procedure Form: Extended Detention Basin (EDB)

UD-BMP (Version 3.07, March 2018)

Designer:
Company: HR Green
Date: December 21, 2022
Project: Affinity at Castle Rock
Location: Forebay B1 (south)

1. Basin Storage Volume

A) Effective Imperviousness of Tributary Area, I_a — I_a = 73.0 %

B) Tributary Area's Imperviousness Ratio ($i = I_a / 100$) — i = 0.730

C) Contributing Watershed Area — Area = 4.410 ac

D) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm — d_6 = in

E) Design Concept (Select EURV when also designing for flood control)

Choose One
- ○ Water Quality Capture Volume (WQCV)
- ◉ Excess Urban Runoff Volume (EURV)

F) Design Volume (WQCV) Based on 40-hour Drain Time ($V_{DESIGN} = (1.0 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i) / 12 * Area$) — V_{DESIGN} = 0.106 ac-ft

G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume ($V_{WQCV\ OTHER} = (d_6 * (V_{DESIGN}/0.43))$) — $V_{DESIGN\ OTHER}$ = ac-ft

H) User Input of Water Quality Capture Volume (WQCV) Design Volume (Only if a different WQCV Design Volume is desired) — $V_{DESIGN\ USER}$ = ac-ft

I) NRCS Hydrologic Soil Groups of Tributary Watershed
- i) Percentage of Watershed consisting of Type A Soils — HSG_A = 0 %
- ii) Percentage of Watershed consisting of Type B Soils — HSG_B = 100 %
- iii) Percentage of Watershed consisting of Type C/D Soils — $HSG_{C/D}$ = 0 %

J) Excess Urban Runoff Volume (EURV) Design Volume
For HSG A: $EURV_A = 1.68 * i^{1.28}$
For HSG B: $EURV_B = 1.36 * i^{1.08}$
For HSG C/D: $EURV_{C/D} = 1.20 * i^{1.08}$
— $EURV_{DESIGN}$ = 0.356 ac-f t

K) User Input of Excess Urban Runoff Volume (EURV) Design Volume (Only if a different EURV Design Volume is desired) — $EURV_{DESIGN\ USER}$ = ac-f t

2. Basin Shape: Length to Width Ratio (A basin length to width ratio of at least 2:1 will improve TSS reduction.) — L : W = 2.0 : 1

3. Basin Side Slopes

A) Basin Maximum Side Slopes (Horizontal distance per unit vertical, 4:1 or flatter preferred) — Z = 4.00 ft / ft

4. Inlet

A) Describe means of providing energy dissipation at concentrated inflow locations:

5. Forebay

A) Minimum Forebay Volume (V_{FMIN} = 2% of the WQCV) — V_{FMIN} = 0.0020 ac-ft

B) Actual Forebay Volume — V_F = 0.002 ac-ft

C) Forebay Depth (D_F = 18 inch maximum) — D_F = 6.0 in

D) Forebay Discharge

i) Undetained 100-year Peak Discharge — Q_{100} = 29.60 cfs

ii) Forebay Discharge Design Flow ($Q_F = 0.02 * Q_{100}$) — Q_F = 0.59 cfs

E) Forebay Discharge Design

Choose One
- ○ Berm With Pipe
- ◉ Wall with Rect. Notch
- ○ Wall with V-Notch Weir

Flow too small for berm w/ pipe

F) Discharge Pipe Size (minimum 8-inches) — Calculated D_P = in

G) Rectangular Notch Width — Calculated W_N = 7.2 in

Design Procedure Form: Extended Detention Basin (EDB)

UD-BMP (Version 3.07, March 2018)

Designer:
Company: HR Green
Date: December 21, 2022
Project: Affinity at Castle Rock
Location: Forebay B2 (north)

1. Basin Storage Volume

A) Effective Imperviousness of Tributary Area, I_a — I_a = 53.7 %

B) Tributary Area's Imperviousness Ratio ($i = I_a / 100$) — i = 0.537

C) Contributing Watershed Area — Area = 0.910 ac

D) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm — d_6 = in

E) Design Concept (Select EURV when also designing for flood control)
Choose One
- ○ Water Quality Capture Volume (WQCV)
- ◉ Excess Urban Runoff Volume (EURV)

F) Design Volume (WQCV) Based on 40-hour Drain Time
($V_{DESIGN} = (1.0 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i) / 12 * Area$) — V_{DESIGN} = 0.016 ac-ft

G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume
($V_{WQCV\ OTHER} = (d_6 * (V_{DESIGN}/0.43))$) — $V_{DESIGN\ OTHER}$ = ac-ft

H) User Input of Water Quality Capture Volume (WQCV) Design Volume (Only if a different WQCV Design Volume is desired) — $V_{DESIGN\ USER}$ = ac-ft

I) NRCS Hydrologic Soil Groups of Tributary Watershed
- i) Percentage of Watershed consisting of Type A Soils — HSG_A = 0 %
- ii) Percentage of Watershed consisting of Type B Soils — HSG_B = 100 %
- iii) Percentage of Watershed consisting of Type C/D Soils — $HSG_{C/D}$ = 0 %

J) Excess Urban Runoff Volume (EURV) Design Volume
For HSG A: $EURV_A = 1.68 * i^{1.28}$
For HSG B: $EURV_B = 1.36 * i^{1.08}$
For HSG C/D: $EURV_{C/D} = 1.20 * i^{1.08}$
— $EURV_{DESIGN}$ = 0.053 ac-f t

K) User Input of Excess Urban Runoff Volume (EURV) Design Volume (Only if a different EURV Design Volume is desired) — $EURV_{DESIGN\ USER}$ = ac-f t

2. Basin Shape: Length to Width Ratio
(A basin length to width ratio of at least 2:1 will improve TSS reduction.) — L : W = 2.0 : 1

3. Basin Side Slopes

A) Basin Maximum Side Slopes (Horizontal distance per unit vertical, 4:1 or flatter preferred) — Z = 4.00 ft / ft

4. Inlet

A) Describe means of providing energy dissipation at concentrated inflow locations:

5. Forebay

A) Minimum Forebay Volume (V_{FMIN} = 0% of the WQCV) — V_{FMIN} = 0.000 ac-ft — **A FOREBAY MAY NOT BE NECESSARY FOR THIS SIZE SITE**

B) Actual Forebay Volume — V_F = 0.0005 ac-ft

C) Forebay Depth (D_F = 12 inch maximum) — D_F = 6.0 in

D) Forebay Discharge

i) Undetained 100-year Peak Discharge — Q_{100} = 4.50 cfs

ii) Forebay Discharge Design Flow ($Q_F = 0.02 * Q_{100}$) — Q_F = 0.09 cfs

E) Forebay Discharge Design
Choose One
- ○ Berm With Pipe
- ◉ Wall with Rect. Notch
- ○ Wall with V-Notch Weir

Flow too small for berm w/ pipe

F) Discharge Pipe Size (minimum 8-inches) — Calculated D_P = in

G) Rectangular Notch Width — Calculated W_N = 2.1 in

Summary of Water Quality Conformance to MS4 Permit

The purpose of this worksheet is to document conformance with the Town of Castle Rock's MS4 permit with regard to permanent water quality on land disturbance projects.

Project Name Affinity at Castle Rock

Project Owner Affinity at Castle Rock, LLC

Project Location South of Meadows Parkway, west of East Plum Creek

ToCR Project Number CD22-0053

Total Site Area 17.4 **acres**

Total Size of Common Plan of Development _____ **acres**

Check all that apply:

- ☑ **Project within Plum Creek Basin**
- ☐ **Project within Cherry Creek Basin**

Estimated construction completion date _____

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1. The water quality control measure(s) for applicable development sites shall meet one of the following base design standards as per the SDDTCM Section 14.4. Please select all design standards that were applied to meet conformance with the MS4 on this site.

   - ☑ WQCV standard
   - ☐ Pollutant removal standard
   - ☐ Runoff reduction standard
   - ☐ Applicable site draining to regional WQVC control measure (accepts drainage prior to discharging to WOTS)
   - ☐ Applicable site draining to regional WQVC control facility (with receiving pervious area control measure upstream of WOTS)
   - ☐ Constrained redevelopment sites standard
     - Imperviousness of existing site _____/_____(Imp. Ac/Site Ac) =____%
     - Variance required TCV No. _____
   - ☐ Existing control measure with WQCV per previous criteria standards
     - Reference Construction Permit No. _____
   - ☐ Cherry Creek Basin only, choose one: ☐ Tier 1 ☐ Tier 2 ☐ Tier 3
   - ☑ No control measures provided (See Permanent WQ Worksheet for applicability)

Summary of Water Quality Conformance to MS4 Permit

2. Was an exclusion to water quality applied as per SDDTCM Section 13.1.5? ☑ Yes ☐ No

   i. If yes, please select all that apply, provide total excluded impervious area(s) and submit variance, as applicable: TCV No. TCV23-0___

   - ❒ Pavement management site
     Excluded impervious area: _____ acres
   - ❒ Excluded roadway redevelopment
     Excluded impervious area: _____ acres
   - ❒ Excluded existing roadway areas
     Excluded impervious area: _____ acres
   - ❒ Above ground and below ground utilities
   - ❒ Large lot single family home
   - ❒ Non-residential and non-commercial infiltration
     Excluded impervious area: _____ acres
   - ☑ Land disturbance for land to remain undeveloped
     Excluded impervious area: 5.69 acres
   - ❒ Stream Stabilization Sites
     Excluded impervious area: _____ acres
   - ❒ Trails
     Excluded impervious area: _____ acres
   - ❒ Oil and Gas Exploration

3. For Development and Redevelopment sites, following any exclusions claimed above, was any portion of the site excluded up to 20% of the site and not to exceed one acre? ☑ Yes ☐ No

   If yes, complete the following:

   Excluded area: 0.12 acres

   Total Site area: 17.36 acres, 0.7 % site excluded

4. For Constrained sites, was any portion of the site excluded up to 50% of the site and not to exceed 50% of the impervious area? ☐ Yes ☐ No

   If yes, complete the following:

   Excluded area: _____ acres

   Excluded impervious area: _____ acres

   Total Site area: _____ acres, _____ % site excluded

   Total Impervious area: _____ acres, _____ % impervious excluded

Permanent Water Quality Determination Worksheet (Taken from 2019 SDDTCM Sections 13.1.4 and 13.1.5)

Project:		**Project#**		**Applicant:**
Section	**Questions**	**Response**	**Check those that apply**	**Instructions**
1	**Non-applicable Sites**			
1.1	Will the project result in a temporary disturbance of greater than one acre?	No	☐	Proceed to section 1.2.
		Yes	☑	Proceed to section 2.
1.2	Is the project part of a larger common plan of development or sale where multiple separate and distinct construction activities may be taking place at different times on different schedules, but remain related and are within 1/4 mile of each other? (A common plan of development will generally be documented on a site development plan, master plan, or equivalent, for the property/project)	No	☐	Proceed to section 1.3.
		Yes	☐	Proceed to section 2.
1.3	Is the project within the Cherry Creek Watershed?	Yes	☐	Permanent water quality control measures may be required. Refer to Water Qualtiy Control Regulation 72.7 for details and allowable exclusions.
		No	☐	Permanent water quality control measures are not required.
2	**Applicable Site Types and Exclusions by Variance**			
2.1	Does the project have more than 35% impervious area on the existing site?	No	☑	Project is an applicable Development Site. Proceed to section 3.
		Yes	☐	Proceed to 2.2.
2.2	Does the project have greater than 75% impervious area on the existing site?	No	☐	Project is an applicable Redevelopment Site. Proceed to section 3.
		Yes	☐	Project is an applicable Constrainted Redevelopment Site. Proceed to 2.3.
2.3	Will 100% of the runoff from the existing and proposed site be captured and treated using one or more of the allowable design standards for permanent water quality?	Yes	☐	No further action required.
		No	☐	Proceed to 2.4.
2.4	Do any other water quality exclusions apply to the site?	No	☐	Portions of the project are excluded. Proceed with design in accordance with Constrained Redevelopment standards and apply for **variance** for Constrained Redevelopment Sites.
		Yes	☐	Proceed to section 3. Following approval of other exclusions, design remaining site in accordance with Constrained Redevelopment standards and apply for **variance** for Constrained Redevelopment Sites.
3	**Applicable Sites with Other Exclusions by Variance**			
3.1	**Category 1: Roadways, bridges and trails only**			
3.1.1	Is the project a bike or pedestrian trail?	Yes	☐	Proceed to next line.
		No	☐	Proceed to 3.1.2.
	Is the trail for a roadway?	Yes	☐	Proceed to 3.1.2.
		No	☐	Project is excluded. Submit **variance** for Trails Excluded from Permanent Water Quality Requirements.
3.1.2	Is the project primarily used for parking or access to parking?	Yes	☐	This exclusion does not apply. Permanent water quality is required.
		No	☐	Proceed to 3.1.3.
3.1.3	Does the project add impervious area?	No	☐	Project is excluded. Submit **variance** for Pavement Management Sites Excluded from Permanent Water Quality Requirements.
		Yes	☐	Proceed to 3.1.4.

Section	Questions	Response	Check those that apply	Instructions
3.1.4	Does the project add more than 8.25 feet of paved width at any location to the existing roadway?	No	☐	Project is excluded. Submit **variance** for Roadway Redevelopment Sites Excluded from Permanent Water Quality Requirements.
		Yes	☐	Proceed to next line.
	Does the project add more than one acre of paved area per mile to an existing roadway?	No	☐	Project is excluded. Submit **variance** for Roadway Redevelopment Sites Excluded from Permanent Water Quality Requirements.
		Yes	☐	Proceed to next line.
	Does the project increase the width by two times or more, on average, of the original roadway area?	No	☐	Existing areas of site are excluded only. Submit **variance** for Existing Roadway Surfaces Only Excluded from Permanent Water Quality Requirements.
		Yes	☐	This exclusion does not apply. Permanent water quality is required.
3.2	**Category 2: Non-residential and non-commercial projects only**			
3.2.1	Is the project associated with oil and gas exploration, production, processing, or treatment operations or transmission facilities, including activities necessary to prepare a site for drilling and the movement and placement of drilling equipment?	Yes	☐	Project is excluded. Submit **variance** for Oil and Gas Exploration Sites Excluded from Permanent Water Quality Requirements.
		No	☐	Proceed to 3.2.2.
3.2.2	Is the project for stream stabilization?	Yes	☐	Project is excluded. Submit **variance** for Stream Stabilization Sites Excluded from Permanent Water Quality Requirements.
		No	☐	Proceed to 3.2.3.
3.2.3	Is the project for installation or maintenance of aboveground or underground utilities or infrastructure that does not permanently alter the terrain, ground cover, or drainage patterns from those present prior to the construction activity including activities to install, replace or maintain utilities under roadways or other paved areas that return the surface to the same condition?	Yes	☐	Project is excluded. Submit **variance** for Aboveground and Underground Utilities Excluded from Permanent Water Quality Requirements.
		No	☐	Proceed to 3.2.4.
3.2.4	Is the project on undeveloped land (land with no human-made structures such as buildings or pavement) that will remain undeveloped after the project?	Yes	☐	Project is excluded. Submit **variance** for Sites with Land Disturbances to Undeveloped Land that will Remain Undeveloped Excluded from Permanent Water Quality Requirements.
		No	☐	Proceed to 3.2.5.
3.2.5	Will the post-project condition result in surface water discharge during the 80th percentile storm runoff event?	No	☐	Project is excluded. Submit **study** along with **variance** for Non-residential and Non-commercial Infiltration Conditions Excluded from Permanent Water Quality Requirements.
		Yes	☐	This exclusion does not apply. Permanent water quality is required.
3.3	**Category 3: Residential, Agricultural and Commercial projects**			
3.3.1	Is the project a single-family residential lot, or agricultural zoned lands, greater than or equal to 2.5 acres in size per dwelling unit?	Yes	☐	Proceed to next line.
		No	☑	Proceed to 3.3.2.
	Is the project site greater than 10% impervious?	No	☐	Project is excluded. Submit **variance** for Large Lot Single Family Sites Excluded from Permanent Water Quality Requirements.
		Yes	☐	Proceed to next line.
	Is the project site greater than 20% impervious?	Yes	☐	This exclusion does not apply. Permanent water quality is required.
		No	☐	Proceed to next line.
	Will the post-project condition result in surface water discharge during the 80th percentile storm runoff event?	No	☐	Project is excluded. Submit **study** along with **variance** for Large Lot Single Family Sites Excluded from Permanent Water Quality Requirements.
		Yes	☐	This exclusion does not apply. Permanent water quality is required.

