Ordinance 02-2019, Series of 2019
Dillon Homewood Suites PUD Development Plan
Major PUD Amendment

Exhibit 'D'
Drainage Report

DILLON HOMEWOOD SUITES
TOWN OF DILLON, COLORADO

DRAINAGE REPORT

December 2018

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A. Introduction

This drainage report is being provided to serve as an urban storm water management plan for conveying and treating excess storm runoff for the proposed Dillon Homewood Suites site, herein known as the "Property".

The drainage design presented within this report is based on the "C" values identified within the 1982 EMGH Town Wide Drainage Study and the 1982 EHMG Master Drainage Report Plates, as required by the Town of Dillon Engineering Department. Where applicable, this report is supplemented by the *Urban Drainage Flood Control District Criteria*.

1. Location

A. Existing Site

The Property is located within the Town of Dillon, Summit County, located south of the intersection of Highway 6 & Lake Dillon Drive, along the west side of Lake Dillon Drive. The Property is currently going through a re-platting process to turn the existing four individual parcels to one single parcel. The proposed single parcel will be approximately 1.50 acres in size. The existing parcels consist of a gas service station parcel (Lot 1), undeveloped land (Lot 1A), a parcel that houses a two-story building (Lot 1B), and the old Dillon Theatre parcel (Lot 1C). The existing site is depicted on the Existing Basin Map included in the Appendix of this report.

B. Surrounding Area

The site is bordered to the north by Colorado Department of Transportation (CDOT) Right of Way (ROW), Lake Dillon Drive to the east, unimproved Town ROW to the south and a Century Link facility to the west. The property located south of the unimproved Town ROW is currently being designed and is planned to be a hotel or multi-family development.

2. Proposed Development

A. Type of Development

The proposed project will consist of a 23,000+/- SF Dillon Homewood Suites hotel building with asphalt parking, concrete walks, landscaping, and water, sanitary, electrical, gas and communication utilities as well as an onsite detention pond.

The proposed pond will be sized to accommodate the 5-year, 10-year and 100-year storm events per Town of Dillon stormwater requirements.

B. Requested Site Drainage Variances

The existing site currently contributes offsite flow to the storm drainage system located south of the site in the existing condition. The drainage variance being requested is to allow the proposed site to directly release up to or less than the amount of stormwater runoff leaving the site to the south in the existing condition.

B. Historic Drainage

1. Description of Property

A. General Historic Drainage Patterns

The existing property drainage patterns are split, with approximately 48% of the property draining to the north and west to the CDOT ROW and Century Link property (Existing Basin 1) and approximately 52% of the property draining south to the unimproved Town ROW and Lake Dillon Drive storm sewer system (Existing Basin 2). No offsite basins contribute stormwater to the project site. The above noted basins are depicted on the Existing Drainage Map included in the Appendix.

B. Property Conditions

The existing site ground cover consists of asphalt, concrete, and building roofs primarily located on the southern ¾ of the site and natural vegetation and trees located primarily at the north ¼ of the site.

Soil data for the proposed site was obtained from the USDA Natural Resources Conservation Service's Web Soil Survey. The Web Soil Survey characterizes the on-site soils as Frisco-Peeler complex, 6 to 25 percent slopes. These soil types are classified within the Hydrologic Soils Group B, which have a moderate infiltration rates and moderately low runoff potential when thoroughly wet.

The proposed project site is within Zone X as referenced from the FEMA Flood Insurance Rate Map (08117C0243F). The FEMA map legend defines "Zone X" as "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, or Area of Minimal Flood Hazard," thus, the proposed project site is not within a FEMA Regulated Floodplain.

C. Major Drainageways

There are no major drainageways that are impacted by the proposed project. The Dillon Reservoir is located approximately 2,000+/- feet south of the proposed site and is not anticipated to be negatively impacted by the proposed development.

D. Outfalls Downstream from Property

The existing discharge points for the Property appear to be at the northwest end of the site to the CDOT ROW and Century Link property and south to the unimproved Town ROW and Lake Dillon Drive curb and gutter and storm sewer system and ultimately the Dillon Reservoir.