Section	Questions	Response	Check those that apply	Instructions
3.3.2	Will 100% of the runoff from the residential or commercial site be captured?	Yes	☐	This exclusion does not apply. Permanent water quality is required.
		No	☑	Proceed to next line.
	Is all or a portion of the site undeveloped or will it remain undeveloped after construction?	Yes	☑	This portion of the project is excluded. Submit **variance** for Sites with Land Disturbance to Undeveloped Land that will Remain Undeveloped Excluded from Permanent Water Quality Requirements. Proceed to next line.
		No	☐	Proceed to next line.
	Is the remaining untreated impervious area greater than 20% of the site?	Yes	☐	This exclusion does not apply. Permanent water quality is required.
		No	☑	Proceed to next line.
	Is the remaining untreated impervious area greater than one acre?	Yes	☐	This exclusion does not apply. Permanent water quality is required.
		No	☑	Proceed to next line.
	Is it practicable to capture runoff from portions of the site that will not drain to a control measure?	No	☑	Document justification demonstrating that it is not practicable to capture runoff from this portion of the site in the **drainage report**. No further action is needed.
		Yes	☐	This exclusion does not apply. Permanent water quality is required.

WATER QUALITY COMPLIANCE SUMMARY

Project #: 211400
Project: Affinity at Castle Rock

Date: 1/24/2023
Date: 1/24/2023

Facility / Region	Basins	Area (ac)	Percentage of Total Area
Pond A	A1 - A11	6.08	35.1%
Pond B	B1 - B10	5.98	34.5%
Untreated to Meadows Pkwy	OS1	1.46	8.4%
Untreated to East Plum Creek	OS2, OS3	1.43	8.2%
Untreated Existing Detention	OS4	2.80	16.1%
Total Treated (excluding off-site treated)	A1 - A11 & B1 - B10	11.65	67.2%
Total Untreated Pervious	OS1 - OS4	5.57	32.1%
Total Untreated Impervious	OS1	0.12	0.7%
Total (Site Boundary)	-	17.34	100%

APPENDIX E

COPIES OF REFERENCED REPORTS AND DOCUMENTS

PREBLE'S MEADOW JUMPING MOUSE

HABITAT DOCUMENTATION

HRGreen

DEPARTMENT OF THE INTERIOR
U.S. FISH AND WILDLIFE SERVICE

FEDERAL FISH AND WILDLIFE PERMIT

3-201 (10/86)

2. AUTHORITY-STATUTES
16 USC 1539(a)
16 USC 1533(d)

REGULATIONS (ATTACHED)
50 CFR §13, 17, & 21

3. NUMBER
TE-064965-0

4. RENEWABLE	5. MAY COPY
X YES ___ NO	X YES ___ NO

6. EFFECTIVE	7. EXPIRES
	30 years from Issuance

1. PERMITTEE

Castle Rock Development Company
3033 East First Avenue, Suite 410
Denver, Colorado 80206
303-394-5500

Castle Rock Land Company, LLC
3033 East First Avenue, Suite 410
Denver, Colorado 80206
303-394-5500

8. NAME AND TITLE OF PRINCIPAL OFFICER (IF # 1 IS A BUSINESS)
Jim Riley, Development Manager

9. TYPE OF PERMIT
Endangered/Threatened Species

10. LOCATION WHERE AUTHORIZED ACTIVITY MAY BE CONDUCTED
A Portion of the Meadows Property in Douglas County, Colorado - as specified in the Permittee's EA/HCP.

11. CONDITIONS AND AUTHORIZATIONS:

A GENERAL CONDITIONS SET OUT IN SUBPART D OF 50 CFR § 13, AND SPECIFIC CONDITIONS CONTAINED IN FEDERAL REGULATIONS CITED IN BLOCK #2 ABOVE, ARE HEREBY MADE A PART OF THIS PERMIT. ALL ACTIVITIES AUTHORIZED HEREIN MUST BE CARRIED OUT IN ACCORD WITH AND FOR THE PURPOSES DESCRIBED IN THE APPLICATION SUBMITTED CONTINUED VALIDITY, OR RENEWAL, OF THIS PERMIT IS SUBJECT TO COMPLETE AND TIMELY COMPLIANCE WITH ALL APPLICABLE CONDITIONS, INCLUDING THE FILING OF ALL REQUIRED INFORMATION AND REPORTS.

B THE VALIDITY OF THIS PERMIT IS ALSO CONDITIONED UPON STRICT OBSERVANCE OF ALL APPLICABLE FOREIGN, STATE, LOCAL OR OTHER FEDERAL LAW

C. VALID FOR USE BY PERMITTEE NAMED ABOVE, AND HIS DESIGNATED AUTHORIZED AGENTS

D FURTHER CONDITIONS OF AUTHORIZATION ARE CONTAINED IN THE ATTACHED SPECIAL TERMS AND CONDITIONS.

☒ ADDITIONAL CONDITIONS AND AUTHORIZATIONS ON REVERSE ALSO APPLY

12. REPORTING REQUIREMENTS

AS DESCRIBED IN THE PERMITTEE'S EA/HCP.

ISSUED BY	TITLE	DATE
Ralph O. Morgenweck RALPH O. MORGENWECK	Regional Director	FEB 17 2004

ORIGINAL

U.S. FISH AND WILDLIFE SERVICE, LAKEWOOD, COLORADO
PERMIT CONDITIONS FOR TE-064965-0 page 2 of 4

E. All sections of Title 50 *Code of Federal Regulations*, parts 13 and 17 are conditions of this Permit (Attachments 1 and 2).

F. The Permittee agrees to allow U.S. Fish and Wildlife Service personnel to enter the property, upon reasonable notice, as identified in Block 10 of this Permit for general purposes as specified in 50 CFR § 13.21(d)(2).

G. The authorization granted by this Permit is subject to compliance with, and implementation of, the final "Environmental Assessment/Habitat Conservation Plan for the Issuance of an Endangered Species Act Section 10(a)(1)(B) Permit for the Incidental Take of the Preble's Meadow Jumping Mouse, *Zapus hudsonius preblei* (Preble's), for a portion of the Meadows Property in Douglas County, Colorado" (EA/HCP), which is hereby incorporated into this Permit.

H. In the event that any judicial decision or determination, including without limitation the decision from the District Court for the District of Columbia in *Spirit of the Sage, et al v. Norton, et al, 98-CV-1873 (D.D.C. 2003)*, may hold that the Department of the Interior's "No Surprises" assurances rule (or similar successive rule) is vacated, unenforceable or enjoined for any reason or to any extent, the assurances as stated in Section 6.6.4 of the EA/HCP shall be enforceable only to the degree allowed by any such decision or determination; provided that the remainder of the EA/HCP shall remain in full force and effect to the maximum extent permitted by law. In the event that the "No Surprises" assurances rule may be vacated, unenforceable or enjoined by such decision or determination but is later reinstated, the provision in the EA/HCP shall likewise be automatically reinstated and apply to the entire term of this HCP. If, in response to any such judicial decision or determination, the "No Surprises" assurance rule is revised, the provision in the EA/HCP shall be automatically amended in a manner consistent with the revised rule so as to afford the maximum protection to the Permittee consistent with the revised rule.

I. The Permittee and agents designated by the Permittee are authorized under the Federal Endangered Species Act of 1973, as amended (Act), to incidentally take those Preble's associated with the permanent take of 8.6 acres and temporary take of 24.87 acres of suitable habitat. If this level of incidental take is exceeded, the Permittee shall immediately provide an explanation of the causes of the taking and review with the Service the need for possible modification of the reasonable and prudent measures.

J. The Permittee, or agents designated by the Permittee, shall ensure that the mitigation measures described in the EA/HCP to avoid, minimize, and compensate for adverse impacts to the Preble's and its habitat are completed.

K. The Permittee, or agents designated by the Permittee, shall ensure that any incidental take of Preble's complies with all terms and conditions of the Biological Opinion (ES/LK-6-CO-04-F-002) accompanying this Permit and incorporated herein by reference.

L. The Permittee, or agents designated by the Permittee, shall ensure that workers onsite will be informed by the Permittee, or agents designated by the Permittee, as to the reason for, and importance of, limiting impacts within habitat located outside the designated fenced work area.

PERMIT CONDITIONS FOR TE-064965-0, cont'd, page 3 of 4

M. The Permittee, or agents designated by the Permittee, shall ensure that activities in the subject property follow Best Management Practices as described in the EA/HCP.

N. The Permittee, or agents designated by the Permittee, shall conduct annual monitoring of all revegetation efforts and other mitigation efforts for the first five-year period or until success is achieved, as described in the EA/HCP. Compliance reports shall be forwarded to the Service after each growing season of each calendar year.

O. The Permittee, or agents designated by the Permittee, shall submit a Restoration Plan to the Service for review and approval at least 30 days prior to undertaking any development that will involve temporary disturbances to vegetation. The Restoration Plan will outline measures to meet success criteria and mitigation objectives as described in the EA/HCP. No development may occur prior to obtaining Service approval of said Restoration Plan.

P. The Permittee, or agents designated by the Permittee, shall submit a Vegetation Enhancement Plan to the Service for review and approval at least 60 days prior to undertaking any construction activities for Parcels A and B, new trail development, or water well development. The Enhancement Plan will outline revegetation measures to meet success criteria and mitigation objectives as described in the EA/HCP. No development may occur prior to obtaining Service approval of said Enhancement Plan.

Q. Prior to development or temporary disturbance of the subject property, the Permittee shall provide to the Service's Colorado Field Office a signed, executed Declaration of Use Restrictions (deed restriction or conservation easement) and a finalized trust account, irrevocable letter of credit, insurance or surety bond, as described in the EA/HCP. This Permit is conditional on the submission of the abovementioned documents; therefore, no construction or disturbance of any kind, temporary or permanent, will be allowed on the subject site until such documents are received and approved by the Service.

R. The Permittee shall notify the Service of any transfer of ownership of any lands within the permitted HCP project area, before the transfer is finalized. The new landowner will be regarded by the Service as having the same rights with respect to the Permit as the original landowner, provided that the new landowner agrees to be bound by the terms and conditions of the original Permit, as explained by the original Permittee upon Permit transfer. Actions taken by the new landowner resulting in the incidental take of species covered by the Permit would be authorized if the new landowner agrees to the Permit and continues to implement the minimization and mitigation strategies of the HCP.

S. Upon finding dead, injured, or sick endangered or threatened wildlife species, the Permittee or designated agents must notify, orally within 1 working day, the Service's Colorado Field Office. Written notification to the Colorado Field Office must be made within 3 working days and must include the date, time, and location of the specimen and any other pertinent information. Dead animals may be marked in an appropriate manner, photographed, and left on site. Should any sick or injured animals survive, the Service should be contacted regarding final disposition of the animals. Care should be taken in handling sick or injured specimens to ensure effective treatment and care taken in handling dead specimens to preserve biological materials in the best possible state for later analysis of cause of death. In conjunction with the care of sick or injured endangered species or preservation of biological materials from a dead animal, the finder has the responsibility to ensure that evidence intrinsic to the specimen is not unnecessarily disturbed. In the event that a species has been taken in contravention of any Federal, State, or local law, all relevant information shall be reported within 24 hours to the Colorado Field Office or the Service's Division of Law Enforcement in Lakewood, Colorado (telephone 303-274-3560).

PERMIT CONDITIONS FOR TE-064965-0, cont'd, page 4 of 4

T. A copy of this Permit must be in the possession of the Permittee or designated agents while conducting activities. Please refer to the Permit number in all correspondence concerning Permit activities.

U. The Permittee and the U.S. Fish and Wildlife Service acknowledge that even with the above detailed provisions for mitigating impacts to Preble's, circumstances could arise which were not fully anticipated by this Permit and which are considered unforeseen. Such circumstances may become apparent either to the Permittee, his authorized agents, or to personnel of the Service. For purposes of implementation of this condition, unforseen circumstances are defined as any significant, unanticipated adverse change in the status of the species; any significant, unanticipated adverse change in impacts of the Projects, or in other factors upon which the HCP and Permit are based; or any other significant new information relevant to the Permit and Project that was unforseen by the Permittee and the Service that could give rise to the need to review the Permittee's conservation program. If unforseen circumstances arise, the Permittee and the contact office of the Service shall meet within twenty (20) working days following notice of such unforseen circumstances. In the event that any unforseen circumstances interfere with the success of the conservation program, Permittee will submit to the Service a supplemental Vegetation Enhancement Plan or Restoration Plan. Upon approval by the Service, the unforseen circumstances will be remedied to the extent practicable by the means identified in the relevant Restoration Plan or Vegetation Enhancement Plan. In the event of unforseen events, the Service shall not require the commitment of additional land or financial compensation beyond the level of mitigation otherwise provided for in this Permit and associated EA/HCP, recognizing that the mitigation provided herein is adequate to provide for the conservation of Preble's. If additional mitigation measures are subsequently deemed by the Service to be necessary to provide for the conservation of Preble's, the obligation for such measures shall not rest with the Permittee, unless the Permittee consents to such measures.

V. For purposes of administration of the monitoring and compliance aspects, addressing unforseen circumstances, and other matters associated with implementation of this Permit, the contact office of the U.S. Fish and Wildlife Service is:

Field Supervisor
U.S. Fish and Wildlife Service
Colorado Field Office
755 Parfet Street, Suite 361
Lakewood, CO 80215
Telephone 303-275-2370

- END OF PERMIT TE-064965-0 -

OFFICIAL RECORDS
DOUGLAS COUNTY CO
CAROLE R. MURRAY
CLERK & RECORDER
RECORDING FEE: $56.00
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10/19/2004 04:41 PM

DECLARATION OF USE RESTRICTIONS

2004107699 11 PGS

THIS DECLARATION OF USE RESTRICTIONS (this "Declaration") is made as the date set forth below next to the signature of Declarant, as hereinafter defined, by and between **CASTLE ROCK LAND CO., LLC**, a Colorado limited liability company, whose address is 3033 East First Avenue, Suite 410, Denver, Colorado 80206, (hereinafter referred to as "Declarant") for the benefit of the **UNITED STATES FISH AND WILDLIFE SERVICE** (hereinafter referred to as "Service").

RECITALS

This Declaration is made with respect to the following facts:

WHEREAS, Declarant is the owner of certain real property located within the Town of Castle Rock, County of Douglas, State of Colorado (the "Property"); and

WHEREAS, the Preble's meadow jumping mouse ("PMJM") is listed as a threatened species under the United States Endangered Species Act ("ESA"). The ESA prohibits the unlawful take of PMJM; and

WHEREAS, Declarant anticipates that it will undertake certain activities on the Property which may impact PMJM habitat. As a result, Declarant has applied for and received from the Service an Incidental Take Permit under Section 10 of the ESA (the "Incidental Take Permit"); and

WHEREAS, the Habitat Conservation Plan approved by the Service in granting the Incidental Take Permit (the "HCP") requires that the temporary and permanent impacts of Declarant's activities within the Property be mitigated by (a) maintaining that portion of the Property which is more particularly described in Exhibit A, attached hereto and incorporated herein (the "Open Space Property") as open space; and (b) by adhering to the mitigation measures which are more particularly described in the HCP; and

WHEREAS, the HCP requires Declarant, prior to the development of any portion of the Property, to execute a deed restriction or conservation easement, with the Service as a beneficiary, to ensure that the Open Space Property shall remain as open space consistent with the terms and conditions of the HCP; and

WHEREAS, Declarant desires to establish the Restrictions, as hereinafter defined, on the Open Space Property, consistent with and in accordance with the terms and provisions of the Incidental Take Permit and the HCP, as hereinafter set forth.

DECLARATION

NOW, THEREFORE, Declarant hereby declares that from and after the date of this Declaration, the Open Space property shall be owned, held, transferred, conveyed, sold, leased, rented, hypothecated, encumbered, used, occupied, maintained, altered and improved at all times subject to the Restrictions set forth in this Declaration, which are declared to be a part of, pursuant to, and in furtherance of a common and general plan for the improvement and development of the Open Space Property. The provisions of this Declaration are imposed as equitable servitudes upon the Open Space Property, and are intended to and shall run with the land and shall bind, be charged upon, and inure to the benefit of the Service, its successors and assigns.

RESTRICTIONS

I. Use Limitations.

Subject to the conditions and limitations set forth below, the Open Space Property shall be perpetually maintained in a scenic, natural or open condition, and shall be used only for purposes consistent with such limitation, including but not limited to the Permitted Uses and Practices set forth below. The Service shall have the right from time to time, upon reasonable prior written notice to Declarant and in a manner that will not unreasonably interfere with Declarant's use of the Open Space Property in a manner that is consistent with this Declaration, to enter upon the Open Space Property to inspect the Open Space Property and to enforce its rights under this Declaration.

II. Permitted Uses and Practices. Declarant shall have the right to use the Open Space Property for any use that is consistent with the foregoing obligation to maintain the Open Space Property in a scenic, natural or open condition. Without limiting the generality of the foregoing, Declarant shall further have the following specific retained rights with respect to the use of the Open Space Property:

2.1 Any and all uses of the Open Space Property permitted under the HCP, as amended from time to time, or as otherwise approved by the Service.

2.2 Maintenance, repair, replacement, removal and use of all fences, roads, trails and structures existing on the Open Space Property as of the date of this Declaration, substantially in their present condition and not to exceed their existing permanent footprint.

2.3 Installation, maintenance, repair, removal, relocation, and replacement of existing drainage facilities and underground utility mains, lines and facilities for the purpose of providing utility services and drainage to or through the Open Space Property substantially in their present condition. The foregoing notwithstanding, the planned sanitary sewer line that is located in the northwesterly portion of the area subject to the HCP, as generally depicted in Figure 7 of the HCP, shall be deemed an existing utility for purposes of this Section 2.3, provided that at the time such line is constructed, any disturbance to the Open Space Property shall be restored, using

native vegetation, to the grade and condition it was in immediately prior to said construction except as may be necessary to accommodate any above ground appurtenances associated with the sewer line (such as, by way of example but not limitation, manholes), substantially in accordance with the provisions of the HCP.

2.4 Weed control through the application of agrochemicals, including but not limited to fertilizers and biocides, but only in those amounts and with the frequency of application necessary to accomplish suppression of noxious weeds and maintenance or enhancement of PMJM habitat. Declarant shall have the right to control all noxious weeds on the Open Space Property according to the provisions of Title 35 of the Colorado Revised Statutes and/or any rules and regulations promulgated by the Commissioner of Agriculture of the State of Colorado, by the Board of County Commissioners of Douglas County, Colorado, or the Town Council of the Town of Castle Rock Colorado, or any other governmental agency having jurisdiction over the Open Space Property.

2.5 Control of predatory and problem animals by the use of techniques that will control specific animals or species which have caused or are likely to cause damage to the Open Space Property, provided that any such control techniques shall have no adverse effects on the biological integrity of the Open Space Property as habitat for the PMJM.

2.6 Passive recreation, other than that permitted within the conditions identified within the Section 10(a) Incidental Take Permit, shall be permitted as long as those activities will have no adverse effects on the biological integrity of the Open Space Property as PMJM habitat.

2.7 Any use approved by the Town Council of the Town of Castle Rock and Service.

III. Prohibited Uses.

3.1 Except as otherwise provided in the HCP or the Incidental Take Permit, no alterations will occur in the Open Space Property that would have a material adverse impact on the biological integrity of the Open Space Property as PMJM habitat, including, but not limited to: (a) dumping or placing of soil, or other material, such as trash, on the Open Space Property; (b) mowing, removal or destruction of vegetation, except as otherwise set forth in Section 2.4, above; (c) excavation of soil; and (d) activities detrimental to flood control, water conservation or erosion control.

3.2 Free roaming pets, including but not limited to domestic cats and dogs, are prohibited on the Open Space Property.

IV. Enforcement.

4.1 The Service shall have the right to enforce the Restrictions set forth in this Declaration. The right of enforcement shall include only the right to bring an action for equitable relief, including, without limitation, any action to enjoin any violation or specifically enforce the Restrictions or other provisions of this Declaration.

V. TERM

5.1 This Declaration shall be perpetual in duration. The foregoing notwithstanding, in the event that the PMJM is removed from the list of threatened or endangered species under the ESA as a result of a final determination by the Service that the PMJM was listed as a threatened or endangered species as a result of erroneous information, the Service shall execute a termination and release of this Declaration and thereafter this Declaration shall terminate and be of no further force and effect.

VI. MISCELLANEOUS

6.1 This Declaration shall be binding upon Declarant and its successors in interest to the Open Space Property. The terms "Declarant" and "Service", whenever used herein, and any pronouns used in place thereof, shall mean and include the above-named Declarant and Declarant's successors, assigns and lessees, and the above-named Service and its successors and assigns, respectively.

6.2 If any provision of this Declaration or the application thereof to any person or circumstance is found to be invalid, the remainder of the provisions of this Declaration and the application of such provisions to persons or circumstances other than those as to which it is found to be invalid, shall not be affected thereby.

6.3 This Declaration may be modified only by an instrument in writing, duly executed by the Service and the then current owner or owners of the entirety of the Open Space Property.

IN WITNESS WHEREOF, the Declarant has caused this Declaration to be duly executed this 15th day of October, 2004.

CASTLE ROCK LAND CO., LLC
a Colorado limited liability company

By: _____
Title: Authorized Agent

STATE OF COLORADO)
) ss.
City & COUNTY OF Denver)

The foregoing instrument was acknowledged before me this 15th day of Oct, 2004, by John Fox as Authorized Agent of Castle Rock Land Co., LLC, a Colorado limited liability company.

Witness my hand and official seal.

(S E A L)

Stephanie L. Sims
Notary Public
State of Colorado
My Commission Expires 11/01/2007

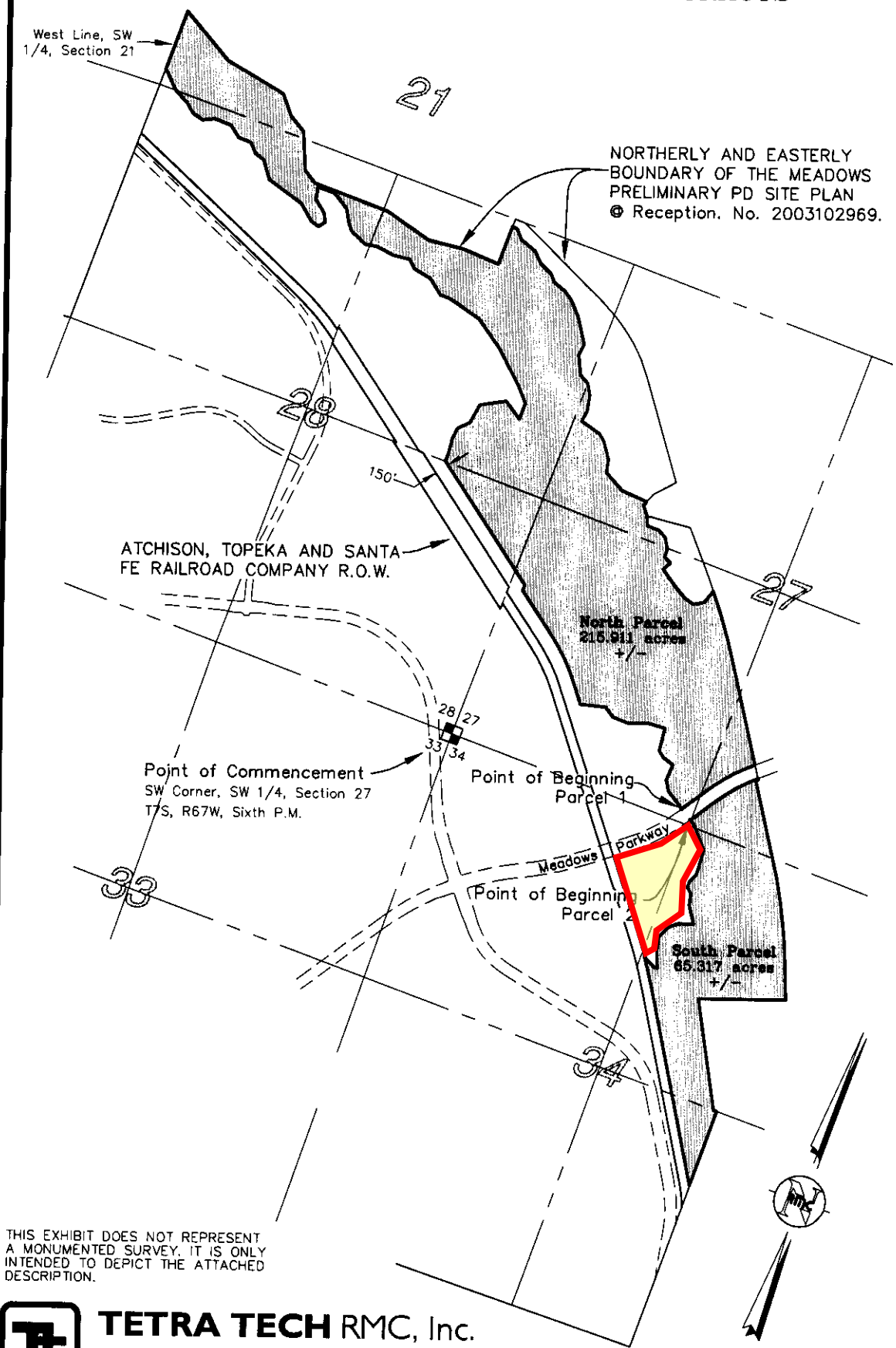
Notary Public

My Commission Expires: _____

EXHIBIT

EXHIBIT A
Page 5 of 5

HCP PROPERTY – CONSERVATION TRACTS



THIS EXHIBIT DOES NOT REPRESENT A MONUMENTED SURVEY. IT IS ONLY INTENDED TO DEPICT THE ATTACHED DESCRIPTION.

TETRA TECH RMC, Inc.
8301 E. Prentice Ave., Suite 101, Greenwood Village, CO. 80111
TEL 303.741.6000 FAX 303.741.6106

Scale: 1" = 1200'

JOB NO. 3572.005.02	DATE: 07-30-2004	REVISED

TOWN OF CASTLE ROCK

STORMWATER MASTER PLAN UPDATE

HRGreen

Stormwater Master Plan Update 2017

Stormwater Division

Table 3-5 – Capital Improvement Projects In-Progress

PROJECT	TYPE	STATUS	COST
East Plum Creek at Meadows Pkwy (Joint Project with Castle Rock Water)	Stream Stabilization	Construction	$700,000
East Plum Creek at South Well Field (Joint Project with Castle Rock Water)	Stream Stabilization	Permitting	$1,512,000
Douglas Lane Tributary Stabilization Phase I	Stream Stabilization	Design	$1,250,000
Sellars Gulch at Plum Creek Pkwy Culvert Rehabilitation (80% Grant Funded through CDOT Bridge Rehab Program)	Storm Drainage Conveyance	Design	$680,000
Hangman's Gulch Stabilization Phases III & IV	Stream Stabilization	Design	$1,263,000
Omni Tributary at Wolfensberger Road Culvert	Storm Drainage Conveyance/ Flood Control	Design	$567,000
		TOTAL	**$5,972,000**

e. Inspection and Maintenance

- Implementation of Cartegraph Asset Management tracking for all stormwater maintenance and inspection activities.
- Annual cleaning of all stormwater catch basins and underground water quality vaults since 2010.

f. Stormwater Quality and Regulatory Administration

- Adoption of Storm Drainage Design and Technical Criteria Manual Update in 2012
- Adoption of Grading, Erosion and Sediment Control/Drainage, Erosion and Sediment Control Manual Update in 2011 and 2015

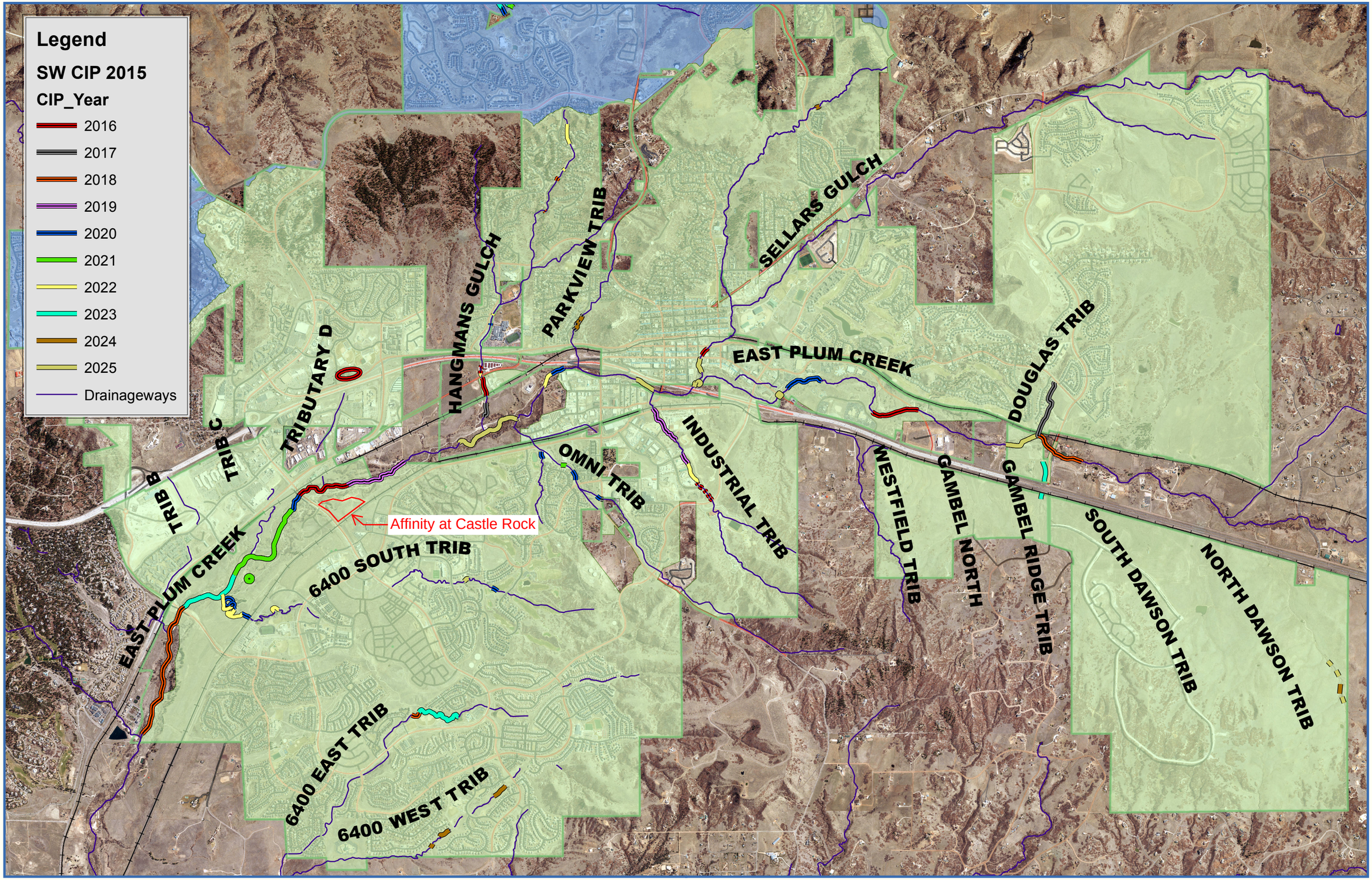
g. Stormwater Enterprise Staffing

- The Enterprise increased staffing levels from 10.4 full-time equivalents in 2010 to 16.0 full-time equivalents in 2017 including the addition of one field services technician, stormwater specialist and project manager.