C. Design Criteria

1. Hydrologic Criteria

A. Rainfall/Runoff

The Rational Method was used to calculate peak runoff rates for the 5-year, 10-year, and 100-year storm events. Time of concentration was calculated using equations RO-3 from Section 2.4.1 and equation RO-4 from section 2.4.2 of the *UDFCD Drainage Criteria Manual*. One-hour rainfall depths, P_1 , were taken from the Town of Dillon IDF Curve. A value of 0.85 inches was used for the 5-year P_1, a value of 1.10 was used for the 10-year P_1 and a value of 1.70 was used for the 100-year P_1. Composite impervious and runoff coefficients were developed for the proposed property based on Table RO-3 and RO-5 of the *UDFCD Drainage Criteria Manual*.

B. Detention and Water Quality

The modified FAA method was used in lieu of the SCS (NRCS) method for detention pond sizing calculations as the modified FAA method is an effective method for calculating volumes and maintains consistency between the storm sewer sizing and pond volume calculations. The modified FAA method is based on the rational method and is applicable on sites up to 90 acres in size, consistent with the Town of Dillon stormwater criteria.

C. Design Storm Frequencies

This report considers the 5-year storm the minor event and the 100-year storm the major event. The proposed storm system has been designed to convey the 100-year storm event. The 100-year storm will be transmitted through the site without impacting downstream or adjacent properties.

2. Hydraulic Criteria

A. Orifice flow and culvert capacities were analyzed using *Bentley FlowMaster V8i (SELECT series 1).*

D. Drainage Plan

1. General Concept

A. Drainage Concept

The general concept for the proposed project is to safely and efficiently convey flows generated from the project through the project site to the proposed detention pond and keep pond release rates at or below the historical 5-year flow rates per the Town of Dillon stormwater requirements.

To accommodate the increase in site runoff from the proposed project a detention pond will be located in the northwest corner of the site. The detention pond will be sized to attenuate the 5-year, 10-year and 100-year storm events, releasing at or below the 5-year pre-developed flow rate for each storm event. Stormwater discharged from the detention pond will be transmitted to the existing roadside swale on the south side of Highway 6 and follow the natural drainage pattern to the west.

A portion of the site's runoff will be discharged south to the Town ROW where it will be conveyed to the Lake Dillon Drive storm sewer system. The runoff discharged offsite will be at or below the existing condition flow rates for the 5-, 10-, and 100-year storm events that are currently being discharged from the site.

B. Major Conveyance Elements

There are no major drainageways affected by the development of this property.

2. Specific Details

A. Proposed Drainage Concept

The proposed drainage concept for the site includes three onsite basins. Basin 1 will consist of the north half of the site and the proposed building roof. The stormwater runoff generated by Basin 1 will be routed through the onsite detention pond and discharged to the CDOT ROW.

Basin 2 will consist of the site located generally east of the building. The stormwater runoff generated by Basin 2 will be collected by storm sewer or Lake Dillon Drive curb and gutter and will be directed to the Lake Dillon Drive storm sewer, un-detained.

Basin 3 will consist of the rear site asphalt parking lots and will be collected via a series of inlets and storm sewer pipe. The collected runoff will be conveyed to the storm system in the Town ROW and then to the Lake Dillon Drive storm sewer, un-detained.

As noted earlier, the runoff from Basins 2 and 3 that is leaving the site un-detained has been calculated to be at or below the existing condition flow rates currently being discharged from the site.

B. Onsite Detention Pond

The proposed development increases the impervious area on the property, thus a detention pond is required to limit flow to the allowable release rate, which cannot exceed the pre-developed 5-year storm flow rate. Summary tables of release rates and detention volume are shown on the following page.

Pond & Offsite Discharge Rate vs. Existing Allowable Flowrate Table

Detention Pond	5-Year Rel. Rate (CFS)	5-Year Allow. (CFS)	10-Year Rel. Rate (CFS)	10-Year Allow. (CFS)	100-Year Rel. Rate (CFS)	100-Year Allow. (CFS)
Basin 1 Pond	0.50	0.75	0.60	0.75	0.70	0.75
Basin 2*	0.44	0.85	0.59	1.07	1.14	1.83
Basin 3*	0.93	1.08	1.16	1.36	2.00	2.33

*Basin 2 and 3 are discharging offsite un-detained. As shown above, the proposed flow rates anticipated are less than the existing calculated flow rates currently being discharged from the site.