h. Stormwater Enterprise Funding

- The Enterprise increased stormwater monthly charges from $6.08 in 2011 to

Figure 5.12 - Ten Year CIP Plum Creek Basin

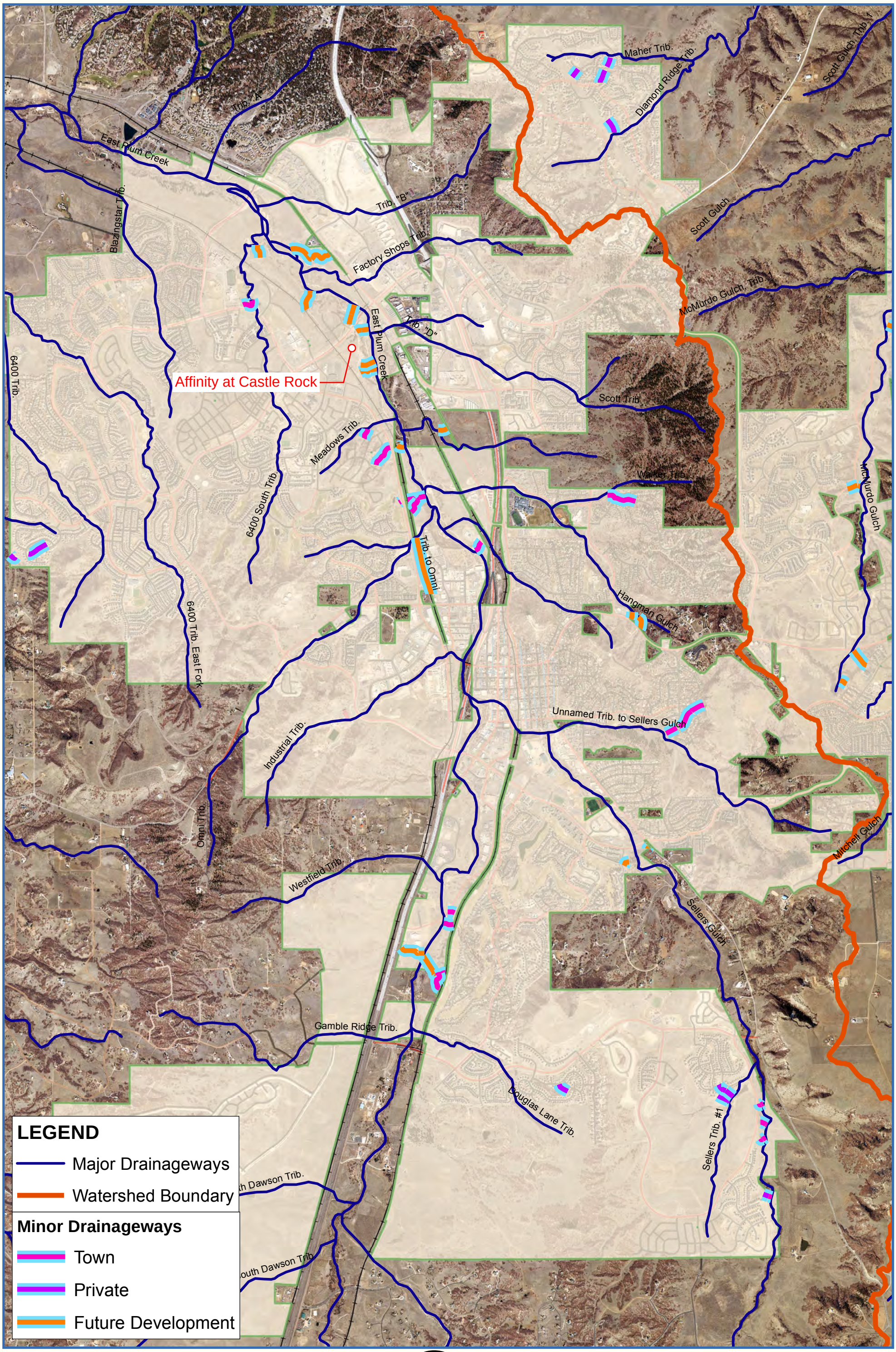


10-YEAR CAPITAL PLAN
PLUM CREEK BASIN

Disclaimer: The data presented has been compiled from various sources, each of varying degrees of accuracy and completeness. The Town of Castle Rock assumes no liability for it's use or accuracy. Questions or comments regarding the cartographic composition of this map including, but not limited to, omissions or inaccuracies should be directed to (720) 733-6087. Utilities Department, Town of Castle Rock. (720) 733-6087. Copyright 2012. Town of Castle Rock Utilities Mapping.

1 inch = 3,000 feet

CASTLE ROCK Water
Securing our future drop by drop



CASTLE ROCK Qwater
Securing our future drop by drop

1 inch = 3,000 feet

Disclaimer: The data presented has been compiled from various sources, each of which introduces varying degrees of inaccuracies or inconsistencies. Such discrepancies in data are inherent and in supplying this product the Town of Castle Rock assumes no liability for it's use or accuracy. Questions or omments regarding the cartographic composition of this map including, but not limited to, errors, omissions, corrections, and/or updates, should be directed to the Utilities Department, Town of Castle Rock, (720) 733-6087. Copyright 2012, Town of Castle Rock Utilities Mapping.

MINOR DRAINAGEWAY LONG-TERM CAPITAL PLAN PLUM CREEK BASIN

East Plum Creek major Drainageway Plan

Enginuity Engineering Solutions, September 2016

HRGreen

Executive Summary

Background

The Town of Castle Rock, herein referred to as the Town, has grown from a small, rural town of 3,900 citizens in 1980 to a community of over 40,000 today. As the Town continues to grow, new buildings and paved areas such as parking lots, driveways and roads create impervious areas that prevent stormwater from naturally infiltrating into the ground. This urbanization creates additional storm runoff that can cause downstream erosion and unstable channels, and can pick up pollutants not found in natural stormwater. If this urban runoff is not controlled from both a quantity and quality perspective, it can create public safety issues from flooding, cause property damage, and have adverse impacts on downstream water quality affecting public health, recreation, vegetation, aquatic life, and wildlife.

In early 2004, the Town adopted its first Stormwater Master Plan (SWMP) to address stormwater issues in a comprehensive manner. The SWMP provided the foundation for the Town's storm water utility, and focused on key big-picture issues such as federal regulatory requirements, a long-term capital improvement plan, program funding, and drainage master planning. The SWMP recommended that several additional more detailed master drainageway planning studies be done on critical basins in the Town, and presented a prioritization schedule for completing these plans. The East Plum Creek watershed was determined to be one of the Town's higher priorities for a major drainageway master plan.

East Plum Creek is a major drainageway serving as the principal means of conveying runoff from south to north through the center of the Town of Castle Rock as shown in Figure i-1. The contributing area of the watershed from the upper reaches of East Plum Creek to the downstream limits of the Town Boundary is approximately 122 square miles. East Plum Creek is a watershed that originates south of Town and has a large drainage basin. Development in the watershed ranges from highly urbanized clusters of single family, multi-family, and commercial land uses within the Town to agricultural land uses and forested areas in the upper reaches.

On July 24th, 2007 Town Council approved the proposed contract between the Town and CH2M HILL, INC (Consultant) for the East Plum Creek Master Plan and Flood Hazard Area Delineation (FHAD) as presented by Castle Rock's Utilities Department. The purpose of this study is to determine mainstem improvements along East Plum Creek, and does not include tributaries to East Plum Creek.

The final Watershed Master Plan was submitted to the Town in November, 2008. At the regular meeting of the Town Utilities Commission on December 10, 2008, approval of the Master Plan was recommended to Town Council. On January 6, 2009, Town Council passed, approved, and adopted Resolution 2009-03, a resolution approving the East Plum Creek Drainageway Master Plan. Copies of the Utilities Commission Meeting Minutes and Council Resolution are presented as Figure i-7.

Purpose and Objectives

A Master Plan and FHAD are being developed for East Plum Creek through the corporate limits of the Town (Study Area) shown in Figure i-1, which will provide a current comprehensive drainage plan for areas of the watershed that are within the Study Area. This information will serve to establish a framework for the development of drainage and stream stability improvements that will be implemented in the future. Specifically, the Master Plan will discuss how watershed runoff impacts the East Plum Creek channel and what strategies may be employed to mitigate the impacts to stormwater conveyance, floodplain management, stream stability, and stormwater quality.

This East Plum Creek Drainageway Master Plan is intended to document the hydrologic analysis, hydraulic analysis, alternative evaluations, and recommended improvements for the study area. If there is an identified area that closely contributes to the mainstem of East Plum Creek an alternative analysis and preliminary design may be presented for these specific conditions. In general, the results of this study may not be representative of more detailed studies performed on individual sub basins. From a hydrologic standpoint, the individual sub basins should generally be modeled with more refined basin delineations along with shorter duration higher intensity rainfall events to establish their respective peak flows. The hydraulic performance of individual sub basins on a more refined scale will differ when hydraulic structures, such as culverts and detention ponds, are included in the analysis.

Planning Process

The Master Planning of East Plum Creek was developed in two distinct phases: 1) Alternatives Evaluation Phase and 2) Preliminary Design Phase. The Alternatives Evaluation Phase includes elements that quantify the hydrology associated with existing and future development conditions for the Study Area. In addition to the hydrologic analysis, stream stability and water quality analyses of the Study Area were conducted. Alternatives were developed that can mitigate the identified impacts. The Preliminary Design Phase develops a preliminary design of hydraulic facilities along the East Plum Creek mainstem.

Project Area Description

The East Plum Creek Watershed lies primarily in Douglas County, with small portions of the south part of the watershed in El Paso County and Teller County, Colorado. East Plum Creek originates in Teller County, Colorado near Saylor Park and the Rampart Range. From this forested area of the watershed, East Plum Creek drains approximately 13 miles mile to its confluence with Carpenter Creek, which is approximately ¼ mile south of Larkspur, Colorado. From this location, East Plum Creek drains mostly north to northwest following the I-25 corridor. East Plum Creek joins West Plum Creek about one half mile southwest of Sedalia and form Plum Creek, which flows northwest to Chatfield Reservoir.

The Study Area includes the portions of East Plum Creek within the corporate limits of the Town. The total contributing area to the downstream corporate Town limit is measured to be 122 square miles. The 122 square mile watershed is composed of developed land, undeveloped land, forested areas, and land committed to agricultural use and open space. Most of the developed land is seen in or slightly south of the Town limits in Douglas County. Other portions of developed areas are located within the Town of Larkspur and the northern edge of the Town of Monument which are both found in the southern portion of the watershed.

Engineering Analysis

A hydrologic analysis for the watershed was conducted to estimate stormwater runoff associated with existing and future development conditions. The analysis was conducted for both development conditions using the 2, 5, 10, 25, 50, and 100-year design rainfall events. The Hydrologic Engineering Center Hydrologic Modeling System (HEC-HMS) was used to synthesize adjusted rainfall distributions and hydrologic parameters to create outflow hydrographs for 17 sub basins within the watershed. The

Alternative Analysis

The foundation of the planning process was the development of a range of plans and plan elements that provide the framework for protection of the watershed. To do this, the stretch of East Plum Creek through the study area was separated into six defined reaches. The reaches are identical to the reaches defined previously in the Stream Stability Assessment.

The portion of East Plum Creek through the study area is innately diverse. As such, constructing an alternative matrix requires the separation of improvement alternatives that differ by nature and priority. Alternative development was done by creating sub-plans with respective priority rankings. Below are the three sub plans used for this study:

- Sub Plan A: This plan will address problems and / or concerns associated with infrastructure, conveyance, and flooding
- Sub Plan B: Sub plan B will address problems and/or concerns associated with recreational improvements, public appeal, aesthetics, and opportunities to enhance the watershed
- Sub Plan C: Sub plan C will address problems and/or concerns associated with stream stability, bank erosion, and tributary issues

Each sub plan is then applied a priority. The priority ranking ranges from one to three and defines the criticality, or sensitivity of the identified problem.

Description of Recommended Plan

After evaluation of several alternatives, the Town selected the Recommended Alternative as the plan that provides the Town with the best tool to manage current and future storm runoff and assure the East Plum Creek is protected. Elements of this plan will provide suitable protections for existing and proposed developments while also preserving and enhancing the environment and water quality of East Plum Creek. The Recommended Plan (Plan) in general utilizes drop structures 2′ – 5′ in height to stabilize the low flow channel. Bank protection is called for in areas with severely eroded banks. In general the recommended plan will raise the channel invert, increasing the groundwater table and increasing flood frequency in the overbanks. This will result in preservation of the riparian habitat and will increase wetland areas in the study area.

Watershed Master Plan

Subsequent to the identification of the Plan, the Engineer was directed to prepare a preliminary design of the recommended improvements. This design is intended to further the project elements identified in the alternate plan evaluation and to better define specific elements and cost. Implementation of the proposed Plan can be accomplished in a sequential manner. Recommended priorities for stabilizing the profile of the channel are:

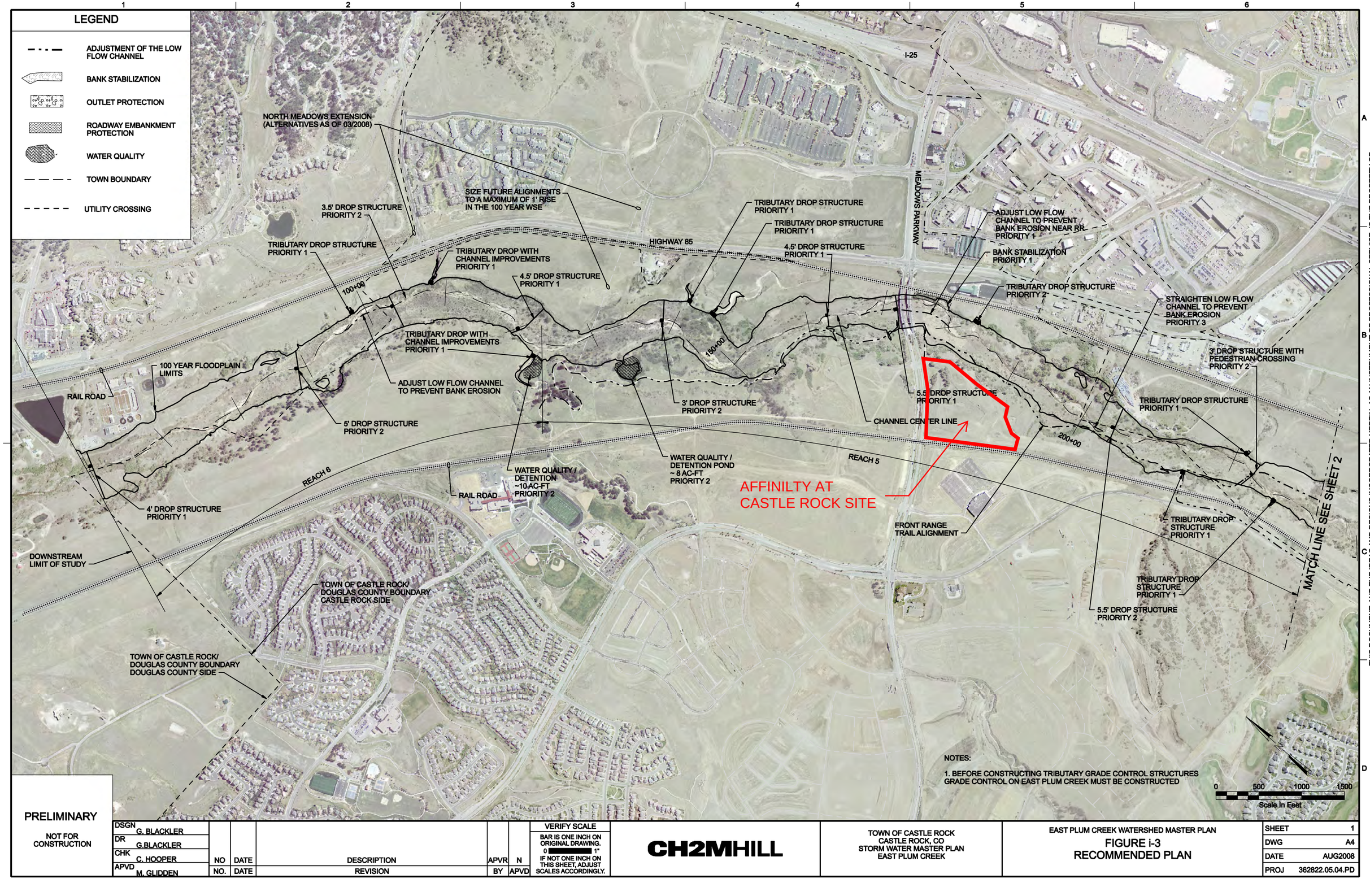
- Priority 1: Improvements under this priority are required to protect critical structures and private property or are necessary now to mitigate damage to existing flood control facilities and environmentally sensitive areas. Drop structures under this priority are identified at locations with active head cutting or stream bed erosion where the potential for damage is imminent.
- Priority 2: Improvements under this priority will be necessary to protect critical structures and private property or to preserve environmentally sensitive areas of East Plum Creek if development or significant changes to the watershed occur. Drop structures under this priority are located to provide hydraulic controls that address the majority of the anticipated threats associated with long term channel instability.
- Priority 3: Improvements under this priority are long term improvements. These will help to enhance the existing condition of the corridor and protect structures if conditions warrant. Prior to implementing any improvements recommended under this priority, streams should be monitored for changes or further bank erosion and channel degradation. If the priority 1 and 2 improvements do not completely stabilize the channel bed or if there are major changes in the watershed. Then these improvements should be considered.

The following is a summary of Priority 1, 2, and 3 improvements.

Priority 1 improvements include all drop structures providing grade control to utility crossings, hydraulic structures, tributary confluences, and the joint drop structure with Sellars Gulch. All tributary drop structures with head cutting and/or erosion to the existing hydraulic structure, the 28-acre-ft detention pond at the Omni tributary, bank protection where property is at risk from erosion, and the demolition of the old Crystal Valley Parkway Bridge are also Priority 1 improvements. Priority 2 improvements include drop structures not providing grade control to hydraulic structures, utility crossings, or tributary confluences, tributary drop structures where head cutting and/or erosion has not occurred, water quality ponds, and bank improvements where property is not at risk. Priority 3 improvements include the drop structures near the private roads in Reach 1 and roadway embankments for future crossings. Elements of the adopted plan are shown as Figures i-3 to i-5.

In addition to the general drainage improvement elements, an effort was made to estimate the required water quality and detention volume for the downtown area. This was intended to define ways to mitigate past impacts from downtown development and to establish detention sites that can be used in lieu of detention physically located in the downtown area. Computations indicated a 28 acre-ft detention pond is needed to offset the runoff from the downtown area. The Omni Tributary was selected as the location of the detention pond because there is sufficient drainage through this tributary to offset the runoff from downtown and there is sufficient space available to store the desired volume of water. Water quality ponds are also at outfalls from the downtown area to treat stormwater runoff. Approximately 5 acre-ft of water quality storage is required for the downtown area. The recommended improvements suggest approximately 10 acre-ft of water quality storage is available to mitigate impacts for future development in the downtown area. The locations of the water quality ponds are shown in Appendix D.

The costs associated with the Recommended Plan are summarized in Table i-4. No costs associated with easement acquisition or operations and maintenance are presented in this table. Contingency and construction access costs are 30% and 5% of the drainageway costs, respectively. The sum of the drainageway, contingency, and construction access is the subtotal. Mobilization costs are 15% of the subtotal. The sum of the mobilization costs and the subtotal is the construction total. Engineering and administration costs are 20% of the construction total.



REUSE OF DOCUMENTS: THIS DOCUMENT, AND THE IDEAS AND DESIGNS INCORPORATED HEREIN, AS AN INSTRUMENT OF PROFESSIONAL SERVICE, IS THE PROPERTY OF CH2M HILL AND IS NOT TO BE USED, IN WHOLE OR IN PART, FOR ANY OTHER PROJECT WITHOUT THE WRITTEN AUTHORIZATION OF CH2MHILL. © CH2M HILL

PRELIMINARY

NOT FOR CONSTRUCTION

DSGN	G. BLACKLER	NO	DATE	DESCRIPTION	APVR	N	VERIFY SCALE
DR	G.BLACKLER						BAR IS ONE INCH ON ORIGINAL DRAWING. 0 1" IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.
CHK	C. HOOPER	NO.	DATE	REVISION	BY	APVD	
APVD	M. GLIDDEN						

CH2MHILL

TOWN OF CASTLE ROCK
CASTLE ROCK, CO
STORM WATER MASTER PLAN
EAST PLUM CREEK

EAST PLUM CREEK WATERSHED MASTER PLAN

FIGURE i-3
RECOMMENDED PLAN

SHEET	1
DWG	A4
DATE	AUG2008
PROJ	362822.05.04.PD

Commentary Sheet 3

East Plum Creek

Existing Condition: This section of East Plum Creek flows through rural and agricultural areas and is characterized by a relatively wide floodplain and steep embankments. At some locations within this section, slope failure has occurred due to severe bank erosion, and some locations within this reach cannot support vegetation due to the incised banks and degradation of the low flow channel. This section of East Plum Creek flows under the Meadows Parkway Bridge and is joined by Tributary D at Station 183+00. Just upstream of Meadows Parkway, the east bank has been eroded close to the railroad. In this section, the slope of the main channel is too large requiring the use of drop structures to stabilize the channel.

Proposed Improvements: In this section, recommended Priority 1 improvements are a 4.5' drop structure at Station 162+60, a 5.5' drop structure at Station 171+50, bank stabilization with riprap at between Station 173+50 and 178+00, and adjustment of the low flow channel between Station 168+00 and 179+00. The drop structure at Station 171+50 is downstream of Meadows Parkway Bridge and provides grade control for the channel in that area. The adjustment of the low flow channel is recommended to prevent further erosion at the bank's toe. Priority 2 recommended improvements are a 5' drop structure at Station 204+70 and a 2' drop structure at Tributary D. The adjustment of the low flow channel between Station 201+00 and 204+00 is recommended as a Priority 3 improvement.

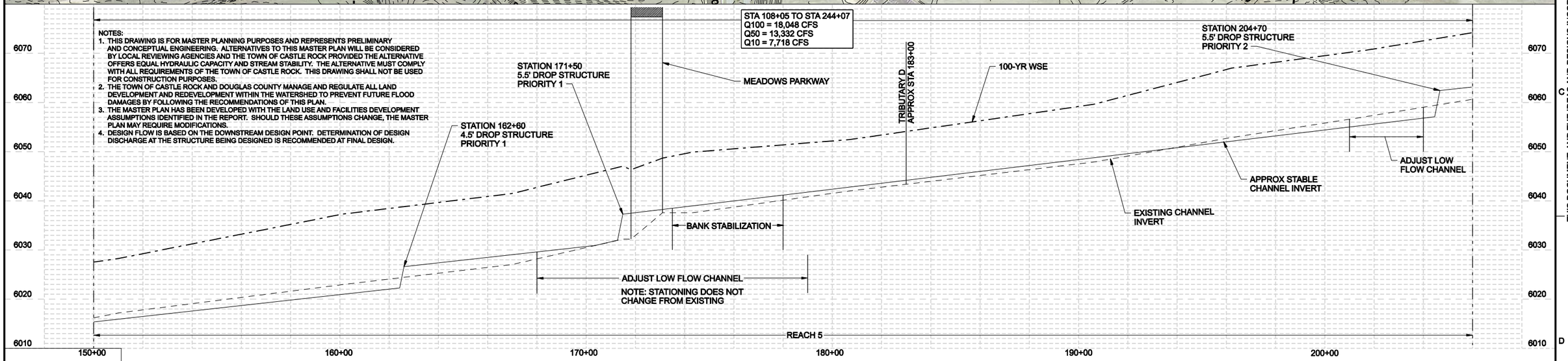
* Priority 3 subtotal costs include 30% of drainageway costs for contingency and unscoped items and 5% of drainageway costs for construction access. The construction total is the subtotal plus 15% of the subtotal for mobilization and permitting requirements. The total cost is the construction total plus 20% of the construction total for administration and engineering.

* Drop structure costs are a combination of grouted sloping boulders and riprap in the main channel and sheet pile extending to the 100-year floodplain.

Stations: STA 150+00 to 206+00

Preliminary Design Cost Estimate

Item	Priority	Unit	Quantity	Unit Cost	Total Cost	Cost to Utilities	Cost to Other
Bank Stabilization with Riprap between Sta 173+50 and 178+00	1	SF	15000	$ 8	$ 120,000	$ 60,000	$ 60,000
Drop Structure at Station 162+60	1	Each	1	$ 130,000	$ 130,000	$ 65,000	$ 65,000
Drop Structure at Station 171+50	1	Each	1	$ 167,000	$ 167,000	$ 83,500	$ 83,500
Adjustment of Low Flow Channel between Station 168+00 and 179+00	1	LF	1,100	$ 19	$ 20,900	$ 20,900	
Drop Structure at Tributary D - Sta 183+00	2	Each	1	$ 80,000	$ 80,000	$ 40,000	$ 40,000
Drop Structure at Station 204+70	2	Each	1	$ 168,000	$ 168,000	$ 84,000	$ 84,000
Adjustment of Low Flow Channel between Station 201+00 and 204+00	3	LF	300	$ 19	$ 5,700	$ 5,700	
Drainageway Costs (Priority 1)					$ 437,900	$ 229,400	$ 208,500
Contingency and Unscoped Items (30% of Drainageway Costs)					$ 131,000	$ 69,000	$ 63,000
Construction Access (5% of Drainageway Costs)					$ 22,000	$ 11,000	$ 10,000
Subtotal (Priority 1)					$ 590,900	$ 309,400	$ 281,500
Mobilization and Permitting Requirements (15% of Subtotal)					$ 89,000	$ 46,000	$ 42,000
Construction Total (Priority 1)					$ 679,900	$ 355,400	$ 323,500
Administration and Engineering (20% of Construction Total)					$ 136,000	$ 71,000	$ 65,000
Total (Priority 1)					**$ 815,900**	$ 426,400	$ 388,500
Drainageway Costs (Priority 2)					$ 248,000	$ 124,000	$ 124,000
Contingency and Unscoped Items (30% of Drainageway Costs)					$ 74,000	$ 37,000	$ 37,000
Construction Access (5% of Drainageway Costs)					$ 12,000	$ 6,000	$ 6,000
Subtotal (Priority 2)					$ 334,000	$ 167,000	$ 167,000
Mobilization and Permitting Requirements (15% of Subtotal)					$ 50,000	$ 25,000	$ 25,000
Construction Total (Priority 2)					$ 384,000	$ 192,000	$ 192,000
Administration and Engineering (20% of Construction Total)					$ 77,000	$ 38,000	$ 38,000
Total (Priority 2)					**$ 461,000**	$ 230,000	$ 230,000
Drainageway Costs (Priority 3)					$ 5,700	$ 5,700	$ -
Total (Priority 3)					**$ 11,000**	$ 11,000	$ -
Total Cost					**$ 1,288,000**	$ 667,000	$ 619,000
Operations and Maintenance (50 Years)					**$ 560,000**		
Total Estimated Cost					**$ 1,847,900**		



NOTES:
1. THIS DRAWING IS FOR MASTER PLANNING PURPOSES AND REPRESENTS PRELIMINARY AND CONCEPTUAL ENGINEERING. ALTERNATIVES TO THIS MASTER PLAN WILL BE CONSIDERED BY LOCAL REVIEWING AGENCIES AND THE TOWN OF CASTLE ROCK PROVIDED THE ALTERNATIVE OFFERS EQUAL HYDRAULIC CAPACITY AND STREAM STABILITY. THE ALTERNATIVE MUST COMPLY WITH ALL REQUIREMENTS OF THE TOWN OF CASTLE ROCK. THIS DRAWING SHALL NOT BE USED FOR CONSTRUCTION PURPOSES.
2. THE TOWN OF CASTLE ROCK AND DOUGLAS COUNTY MANAGE AND REGULATE ALL LAND DEVELOPMENT AND REDEVELOPMENT WITHIN THE WATERSHED TO PREVENT FUTURE FLOOD DAMAGES BY FOLLOWING THE RECOMMENDATIONS OF THIS PLAN.
3. THE MASTER PLAN HAS BEEN DEVELOPED WITH THE LAND USE AND FACILITIES DEVELOPMENT ASSUMPTIONS IDENTIFIED IN THE REPORT. SHOULD THESE ASSUMPTIONS CHANGE, THE MASTER PLAN MAY REQUIRE MODIFICATIONS.
4. DESIGN FLOW IS BASED ON THE DOWNSTREAM DESIGN POINT. DETERMINATION OF DESIGN DISCHARGE AT THE STRUCTURE BEING DESIGNED IS RECOMMENDED AT FINAL DESIGN.

NOTE: TOPOGRAPHY FROM TOWN OF CASTLE ROCK (2006), NAVD 88 VERTICAL DATUM, NAD 83 STATE PLANE COLORADO CONTROL HORIZONTAL DATUM AERIAL MAPPING FROM TOWN OF CASTLE ROCK (2006)

DSGN G BLACKLER						VERIFY SCALE	CH2MHILL
DR A COOK						BAR IS ONE INCH ON ORIGINAL DRAWING. 0 1"	
CHK C HOOPER	NO	DATE	DESCRIPTION	APVR	N	IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.	
APVD M GLIDDEN	NO.	DATE	REVISION	BY	APVD		

TOWN OF CASTLE ROCK COLORADO

EAST PLUM CREEK
PRELIMINARY DESIGN
STA 150+00 TO STA 206+00

SHEET	3
DWG	PP-3
DATE	AUG 2008
PROJ	362822

FILENAME: PDepncpp004.dgn PLOT DATE: 11/20/2008 PLOT TIME: 4:27:33 PM

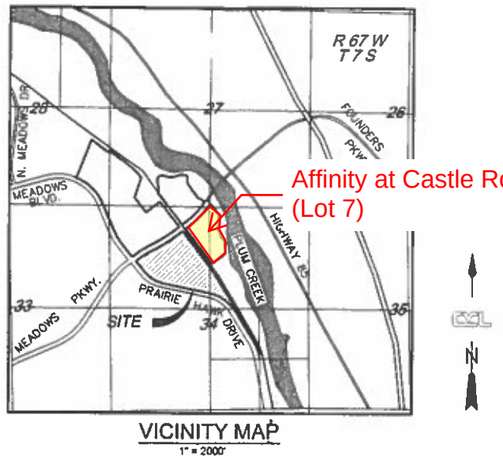
REUSE OF DOCUMENTS: THIS DOCUMENT, AND THE IDEAS AND DESIGNS INCORPORATED HEREIN, AS AN INSTRUMENT OF PROFESSIONAL SERVICE, IS THE PROPERTY OF CH2M HILL AND IS NOT TO BE USED, IN WHOLE OR IN PART, FOR ANY OTHER PROJECT WITHOUT THE WRITTEN AUTHORIZATION OF CH2MHILL. © CH2M HILL

THE MEADOWS FILING 17

CONSTRUCTION PLANS

HRGreen

CONSTRUCTION PLANS
FOR
THE MEADOWS FILING 17
LOT 5 AND 6
TOWN OF CASTLE ROCK



VICINITY MAP
1" = 2000'

SHEET INDEX

1	TITLE SHEET
2	CONSTRUCTION NOTES
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4	OVERLOT GRADING PLAN
5	OVERLOT GRADING PLAN
6	EROSION CONTROL PLAN
7	STREET A PLAN AND PROFILE
8	STREET B PLAN AND PROFILE
9	STREET B PLAN AND PROFILE
10	STREET C PLAN AND PROFILE
11	OVERALL UTILITY PLAN
12	STORM DRAIN PLAN AND PROFILE
13	STORM DRAIN PLAN AND PROFILE
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16	DETENTION POND GRADING
17	DETENTION POND DETAIL SHEET
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19	SANITARY SEWER PLAN AND PROFILE - LINE A
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24	WATERLINE PLAN AND PROFILE - STREET B
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26	DETAIL SHEET
27	DETAIL SHEET
28	DETAIL SHEET
29	DETAIL SHEET
30	DETAIL SHEET
31	EROSION CONTROL DETAIL SHEET

BASIS OF BEARING:

BEARINGS ARE BASED ON THE EASTERLY LINE OF THE SOUTHEAST QUARTER OF SECTION 27, TOWNSHIP 7 SOUTH, RANGE 67 WEST OF THE 6TH PRINCIPAL MERIDIAN, TOWN OF CASTLE ROCK, COUNTY OF DOUGLAS, STATE OF COLORADO AS BEING NORTH 00°04'44" EAST A DISTANCE OF 2629.60 FEET:
–THE EAST QUARTER CORNER BEING A FOUND 3.25" ALUM. CAP, LS 14166.
–THE SOUTHEAST CORNER BEING A FOUND 2.5" ALUM. CAP, LS 17848.