Detention Volume Table

Detention Pond	5-Year Vol. Req. (CF)	10-Year Vol. Req. (CF)	100-Year Vol. Req. (CF)	Vol. Provided (CF)
Basin 1 Pond	1,087	1,591	3,344	3,722

BASIN 1 POND

The total tributary area to the Basin 1 pond is 1.13 acres with a composite imperviousness of 79.4%. The allowable release rate was calculated to be 0.75 CFS for the 5-year, 10-year and 100-year storm events and was based on the "C" values identified in the 1982 EMGH Town Wide Drainage Study.

Detention Volumes

Using the modified FAA Method, the 5-year required pond storage volume was calculated to be 1,087 CF, with a water surface elevation (WSEL) of 9107.55 and an outflow rate of 0.5 CFS. The 10-year required pond storage volume was calculated to be 1,591 CF, with a water surface elevation (WSEL) of 9107.96 and an outflow rate of 0.6 CFS. The 100-year required pond storage volume was calculated to be 3,344 CF, with a water surface elevation (WSEL) of 9109.09 and an outflow rate of 0.7 CFS. The total pond volume is 3,722 CF. The lowest pond top of berm elevation (emergency overflow) has been designed at 9109.50.

Outlet Structure

The pond outlet structure will have one 4" diameter orifice for the various storm events to allow the pond to release stormwater at the flows as specified above. All flows will be discharged via the 10" pond outlet pipe that direct stormwater to the CDOT ROW.

The top of the outlet structure will be equipped with a grate and will be set to the 100-year water surface elevation. Flows exceeding the 100-year storm event will overtop the grate and be discharged via the 10" outlet pipe, which will be equipped with an orifice plate so that the 5-year pre-developed flow rate is not exceeded. The pond will also have an emergency overflow as noted above so that flows exceeding the 100-year storm event will have a safe passage to the CDOT ROW without inundating onsite buildings. Additional information regarding the outlet structure, orifice size and water surface elevations can be found in the Appendix.

C. Snow Melt Runoff

The proposed site will implement inlets in specific locations to capture runoff and snow melt runoff to mitigate the potential for icing on walks, drives and roadways. The proposed storm lines will be designed with adequate slope to mitigate the potential for icing in pipes due to stagnant or slow-moving stormwater. Additionally, the release rates identified herein are below the allowable pre-developed flow rates and the proposed pond storage volumes exceed the minimum required, therefore, we anticipate the proposed storm sewer system and detention pond will function as intended should they experience a slight increase in runoff due to snow melt.

D. Conclusion

The proposed drainage plan is to provide safe and efficient conveyance of flows through the property in compliance with the Town of Dillon stormwater requirements. Runoff from the project site will be conveyed through a system of storm sewers to the detention pond or discharged offsite. Stormwater discharge from the pond will be released at or below the 5-year pre-developed flow rate, reducing the potential for downstream erosion. Flows discharged from the site un-detained will be at or below the existing flow rates leaving the site. Therefore, the proposed development of the property is not anticipated to impose adverse impacts to the adjacent or downstream properties.

F. References

1. *1982 EMGH Town Wide Drainage Study, Dillon, Colorado.*

2. *1982 EHMG Master Drainage Report Plates Dillon, Colorado.*

3. *Web Soil Survey*, Natural Resources Conservation Service, United States Department of Agriculture, Available at http://websoilsurvey.nrcs.usda.gov

Appendix A
Supporting Documents

Hydrologic Soil Group—Summit County Area, Colorado
(Dillon - Homesuites Site)

Map Scale: 1:1,320 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0, 15, 30, 60, 90

Feet: 0, 50, 100, 200, 300

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

MAP LEGEND

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

Soils

Soil Rating Polygons
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features
- Streams and Canals

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

Background
- Aerial Photography

MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: Summit County Area, Colorado
Survey Area Data: Version 9, Oct 12, 2017

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

Date(s) aerial images were photographed: Jul 23, 2011—Nov 19, 2016

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
5E	Frisco-Peeler complex, 6 to 25 percent slopes	B	7.6	100.0%
Totals for Area of Interest			**7.6**	**100.0%**

Description

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

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

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

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

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

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

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

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

National Flood Hazard Layer FIRMette

FEMA

39°38'2.79"N

106°3'4.51"W

106°2'27.05"W

39°37'35.08"N

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

1:6,000

Legend

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

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

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

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

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

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

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

N

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

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

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 12/6/2018 at 6:41:42 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.