BENCHMARK:

THE PROJECT BENCHMARK IS A FOUND 3" DOUGLAS COUNTY CONTROL POINT BRASS CAP IN CONCRETE STAMPED 2.015030 LOCATED APPROXIMATELY 400 FEET NORTHEAST OF THE BNSF RAILROAD IN THE NORTHWEST QUARTER OF SECTION 27, TOWNSHIP 7 SOUTH, RANGE 67 WEST OF THE 6TH PRINCIPAL MERIDIAN, TOWN OF CASTLE ROCK, COUNTY OF DOUGLAS, STATE OF COLORADO. BENCHMARK ELEVATION BEING 6082.17 FEET BASED ON THE TOWN OF CASTLE ROCK VERTICAL CONTROL, NAVD 1988 DATUM. INTERCEPTOR PHASE I IS ON NAV. 29 TO BE CHANGED TO NAV. 88 AT AS-BUILT STAGE.

GENERAL NOTES

1. ALL MATERIALS, WORKMANSHIP, AND CONSTRUCTION OF PUBLIC IMPROVEMENTS SHALL MEET OR EXCEED THE STANDARDS AND SPECIFICATIONS SET FORTH IN THE CASTLE ROCK PUBLIC WORKS REGULATIONS, AND APPLICABLE STATE AND FEDERAL REGULATIONS. WHERE THERE IS CONFLICT BETWEEN THESE PLANS AND THE SPECIFICATIONS, OR ANY APPLICABLE STANDARDS, THE HIGHER QUALITY STANDARD SHALL APPLY. ALL WORK SHALL BE INSPECTED AND APPROVED BY THE TOWN OF CASTLE ROCK (TCR) PUBLIC WORKS INSPECTOR.

2. THE CONTRACTOR IS SPECIFICALLY CAUTIONED THAT THE LOCATION AND/OR ELEVATION OF EXISTING UTILITIES, AS SHOWN ON THESE PLANS, IS BASED ON RECORDS OF THE VARIOUS UTILITY COMPANIES AND, WHERE POSSIBLE, MEASUREMENTS TAKEN IN THE FIELD. THE INFORMATION IS NOT TO BE RELIED UPON AS BEING EXACT OR COMPLETE. THE CONTRACTOR MUST CALL THE LOCAL UTILITY LOCATION CENTER AT LEAST 48 HOURS BEFORE ANY EXCAVATION TO REQUEST EXACT FIELD LOCATIONS OF THE UTILITIES. PRIOR TO CONSTRUCTION, THE CONTRACTOR SHALL VERIFY PERTINENT LOCATIONS AND ELEVATIONS, ESPECIALLY AT CONNECTION POINTS AND AT POTENTIAL UTILITY CONFLICTS. IT SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR TO RELOCATE ALL EXISTING UTILITIES THAT CONFLICT WITH THE PROPOSED IMPROVEMENTS SHOWN ON THESE PLANS.

3. THE CONTRACTOR SHALL BE RESPONSIBLE FOR OBTAINING ALL NECESSARY PERMITS FOR APPLICABLE AGENCIES. THE CONTRACTOR SHALL NOTIFY THE TCR PUBLIC WORKS INSPECTOR AT LEAST 48 HOURS PRIOR TO THE START OF ANY EARTH DISTURBING ACTIVITY, OR CONSTRUCTION ON ANY AND ALL PUBLIC IMPROVEMENTS.

4. THE CONTRACTOR SHALL COORDINATE AND COOPERATE WITH THE TOWN, AND ALL UTILITY COMPANIES INVOLVED, WITH REGARD TO RELOCATIONS OR ADJUSTMENTS OF EXISTING UTILITIES DURING CONSTRUCTION, AND TO ASSURE THAT THE WORK IS ACCOMPLISHED IN A TIMELY FASHION AND WITH A MINIMUM DISRUPTION OF SERVICE. THE CONTRACTOR SHALL BE RESPONSIBLE FOR CONTACTING ALL PARTIES AFFECTED BY ANY DISRUPTION OF ANY UTILITY SERVICE.

5. THE CONTRACTOR SHALL HAVE ONE (1) SIGNED COPY OF THE APPROVED PLANS, AND ONE (1) COPY OF THE APPROPRIATE STANDARDS AND SPECIFICATIONS, AND A COPY OF ANY PERMITS AND EXTENSION AGREEMENTS NEEDED FOR THE JOB, ON-SITE AT ALL TIMES.

GENERAL NOTES (CONT.)

6. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ALL ASPECTS OF SAFETY INCLUDING, BUT NOT LIMITED TO, EXCAVATION, TRENCHING, SHORING, TRAFFIC CONTROL, AND SECURITY.

7. IF, DURING THE CONSTRUCTION PROCESS, CONDITIONS ARE ENCOUNTERED WHICH COULD INDICATE A SITUATION THAT IS NOT IDENTIFIED IN THE PLANS OR SPECIFICATIONS, THE CONTRACTOR SHALL CONTACT THE TCR PUBLIC WORKS INSPECTOR IMMEDIATELY.

8. ALL REFERENCES TO ANY PUBLISHED STANDARDS SHALL REFER TO THE LATEST REVISION OF SAID STANDARD, UNLESS SPECIFICALLY STATED OTHERWISE.

9. THE CONTRACTOR SHALL SUBMIT A TRAFFIC CONTROL PLAN, IN ACCORDANCE WITH MUTCD, TO THE APPROPRIATE RIGHT-OF-WAY AUTHORITY, (TOWN, COUNTRY OR STATE), FOR APPROVAL, PRIOR TO ANY CONSTRUCTION ACTIVITIES WITHIN, OR AFFECTING, THE RIGHT-OF-WAY. THE CONTRACTOR SHALL BE RESPONSIBLE FOR PROVIDING ANY AND ALL TRAFFIC CONTROL DEVICES AS MAY BE REQUIRED BY THE CONSTRUCTION ACTIVITIES.

10. THE CONTRACTOR IS RESPONSIBLE FOR PROVIDING ALL LABOR AND MATERIALS NECESSARY FOR THE COMPLETION OF THE INTENDED IMPROVEMENTS, SHOWN ON THE DRAWINGS, OR DESIGNATED TO BE PROVIDED, INSTALLED, OR CONSTRUCTED UNLESS SPECIFICALLY NOTED OTHERWISE.

11. THE CONTRACTOR SHALL BE RESPONSIBLE FOR KEEPING ROADWAYS FREE AND CLEAR OF ALL CONSTRUCTION DEBRIS AND DIRT TRACKED FROM THE SITE.

12. THE CONTRACTOR SHALL BE RESPONSIBLE FOR RECORDING AS-BUILT INFORMATION ON A SET OF RECORD DRAWINGS KEPT ON THE CONSTRUCTION SITE, AND AVAILABLE TO THE TCR PUBLIC WORKS INSPECTOR AT ALL TIMES.

13. DIMENSIONS FOR LAYOUT AND CONSTRUCTION ARE NOT TO BE SCALED FROM ANY DRAWING. IF PERTINENT DIMENSIONS ARE NOT SHOWN, CONTACT THE CONSULTANT ENGINEER FOR CLARIFICATION, AND ANNOTATE THE DIMENSION ON THE AS-BUILT RECORD DRAWINGS.

14. THE CONTRACTOR SHALL COMPLY WITH ALL TERMS AND CONDITIONS OF THE COLORADO PERMIT FOR STORM WATER DISCHARGE, THE STORM WATER MANAGEMENT PLAN, AND THE EROSION CONTROL PLAN.

GENERAL NOTES (CONT.)

15. ALL STRUCTURAL EROSION CONTROL MEASURES SHALL BE INSTALLED, AT THE LIMITS OF CONSTRUCTION, PRIOR TO ANY OTHER GROUND-DISTURBING ACTIVITY. ALL EROSION CONTROL MEASURES SHALL BE MAINTAINED IN GOOD REPAIR BY THE CONTRACTOR, UNTIL SUCH TIME AS THE ENTIRE DISTURBED AREAS IS STABILIZED WITH HARD SURFACE OR LANDSCAPING.

16. THE CONTRACTOR SHALL SEQUENCE INSTALLATION OF UTILITIES IN SUCH A MANNER AS TO MINIMIZE POTENTIAL UTILITY CONFLICTS. IN GENERAL, STORM SEWER AND SANITARY SEWER SHOULD BE CONSTRUCTED PRIOR TO INSTALLATION OF THE WATER LINES AND DRY UTILITIES.

17. THERE SHALL BE NO SITE CONSTRUCTION ACTIVITIES ON SATURDAYS, UNLESS SPECIFICALLY APPROVED BY THE TCR PUBLIC WORKS INSPECTOR, AND NO SITE CONSTRUCTION ACTIVITIES ON SUNDAYS OR HOLIDAYS, UNLESS THERE IS PRIOR WRITTEN APPROVAL BY THE PUBLIC WORKS DIRECTOR.

18. FOR BENCHMARK AND BASIS OF BEARINGS DATA, REFER TO THE LOWER LEFTHAND CORNER OF THIS SHEET.

19. ALL CONSTRUCTION TRAFFIC SHALL UTILIZE THE ROUTES APPROVED BY THE TOWN.

STANDARD ABBREVIATIONS

AC	–ASPHALTIC CONCRETE
BCR	–BEGINNING OF CURB RETURN
BM	–BENCHMARK
BW	–BOTTOM OF WALL
CI	–CURVE LABEL (SEE CURVE TABLE)
CL	–CENTER LINE
CP	–CONTROL POINT
CPP	–CORRUGATED PLASTIC PIPE
DIA	–DIAMETER
E	–ELECTRIC
EL	–ELEVATION
EQ	–EQUAL
EXIST	–EXISTING
FF	–FINISHED FLOOR
FG	–FINISHED GRADE
FH	–FIRE HYDRANT
FL	–FLOW LINE
G	–GAS
GB	–GRADE BREAK
HDCP	–HANDICAP
HORIZ	–HORIZONTAL
HP	–HIGH POINT
ID	–INSIDE DIAMETER
INV	–INVERT
JT	–JOINT TRENCH
LI	–LINE LABEL (SEE LINE TABLE)
LF	–LINEAL FEET
LS	–LANDSCAPE
MATL	–MATERIAL
MAX	–MAXIMUM
MH	–MANHOLE
MIN	–MINIMUM
NO	–NUMBER
OD	–OUTSIDE DIAMETER
PC	–POINT OF CURVATURE
PCC	–POINT OF COMPOUND CURVATURE
PCR	–POINT CURB RETURN
PT	–POINT OF TANGENCY
PVC	–POLYVINYL CHLORIDE PIPE
R	–RADIUS
RCP	–REINFORCED CONCRETE PIPE
RL	–RIDGELINE
RR	–RAILROAD
SAN	–SANITARY
SF	–SQUARE FOOTAGE
STM	–STORM
T	–TELEPHONE
TC	–TOP OF CURB
TF	–TOP OF FOOTING
TG	–TOP OF GRATE
TW	–TOP OF WALL
TYP	–TYPICAL
VERT	–VERTICAL
W	–WATER
W/	–WITH

INDEMNIFICATION AND ADHERENCE TO STANDARDS STATEMENTS

THESE PLANS HAVE BEEN REVIEWED BY THE TOWN OF CASTLE ROCK FOR CONCEPT ONLY. THE REVIEW DOES NOT IMPLY RESPONSIBILITY BY THE REVIEWING DEPARTMENT, THE TOWN ENGINEER, OR THE TOWN OF CASTLE ROCK FOR ACCURACY AND CORRECTNESS OF THE CALCULATIONS. FURTHERMORE, THE REVIEW DOES NOT IMPLY THAT QUANTITIES OF ITEMS ON THE PLANS ARE THE FINAL QUANTITIES REQUIRED. THE REVIEW SHALL NOT BE CONSTRUED FOR ANY REASON AS ACCEPTANCE OF FINANCIAL RESPONSIBILITY BY THE TOWN FOR ADDITIONAL QUANTITIES OF ITEMS SHOWN THAT MAY BE REQUIRED DURING THE CONSTRUCTION PHASE.

ALL WORK SHALL BE CONSTRUCTED IN ACCORDANCE WITH THE TOWN OF CASTLE ROCK "STANDARD CONSTRUCTION SPECIFICATIONS FOR PUBLIC WORKS" AND/OR OTHER TOWN-APPROVED APPLICABLE STANDARDS.

CAUTION - NOTICE TO CONTRACTOR

THE CONTRACTOR IS SPECIFICALLY CAUTIONED THAT THE LOCATION AND/OR ELEVATION OF EXISTING UTILITIES AS SHOWN ON THESE PLANS IS BASED ON RECORDS OF THE VARIOUS UTILITY COMPANIES AND, WHERE POSSIBLE, MEASUREMENTS TAKEN IN THE FIELD. THE INFORMATION IS NOT TO BE RELIED ON AS BEING EXACT OR COMPLETE. THE CONTRACTOR MUST CALL THE LOCAL UTILITY LOCATION CENTER AT LEAST 48 HOURS BEFORE ANY EXCAVATION TO REQUEST EXACT FIELD LOCATIONS OF THE UTILITIES. IT SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR TO RELOCATE ALL EXISTING UTILITIES WHICH CONFLICT WITH THE PROPOSED IMPROVEMENTS SHOWN ON THE PLANS.

CONTACTS

OWNER

CASTLE ROCK LAND COMPANY, LLC
3033 EAST 1ST AVENUE, #410
DENVER, COLORADO 80206
ATTN: JOHN FOX
(303) 394-5500

DEVELOPER

CASTLE ROCK DEVELOPMENT COMPANY
3033 EAST 1ST AVENUE, #410
DENVER, COLORADO 80111
ATTN: JIM RILEY
(303) 394-5500

CIVIL ENGINEER

CVL CONSULTANTS OF COLORADO, INC.
7901 E. BELLEVIEW AVE., SUITE 150
ENGLEWOOD, CO 80111
ATTN: KURT A. LANG, P.E.
(720) 482-9526

CALL UNCC
TWO WORKING DAYS
BEFORE YOU DIG
1-800-922-1987
534-8700 METRO DENVER AREA
UTILITY NOTIFICATION CENTER OF COLORADO

LEGEND

- EXISTING FIRE HYDRANT
- EXISTING VALVE
- PROPOSED VALVE
- EXISTING MANHOLE
- PROPOSED MANHOLE
- EXISTING LIGHT STANDARD
- EXISTING FENCE
- EXISTING ELECTRIC LINE
- EXISTING TELEPHONE LINE
- EXISTING GAS LINE
- EXISTING SANITARY LINE
- PROPOSED SANITARY LINE
- EXISTING WATER/FIRE LINE
- PROPOSED WATERLINE
- EXISTING STORM DRAINAGE LINE
- EXISTING POWER POLE W/ O.H. LINES
- PROPERTY LINE
- EXISTING MAJOR CONTOURS
- PARCEL BOUNDARY
- EXISTING R.R. TRACKS
- LIMITS OF GRADING

I HEREBY AFFIRM THAT THESE FINAL CONSTRUCTION PLANS WERE PREPARED UNDER MY DIRECT SUPERVISION IN ACCORDANCE WITH ALL APPLICABLE TOWN OF CASTLE ROCK AND STATE OF COLORADO STANDARDS AND STATUTES, RESPECTIVELY, AND THAT I AM FULLY REPONSIBLE FOR ALL DESIGN AND REVISIONS SHOWN ON SAID PLANS.