Appendix B
Hydrologic Calculations

MARTIN/MARTIN
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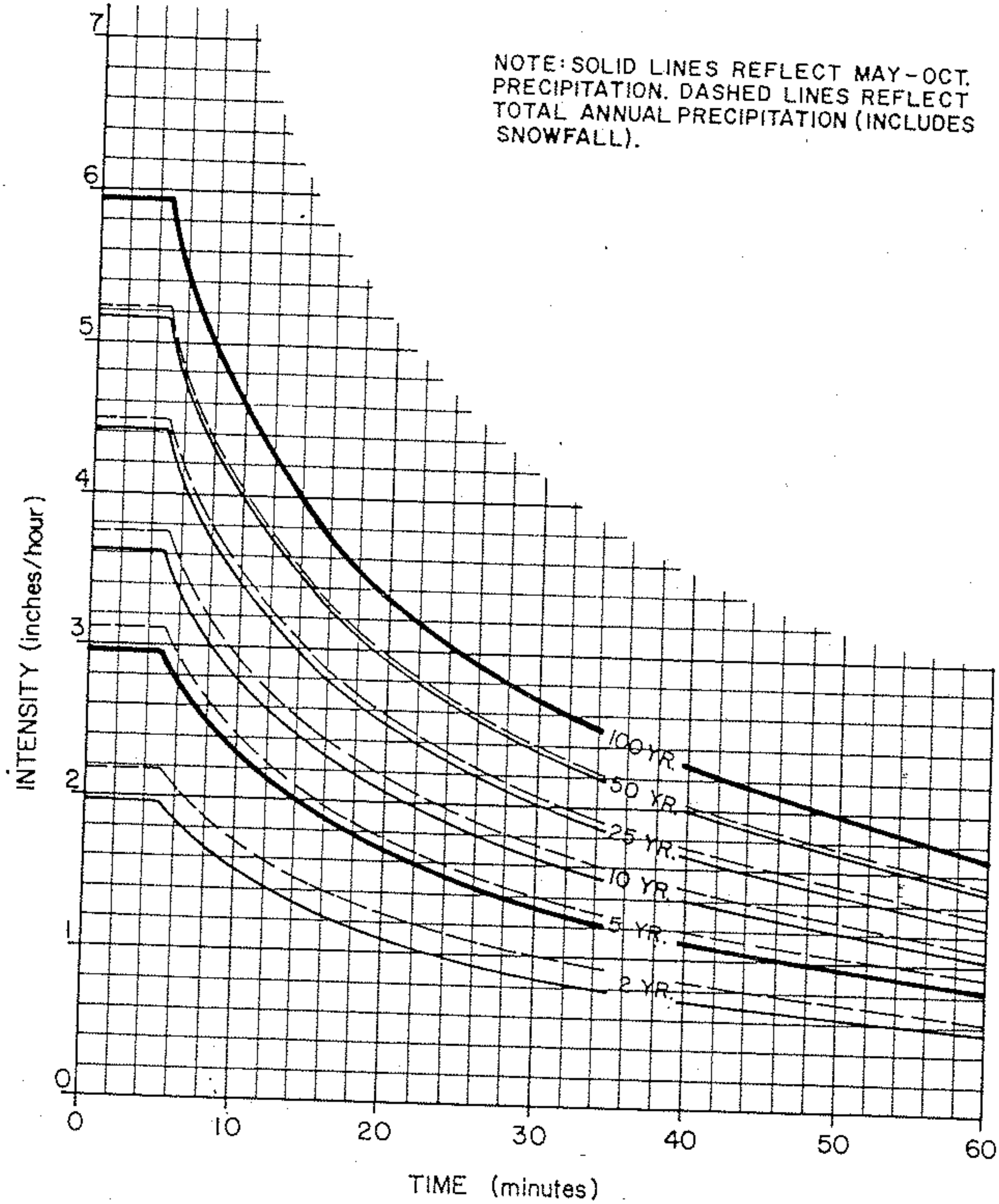