KURT A. LANG, COLORADO P.E. 32249 DATE

TOWN OF CASTLE ROCK APPROVALS
THESE PLANS ARE HEREBY APPROVED FOR ONE YEAR FROM DATE OF DEVELOPMENT SERVICES DIRECTOR APPROVAL

RECOMMEND APPROVAL BY: _____ Development Services 2/22/05
ENGINEERING DIVISION DATE

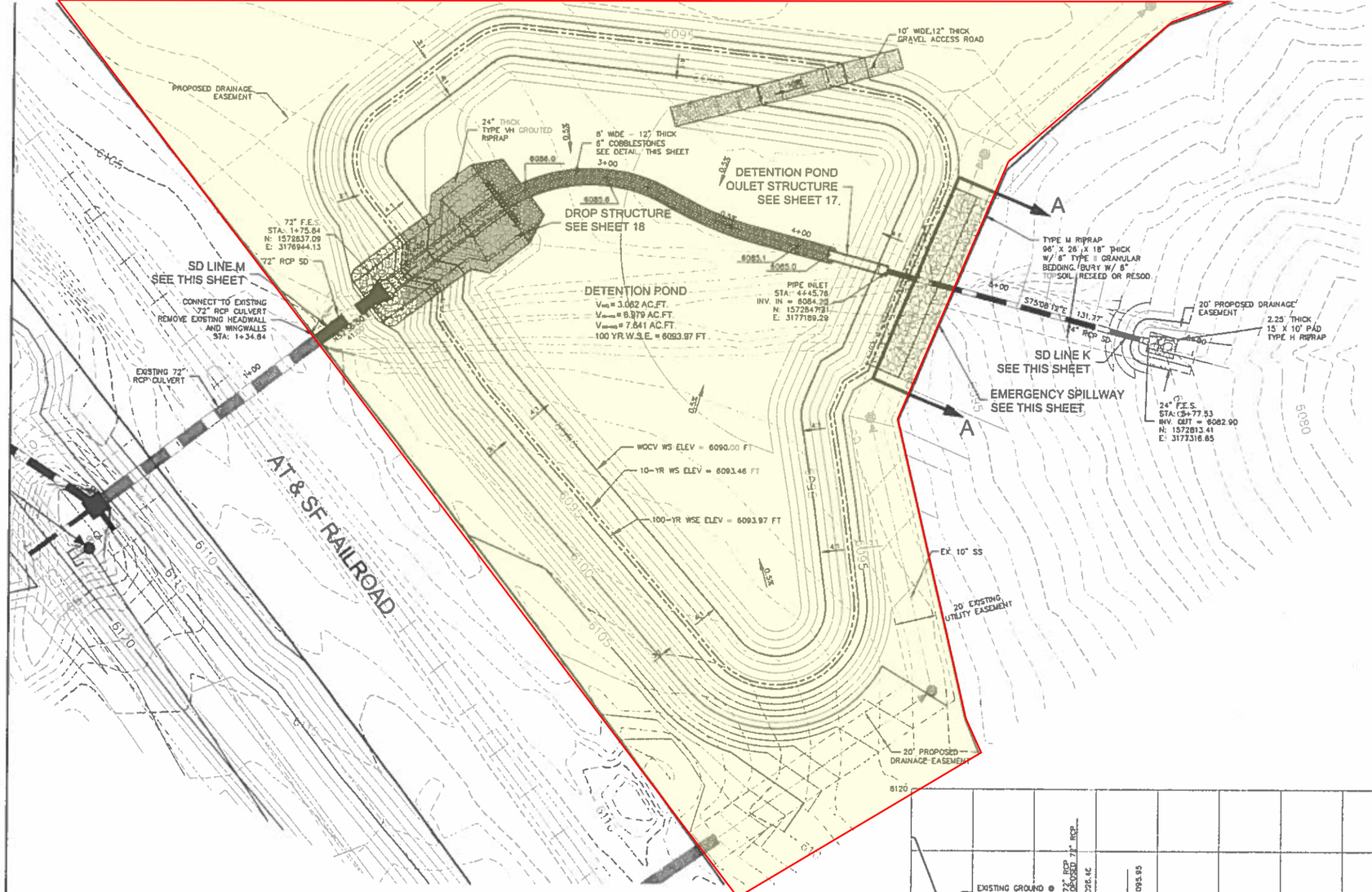
APPROVED BY: _____ 2/22/2005
Castle Rock

THE MEADOWS FILING 17

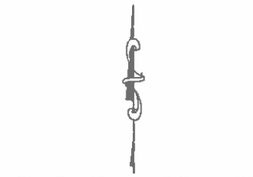
SCALE:

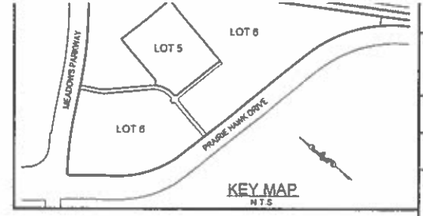
DRAWN BY:

NUMBER



PLAN: DETENTION POND
HORIZONTAL SCALE: 1" = 30'





CALL UNCC
TWO WORKING DAYS
BEFORE YOU DIG
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LEGEND

- EXISTING FIRE HYDRANT
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- PROPOSED VALVE
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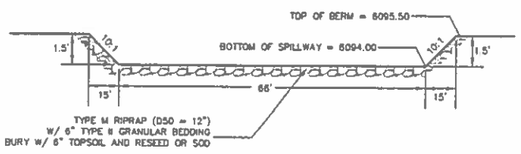
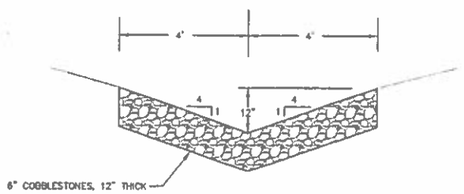
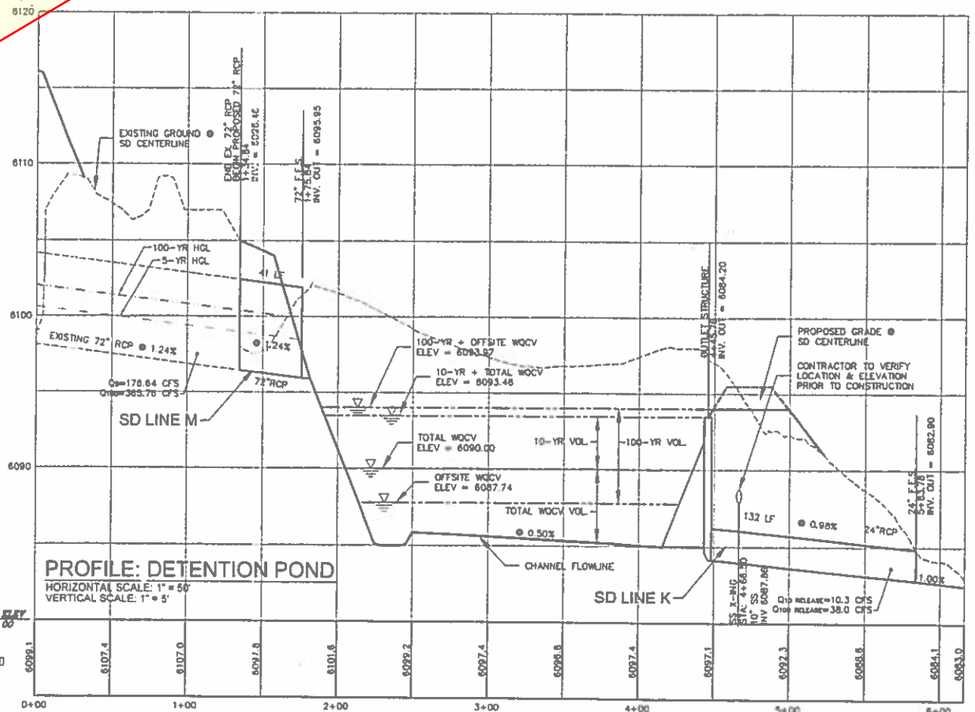
- PARCEL BOUNDARY
- EXISTING R.R. TRACKS
- LIMITS OF GRADING



EMERGENCY SPILLWAY
SECTION A-A
N.T.S.



COBBLESTONE
TRICKLE CHANNEL
N.T.S.



PROFILE: DETENTION POND
HORIZONTAL SCALE: 1" = 50'
VERTICAL SCALE: 1" = 5'

DATUM ELEV. 6080.00

50 25 0 50 100
SCALE: 1" = 50'

I HEREBY AFFIRM THAT THESE FINAL CONSTRUCTION PLANS WERE PREPARED UNDER MY DIRECT SUPERVISION, IN ACCORDANCE WITH ALL APPLICABLE TOWN OF CASTLE ROCK AND STATE OF COLORADO STANDARDS AND STATUTES, RESPECTIVELY; AND THAT I AM RESPONSIBLE FOR ALL DESIGN AND REVISIONS RELATED TO SAID PLANS.

02-15-22

KURT A. LANG, COLORADO P.E. 32249 DATE

TOWN OF CASTLE ROCK APPROVALS
THESE PLANS ARE HEREBY APPROVED FOR ONE YEAR FROM DATE OF DEVELOPMENT SERVICES DIRECTOR APPROVAL

RECOMMEND APPROVAL

Approved Development Services

ENGINEERING DIVISION Feb 22 2022 DATE

APPROVED BY

Town of Castle Rock

THE MEADOWS FILING 17

ISSUED FOR CONSTRUCTION

SCALE:

DRAWN BY:

NUMBER

PHASE II DRAINAGE REPORT

The Meadows
Filing No. 17

Prepared for:

Castle Rock Development Company
3033 E. First Avenue Ste. 410
Denver, CO 80206

Prepared by:

CVL Consultants of Colorado, Inc.
7901 E. Belleview Ave, Suite 150
Englewood, CO 80111
Phone (720) 482-9526

December 22, 2003

1. GENERAL LOCATION AND DESCRIPTION

Location

The Meadows Filing 17 is a proposed 169.4-acre site located in portions of Sections 27, 28, 33, and 34 of Township 7 South, Range 67 West of the 6th Principle Meridian, Town of Castle Rock, County of Douglas. Meadows Filing 17 is located east of Meadows Blvd, east of Prairie Hawk Drive, and west of East Plum Creek. A vicinity map is provided in the Appendix.

Description of Property

Existing ground cover of Meadows Filing 17 consists of native grasses, weeds, and cacti. The topography generally drains northeasterly into East Plum Creek. The majority of the site is moderately steep with slopes ranging from 2 %- 33% across the site.

East Plum Creek is the major drainageway near Filing 17. Although East Plum Creek doesn't encroach upon Filing 17, the 6400 South Tributary of East Plum Creek travels across the northwest corner of Lot 1. This tributary will be discussed in greater detail in the Specific Details section. A drainageway map has been provided in the Appendix.

Meadows Filing 17 contains four different soil types: Bresser sandy Loam (BrB), Englewood clay loam (EN), Kutch clay loam (KuD), and Newlin gravelly sandy loam (NeE). The soils have different SCS hydrologic groups ranging from Type B to Type D. Drainage calculations are based on SCS Type C soils. An SCS soils map has been provided in the Appendix.

Currently, the Meadows Filing 17 is undeveloped open space. Filing 17 is zoned Commercial/Office/Industrial development and proposing to overlot grade the majority of the site for future commercial development. Areas that will be left undisturbed to protect existing trees lie in Lot 1 along the 6400 South Tributary and in Lot 7 along Meadows Parkway.

2. DRAINAGE BASINS AND SUB-BASINS

Major Basin Description

The Meadows Filing 17 is part of the Phase 1 Master Drainage Report dated March 2002 by RMC Consultants. This report uses the Phase 1 Master Drainage Report as the general guide for overall drainage for Meadows Filing 17. Per the Master plan, Meadows Filing 17 will route all runoff to East Plum Creek.

This report will also reference the following reports in the Specific Details section to verify adequate capacity in the existing storm drain system in Meadows Parkway and Meadows Boulevard: the Meadows Parkway Drainage Design Report, by TST

Interim Condition:
The interim condition consists of providing for drainage facilities assuming the site has been overlot graded and interior Streets A & B built but no users have been constructed on the individual pads. The pads will typically sheet flow to a point where the drainage is picked up by a storm system. At that point, the storm system is sized for final condition, as explained in the following paragraphs. Since lots 5 & 6 do not contain regional ponds, we have addressed the basins in this area as being interim condition so ponds are sized for the detention volume and water quality needed only for graded pads. When specific users build on the lots, the pond(s) will have to be increased in size and perhaps relocated. The outlet pipes of the current design are sized for the ultimate buildout and can be extended if the ponds are relocated.

Final Condition:
We consider the Final Condition being the lot contains commercial user(s) with an impervious rate of 95% per the Town of Castle Rock requirements. We feel the impervious rate may be reduced once a Final Site Plan is submitted to the Town for a specific user.

Storm Drain pipes were sized for the final condition. The proposed storm drain pipes in Filing 17 provide routes for developed lots to convey storm drainage across constructed streets without future construction altering the pipe or street configuration. As specific users propose development, the pipe network will have to be analyzed as to whether or not it needs to be extended.

All detention ponds, with the exception of Lots 5 & 6, have been designed for final condition using the commercial impervious rates of 95% and do contain water quality needs. Lots 5 & 6 will most likely have site specific detention ponds for final condition although the current pipe outlets of the two interim ponds are sized for final condition.

6400 South Tributary CLOMAR:

A CLOMR for the 6400 South Tributary will be proposed to revise the boundary the existing FEMA floodplain through the northwest corner of Lot 1. An approximate boundary has been delineated to show the future location of the revised floodplain in relation to the Lot 1 grading. No grading or structures are proposed within the approximate proposed floodplain.

Existing Storm Drain Infrastructure:

The development of Filing 17 causes a change in the historical drainage basins that are routed to Meadows Boulevard and Meadows Parkway. The existing storm drain infrastructure is separated into the Meadows Boulevard and Meadows Parkway systems. The Meadows Boulevard system begins at the southeast intersection of Meadows Boulevard and Meadows Parkway and is routed north along Meadows Boulevard to the existing culvert near the northwest corner of Lot 1. This system was designed using the Meadows Boulevard Drainage Design Report, dated July 1986, by TST Consultants. This

report does not clarify the amount of runoff anticipated from Lots 2 and 5. The hatched area from Lots 2 and 5 on the TST drainage map anticipates 12.9 acres to runoff into the Meadows Boulevard storm drain system. The TST report is not clear how much of this runoff is going into each inlet. Our current proposal is to direct only 2.0 acres into that same system for final condition, thus reducing the runoff which the inlets and pipes are designed to convey. No further analysis on this storm drain systems was conducted due to the significant reduction in area directed to the existing system

The existing Meadows Parkway System begins 550 feet east of the intersection of Meadows Boulevard and Meadows Parkway and routes flow easterly on Meadows Parkway to East Plum Creek. This system was designed per the Meadows Parkway Drainage Design Report, by TST Consultants, dated November 1986. This report accounted for 5.9 acres of developed runoff from lots 3 and 4, 21.5 acres of developed runoff from lots 5 and 6, and 7.8 acres of developed runoff from Lot 7.

Filing 17 proposes to release 3.8 acres of developed flow from Lots 3 and 4, 5.0 acres of developed flow from lots 5 and 6, 4.1 acres of develop from lot 7, and 3.2 acres of developed flow from Lot 8 to the Meadows Parkway Drainage system. Lot 8 is the only increase to the existing system. As a system, the proposed Filing 17 is a reduction in area intercepted by the existing storm drain system by 19.1 developed acres. No further analysis on this storm drain systems was conducted due to the significant reduction in area directed to the existing system.

In certain areas along Meadows Blvd and Meadows Parkway, we are proposing to widen the existing street to accommodate for acceleration or deceleration lanes. As a result, certain existing inlets and connecting pipes will need to be relocated. We will propose to relocate those inlets and pipes with the same sizes.

SCS Soil Group:

Meadows Filing 17 is composed of 4 soil groups ranging from Type B to Type D soils. The majority of the site is composed of Bresser sandy Loam (BrB) and Newlin gravelly sandy loam (NeE), both Type B SCS soils. The remaining third of the property is composed of Englewood clay loam (EN), Type C, and Kutch clay loam (KuD), Type D.

The two issues this report considered for determining the appropriate soil type are sizing storm drain pipes and detention pond release rates. Storm Drain pipes for this development need to convey runoff in the final developed condition. Runoff coefficients for Type C/D soils are higher and generate more runoff then Type B soils.

Type C/D soils affects the detention pond release rates per PWR section 13.3.1. Type B soils apply release factors of 0.23 and 0.85 for the 10 and 100 year volumes while Type C/D soils apply release factors of 0.3 and 1.0.