PREPARED FROM NOAA ATLAS 2 VOL. III – COLORADO, NATL. WEATHER SERVICE, 1973

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DILLON DRAINAGE STUDY

60 MIN. INTENSITY-DURATION CURVES

JOB NO. 8104.01
DATE 8/31/82
SHEET 3 OF 8

Table RO-3—Recommended Percentage Imperviousness Values

Land Use or Surface Characteristics	Percentage Imperviousness
Business:	
Commercial areas	95
Neighborhood areas	85
Residential:	
Single-family	*
Multi-unit (detached)	60
Multi-unit (attached)	75
Half-acre lot or larger	*
Apartments	80
Industrial:	
Light areas	80
Heavy areas	90
Parks, cemeteries	5
Playgrounds	10
Schools	50
Railroad yard areas	15
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	0
Lawns, clayey soil	0

* See Figures RO-3 through RO-5 for percentage imperviousness.

$$C_A = K_A + \left(1.31i^3 - 1.44i^2 + 1.135i - 0.12\right) \text{ for } C_A \geq 0\text{, otherwise } C_A = 0 \quad \text{(RO-6)}$$

$$C_{CD} = K_{CD} + \left(0.858i^3 - 0.786i^2 + 0.774i + 0.04\right) \quad \text{(RO-7)}$$

$$C_B = \left(C_A + C_{CD}\right)/2$$

Table RO-5— Runoff Coefficients, *C*

Percentage Imperviousness	Type C and D NRCS Hydrologic Soil Groups					
	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
0%	0.04	0.15	0.25	0.37	0.44	0.50
5%	0.08	0.18	0.28	0.39	0.46	0.52
10%	0.11	0.21	0.30	0.41	0.47	0.53
15%	0.14	0.24	0.32	0.43	0.49	0.54
20%	0.17	0.26	0.34	0.44	0.50	0.55
25%	0.20	0.28	0.36	0.46	0.51	0.56
30%	0.22	0.30	0.38	0.47	0.52	0.57
35%	0.25	0.33	0.40	0.48	0.53	0.57
40%	0.28	0.35	0.42	0.50	0.54	0.58
45%	0.31	0.37	0.44	0.51	0.55	0.59
50%	0.34	0.40	0.46	0.53	0.57	0.60
55%	0.37	0.43	0.48	0.55	0.58	0.62
60%	0.41	0.46	0.51	0.57	0.60	0.63
65%	0.45	0.49	0.54	0.59	0.62	0.65
70%	0.49	0.53	0.57	0.62	0.65	0.68
75%	0.54	0.58	0.62	0.66	0.68	0.71
80%	0.60	0.63	0.66	0.70	0.72	0.74
85%	0.66	0.68	0.71	0.75	0.77	0.79
90%	0.73	0.75	0.77	0.80	0.82	0.83
95%	0.80	0.82	0.84	0.87	0.88	0.89
100%	0.89	0.90	0.92	0.94	0.95	0.96
	TYPE B NRCS HYDROLOGIC SOILS GROUP					
0%	0.02	0.08	0.15	0.25	0.30	0.35
5%	0.04	0.10	0.19	0.28	0.33	0.38
10%	0.06	0.14	0.22	0.31	0.36	0.40
15%	0.08	0.17	0.25	0.33	0.38	0.42
20%	0.12	0.20	0.27	0.35	0.40	0.44
25%	0.15	0.22	0.30	0.37	0.41	0.46
30%	0.18	0.25	0.32	0.39	0.43	0.47
35%	0.20	0.27	0.34	0.41	0.44	0.48
40%	0.23	0.30	0.36	0.42	0.46	0.50
45%	0.26	0.32	0.38	0.44	0.48	0.51
50%	0.29	0.35	0.40	0.46	0.49	0.52
55%	0.33	0.38	0.43	0.48	0.51	0.54
60%	0.37	0.41	0.46	0.51	0.54	0.56
65%	0.41	0.45	0.49	0.54	0.57	0.59
70%	0.45	0.49	0.53	0.58	0.60	0.62
75%	0.51	0.54	0.58	0.62	0.64	0.66
80%	0.57	0.59	0.63	0.66	0.68	0.70
85%	0.63	0.66	0.69	0.72	0.73	0.75
90%	0.71	0.73	0.75	0.78	0.80	0.81
95%	0.79	0.81	0.83	0.85	0.87	0.88
100%	0.89	0.90	0.92	0.94	0.95	0.96

TABLE RO-5 (Continued)—Runoff Coefficients, *C*

Percentage Imperviousness	Type A NRCS Hydrologic Soils Group					
	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
0%	0.00	0.00	0.05	0.12	0.16	0.20
5%	0.00	0.02	0.10	0.16	0.20	0.24
10%	0.00	0.06	0.14	0.20	0.24	0.28
15%	0.02	0.10	0.17	0.23	0.27	0.30
20%	0.06	0.13	0.20	0.26	0.30	0.33
25%	0.09	0.16	0.23	0.29	0.32	0.35
30%	0.13	0.19	0.25	0.31	0.34	0.37
35%	0.16	0.22	0.28	0.33	0.36	0.39
40%	0.19	0.25	0.30	0.35	0.38	0.41
45%	0.22	0.27	0.33	0.37	0.40	0.43
50%	0.25	0.30	0.35	0.40	0.42	0.45
55%	0.29	0.33	0.38	0.42	0.45	0.47
60%	0.33	0.37	0.41	0.45	0.47	0.50
65%	0.37	0.41	0.45	0.49	0.51	0.53
70%	0.42	0.45	0.49	0.53	0.54	0.56
75%	0.47	0.50	0.54	0.57	0.59	0.61
80%	0.54	0.56	0.60	0.63	0.64	0.66
85%	0.61	0.63	0.66	0.69	0.70	0.72
90%	0.69	0.71	0.73	0.76	0.77	0.79
95%	0.78	0.80	0.82	0.84	0.85	0.86
100%	0.89	0.90	0.92	0.94	0.95	0.96

2.4 Time of Concentration

One of the basic assumptions underlying the Rational Method is that runoff is a function of the average rainfall rate during the time required for water to flow from the most remote part of the drainage area under consideration to the design point. However, in practice, the time of concentration can be an empirical value that results in reasonable and acceptable peak flow calculations. The time of concentration relationships recommended in this *Manual* are based in part on the rainfall-runoff data collected in the Denver metropolitan area and are designed to work with the runoff coefficients also recommended in this *Manual*. As a result, these recommendations need to be used with a great deal of caution whenever working in areas that may differ significantly from the climate or topography found in the Denver region.

For urban areas, the time of concentration, t_c, consists of an initial time or overland flow time, t_i, plus the travel time, t_t, in the storm sewer, paved gutter, roadside drainage ditch, or drainage channel. For non-urban areas, the time of concentration consists of an overland flow time, t_i, plus the time of travel in a defined form, such as a swale, channel, or drainageway. The travel portion, t_t, of the time of concentration can be estimated from the hydraulic properties of the storm sewer, gutter, swale, ditch, or drainageway. Initial time, on the other hand, will vary with surface slope, depression storage, surface cover, antecedent rainfall, and infiltration capacity of the soil, as well as distance of surface flow. The time of concentration is represented by Equation RO-2 for both urban and non-urban areas:

$$t_c = t_i + t_t \qquad \text{(RO-2)}$$

in which:

t_c = time of concentration (minutes)

t_i = initial or overland flow time (minutes)

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

2.4.1 Initial Flow Time

The initial or overland flow time, t_i, may be calculated using equation RO-3:

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L}}{S^{0.33}} \qquad \text{(RO-3)}$$

in which:

t_i = initial or overland flow time (minutes)

C_5 = runoff coefficient for 5-year frequency (from Table RO-5)

L = length of overland flow (500 ft maximum for non-urban land uses, 300 ft maximum for urban land uses)

S = average basin slope (ft/ft)

Equation RO-3 is adequate for distances up to 500 feet. Note that, in some urban watersheds, the overland flow time may be very small because flows quickly channelize.

2.4.2 Overland Travel Time

For catchments with overland and channelized flow, the time of concentration needs to be considered in combination with the overland travel time, t_t, which is calculated using the hydraulic properties of the swale, ditch, or channel. For preliminary work, the overland travel time, t_t, can be estimated with the help of Figure RO-1 or the following equation (Guo 1999):

$$V = C_v S_w^{0.5} \qquad \text{(RO-4)}$$

in which:

V = velocity (ft/sec)

C_v = conveyance coefficient (from Table RO-2)

S_w = watercourse slope (ft/ft)

Table RO-2—Conveyance Coefficient, C_v

Type of Land Surface	Conveyance Coefficient, C_v
Heavy meadow	2.5
Tillage/field	5
Short pasture and lawns	7
Nearly bare ground	10
Grassed waterway	15
Paved areas and shallow paved swales	20

The time of concentration, t_c, is then the sum of the initial flow time, t_i, and the travel time, t_t, as per Equation RO-2.