This report weighted the importance of correctly constructing the storm drain for future design and releasing the appropriate flows and decided to design to Type C/D soils. Each

AFFINITY AT CASTLE ROCK

PHASE II DRAINAGE PLAN

HRGreen

REGENT STREET

50' ROW

ZONING: MEADOWS FOURTH AMENDMENT
EX LAND USE: COMMERCIAL

ZONING: MEADOWS FOURTH AMENDMENT
EX LAND USE: COMMERCIAL

MEADOWS PARKWAY

146' ROW

EXISTING CROSS PAN

50' EX. EASEMENT PARCEL "B" BK. 1086, PG. 1721

100.00' EX. EASEMENT PARCEL "A" BK. 1086, PG. 1721

175' EX. E

IN-B9~TYPE R INLET

18" RCP

IN-B8~TYPE R INLET

18.0'

EMERGENCY SPILLWAY

FOREBAY B2
FES-3~FES

CUTOFF WALL

18" RCP

100-YR WSEL
EL. 6066.46

DETENTION POND B
BOTTOM EL: 6062.6'

MAINTENANCE ACCESS

EX. UTILITY EASEMENT NO. 2005085529

EX. MONUMENT

B10
0.66 | 0.54 | 0.72

18" RCP

EX. 30" RCP AND RIPRAP OUTFALL PROTECTION

MICROPOOL

OS-2~DETENTION POND OUTLET STRUCTURE

FOREBAY B1

PROPERTY BOUNDARY (TYP.)

OS2
0.09 | 0.01 | 0.44

OS1
1.46 | 0.10 | 0.49

REGENT CIRCLE (PRIVATE WITH ACCESS EASEMENT)

24" RCP (PUBLIC)

24" RCP (PUBLIC)

24" RCP (PUBLIC)

IN-B7~SINGLE NO. 16 INLET

40' ACCESS & UTILITY EASEMENT

B8
0.50 | 0.37 | 0.63

B7
0.25 | 0.75 | 0.84

18" RCP (PUBLIC)

18" RCP (PUBLIC)

18" RCP (PUBLIC)

IN-B2~TYPE-R INLET (PUBLIC)

24" RCP (PUBLIC)

25' PR. DRAINAGE EASEMENT.

IN-B3~TYPE-R INLET (PUBLIC)

B5
0.63 | 0.63 | 0.78

B6
1.14 | 0.63 | 0.78

B4
0.88 | 0.63 | 0.78

B2
0.20 | 0.35 | 0.62

B3
0.41 | 0.53 | 0.71

B1
0.90 | 0.63 | 0.78

ZONING: MEADOWS FOURTH AMENDMENT
EX LAND USE: VACANT

PMJM HABITAT SETBACK

MICROPOOL

OS-1~DETENTION POND OUTLET STRUCTURE

EMERGENCY SPILLWAY

CUTOFF WALL

MAINTENANCE ACCESS

40' ACCESS & UTILITY EASEMENT

IN-A6~TYPE-R INLET

A6
0.26 | 0.76 | 0.84

18" RCP

18" RCP (PUBLIC)

B9
0.41 | 0.57 | 0.74

18" RCP (PUBLIC)

18" RCP (PUBLIC)

REGENT CIRCLE (PRIVATE WITH ACCESS EASEMENT)

ATCHINSON, TOPEKA, & SANTA FE RAILROAD
100' ROW

IN-A4~SINGLE NO. 16 INLET

18" RCP

IN-A7~TYPE-R INLET

24" RCP

FOREBAY A1

12" RCP

DETENTION POND A
BOTTOM EL: 6076.50'

12" HDPE

12" HDPE

18" RCP

LS-A9.1~24" LS INLET

A11
0.36 | 0.86 | 0.89

FOREBAY A2

100-YEAR WSEL
EL: 6080.56

IN-A10~SINGLE NO. 16 INLET

PROPERTY BOUNDARY (TYP.)

A7
0.34 | 0.77 | 0.85

12" RCP

A10
0.55 | 0.79 | 0.85

IN-A5.1~SINGLE NO. 16 INLET

A4
0.96 | 0.31 | 0.60

A5.1
0.07 | 0.86 | 0.89

A9
0.90 | 0.28 | 0.58

OS3
1.34 | 0.01 | 0.44

LS-A8.2~12" LS INLET

LS-A8.1~12" LS INLET

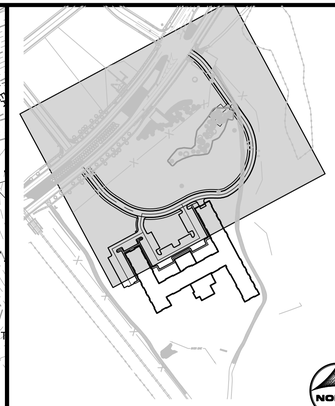
LS-A5~15" LS INLET

ZONING: MEADOWS THIRD AMENDMENT
EX LAND USE: OPEN

PROPERTY BOUNDARY (TYP.)

0 20 40

SEE SHEET 2



N.T.S.

KEYMAP:

NOTES:

1. ALL STORM IS PRIVATE UNLESS OTHERWISE NOTED
2. ALL CURB AND GUTTER IS VERTICAL UNLESS OTHERWISE NOTED
3. LANDSCAPE INLETS ARE NYLOPLAST DRAIN BASINS WITH STANDARD GRATES (OR APPROVED EQUAL) UNLESS OTHERWISE NOTED

LEGEND:

- PROPOSED MAJOR CONTOUR — 5250
- PROPOSED MINOR CONTOUR
- EXISTING MAJOR CONTOUR — 5250
- EXISTING MINOR CONTOUR
- PROPOSED BASIN LINE
- DESIGN POINT — 1
- STORM LINE
- APPROXIMATE PONDING IN 100-YEAR EVENT
- FLOW ARROW
- EMERGENCY OVERFLOW ARROW
- PROPOSED BASIN LABEL

C-6 | 1.00 | .40 | .60
AREA (AC.) | BASIN DESIGNATION | MINOR 5-YR RUNOFF COEF. | MAJOR 100-YR RUNOFF COEF.

LS = LANDSCAPE
U.E. = UTILITY EASEMENT
FL = FLOW LINE

KEY NOTES:

(1) RIGHT-TURN ONLY SIGN
(1) VERTICAL CURB (SPILL CONDITION)
(1A) VERTICAL CURB & GUTTER (SPILL CONDITION)
(2) VERTICAL CATCH CURB & GUTTER (TYPE VC-1)
(3) 5-FOOT SIDEWALK
(4) 6-FOOT SIDEWALK
(4A) 8-FOOT SIDEWALK
(4B) 10-FOOT SIDEWALK
(5) ACCESSIBLE CURB RAMP
(6) SIDEWALK CHASE
(7A) SIGHT DISTANCE LINE
(7B) SAFETY TRIANGLE
(8) PICKLEBALL COURT (CONCRETE SURFACE)
(9) DOG PARK (SOD SURFACE)
(10) COMMUNITY GARDEN (CRUSHED STONE SURFACE)
(11) EAST PLUM CREEK TRAILHEAD PARKING
(12) RETAINING WALL (PRIVATE) - SEE DETAIL (SHEET GN-1)

NO.	DATE	BY	REVISION DESCRIPTION

HR GREEN - DENVER
5619 DTC PARKWAY
SUITE 1150
DENVER CO 80111
PHONE: 720.602.4999
FAX: 844.273.1057

HRGreen

PHASE III DRAINAGE REPORT

DRAINAGE PLAN

AFFINITY AT CASTLE ROCK
CASTLE ROCK DEVELOPMENT CO.
CASTLE ROCK, COLORADO

BAR IS ONE INCH ON OFFICIAL DRAWINGS
0 1"
IF NOT ONE INCH, ADJUST SCALE ACCORDINGLY

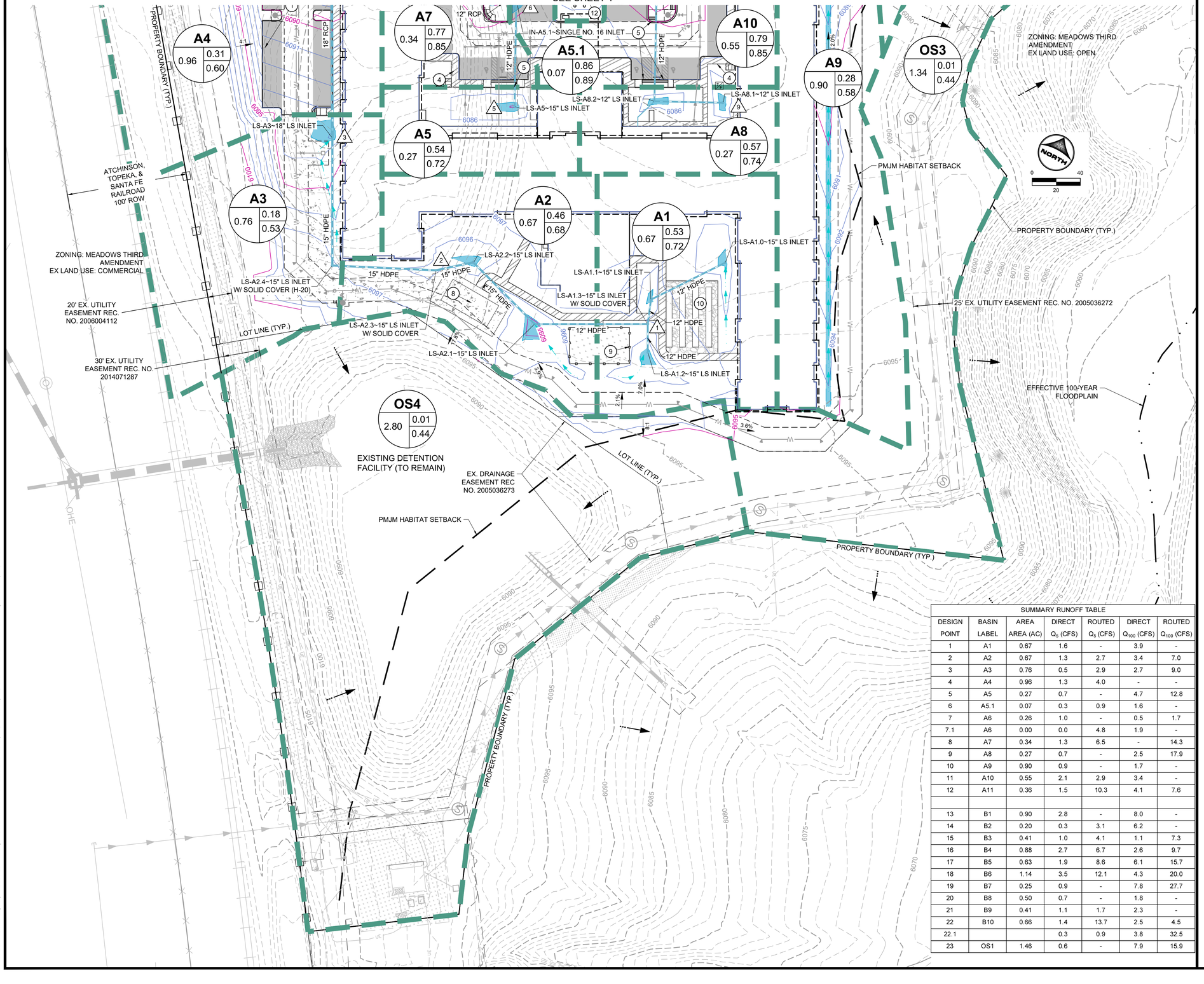
DRAWN BY:	KLH
APPROVED:	AJZ
JOB DATE:	3/28/2023
JOB NO:	211400

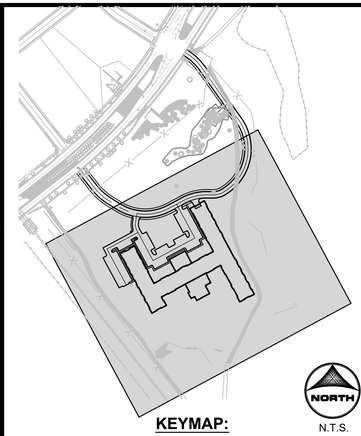
SHEET DR1 | 1

CAD DATE: 3/29/2023
CAD FILE: J:\2021\211400\CAD\Dwgs_Exhibits\DetailedDrainagePlan

HR GREEN Xrefs: xv-dwgn_xgl-1-DV01-SDP; xv-dwgn; xv-nrow; xv-util; 2238-ENG; XG-keymap-fr; XG-keymap-SitePlan; xv-FEMA; xv-FEMA-original; XG-keymap; xv-util

SEE SHEET 1





KEYMAP: N.T.S.

NOTES:

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2. ALL CURB AND GUTTER IS VERTICAL UNLESS OTHERWISE NOTED
3. LANDSCAPE INLETS ARE NYLOPLAST DRAIN BASINS WITH STANDARD GRATES (OR APPROVED EQUAL) UNLESS OTHERWISE NOTED

LEGEND:

- PROPOSED MAJOR CONTOUR — 5250
- PROPOSED MINOR CONTOUR
- EXISTING MAJOR CONTOUR — 5250
- EXISTING MINOR CONTOUR
- PROPOSED BASIN LINE
- DESIGN POINT — 1
- STORM LINE
- APPROXIMATE PONDING IN 100-YEAR EVENT
- FLOW ARROW
- EMERGENCY OVERFLOW ARROW
- PROPOSED BASIN LABEL

C-6 (BASIN DESIGNATION) | AREA (AC.) 1.00 | .40 MINOR 5-YR RUNOFF COEF. | .60 MAJOR 100-YR RUNOFF COEF.

LS = LANDSCAPE
U.E. = UTILITY EASEMENT
FL = FLOW LINE

KEY NOTES:

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7A. SIGHT DISTANCE LINE
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8. PICKLEBALL COURT (CONCRETE SURFACE)
9. DOG PARK (SOD SURFACE)
10. COMMUNITY GARDEN (CRUSHED STONE SURFACE)
11. EAST PLUM CREEK TRAILHEAD PARKING

SUMMARY RUNOFF TABLE

DESIGN POINT	BASIN LABEL	AREA AREA (AC)	DIRECT Q_5 (CFS)	ROUTED Q_5 (CFS)	DIRECT Q_{100} (CFS)	ROUTED Q_{100} (CFS)
1	A1	0.67	1.6	-	3.9	-
2	A2	0.67	1.3	2.7	3.4	7.0
3	A3	0.76	0.5	2.9	2.7	9.0
4	A4	0.96	1.3	4.0	-	-
5	A5	0.27	0.7	-	4.7	12.8
6	A5.1	0.07	0.3	0.9	1.6	-
7	A6	0.26	1.0	-	0.5	1.7
7.1	A6	0.00	0.0	4.8	1.9	-
8	A7	0.34	1.3	6.5	-	14.3
9	A8	0.27	0.7	-	2.5	17.9
10	A9	0.90	0.9	-	1.7	-
11	A10	0.55	2.1	2.9	3.4	-
12	A11	0.36	1.5	10.3	4.1	7.6
13	B1	0.90	2.8	-	8.0	-
14	B2	0.20	0.3	3.1	6.2	-
15	B3	0.41	1.0	4.1	1.1	7.3
16	B4	0.88	2.7	6.7	2.6	9.7
17	B5	0.63	1.9	8.6	6.1	15.7
18	B6	1.14	3.5	12.1	4.3	20.0
19	B7	0.25	0.9	-	7.8	27.7
20	B8	0.50	0.7	-	1.8	-
21	B9	0.41	1.1	1.7	2.3	-
22	B10	0.66	1.4	13.7	2.5	4.5
22.1			0.3	0.9	3.8	32.5
23	OS1	1.46	0.6	-	7.9	15.9

NO.	DATE	BY	REVISION DESCRIPTION

HR GREEN - DENVER
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DENVER CO 80111
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HRGreen

PHASE III DRAINAGE REPORT
DRAINAGE PLAN

AFFINITY AT CASTLE ROCK
CASTLE ROCK DEVELOPMENT CO.
CASTLE ROCK, COLORADO

CAD DATE: 3/29/2023
CAD FILE: J:\2021\211400\CAD\Dwgs_Exhibits\Detailed\DrainagePlan

BAR IS ONE INCH ON OFFICIAL DRAWINGS
0 1"
IF NOT ONE INCH, ADJUST SCALE ACCORDINGLY

DRAWN BY:	KLH
APPROVED:	AJZ
JOB DATE:	3/28/2023
JOB NO:	211400

SHEET DR2 | 2

HR GREEN Xrefs: xv-dsgn; xg#-1-DV01-SDP; xc-dsgn; xc-row; xv-row; xv-util; 2238-ENG_XG-keymap-SitePlan; xv-FEMA; xv-FEMA-original; XG-keymap; xc-util