2.4.3 First Design Point Time of Concentration in Urban Catchments

Using this procedure, the time of concentration at the first design point (i.e., initial flow time, t_i) in an urbanized catchment should not exceed the time of concentration calculated using Equation RO-5.

$$t_c = \frac{L}{180} + 10 \qquad \text{(RO-5)}$$

in which:

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

L = waterway length (ft)

Equation RO-5 was developed using the rainfall-runoff data collected in the Denver region and, in essence, represents regional "calibration" of the Rational Method.

The first design point is the point where runoff first enters the storm sewer system. An example of definition of first design point is provided in Figure RO-2.

Normally, Equation RO-5 will result in a lesser time of concentration at the first design point and will govern in an urbanized watershed. For subsequent design points, the time of concentration is calculated by accumulating the travel times in downstream drainageway reaches.

2.4.4 Minimum Time of Concentration

Should the calculations result in a t_c of less than 10 minutes, it is recommended that a minimum value of 10 minutes be used for non-urban watersheds. The minimum t_c recommended for urbanized areas should not be less than 5 minutes and if calculations indicate a lesser value, use 5 minutes instead.

2.4.5 Common Errors in Calculating Time of Concentration

A common mistake in urbanized areas is to assume travel velocities that are too slow. Another common error is to not check the runoff peak resulting from only part of the catchment. Sometimes a lower portion of the catchment or a highly impervious area produces a larger peak than that computed for the whole catchment. This error is most often encountered when the catchment is long or the upper portion contains grassy parkland and the lower portion is developed urban land.

2.5 Intensity

The rainfall intensity, I, is the average rainfall rate in inches per hour for the period of maximum rainfall of a given recurrence frequency having a duration equal to the time of concentration.

After the design storm's recurrence frequency has been selected, a graph should be made showing rainfall intensity versus time. The procedure for obtaining the local data and drawing such a graph is explained and illustrated in Section 4 of the RAINFALL chapter of this *Manual*. The intensity for a design point is taken from the graph or through the use of Equation RA-3 using the calculated t_c.

2.6 Watershed Imperviousness

All parts of a watershed can be considered either pervious or impervious. The pervious part is that area where water can readily infiltrate into the ground. The impervious part is the area that does not readily allow water to infiltrate into the ground, such as areas that are paved or covered with buildings and sidewalks or compacted unvegetated soils. In urban hydrology, the percentage of pervious and impervious land is important. The percentage of impervious area increases when urbanization occurs

4.0 INTENSITY-DURATION CURVES FOR RATIONAL METHOD

To develop depth-duration curves or intensity-duration curves for the Rational Method of runoff analysis take the 1-hour depth(s) obtained from Figures RA-1 through RA-6 and multiply by the factors in Table RA-4 to determine rainfall depth and rainfall intensity at each duration. The intensity can then be plotted as illustrated in Figure RA-15.

TABLE RA-4—Factors for Preparation of Intensity-Duration Curves

Duration (minutes)	5	10	15	30	60
Rainfall Depth at Duration (inches)	$0.29P_1$	$0.45P_1$	$0.57P_1$	$0.79P_1$	$1.0P_1$
Intensity (inches per hour)	$3.48P_1$	$2.70P_1$	$2.28P_1$	$1.58P_1$	$1.0P_1$

Alternatively, the rainfall intensity for the area within the District can be approximated by the equation:

$$I = \frac{28.5\,P_1}{(10 + T_c)^{0.786}} \qquad \text{(RA-3)}$$

in which:

I = rainfall intensity (inches per hour)

P_1 = 1-hour point rainfall depth (inches)

T_c = time of concentration (minutes)

PROPOSED

PROJECT INFORMATION

PROJECT NAME:	Dillon Homewood Suites - PROP
PROJECT NO:	MC18.0436
DESIGN BY:	MAT
REVIEWED BY:	LML
JURISDICTION:	Town of Dillon
REPORT TYPE:	Drainage
DATE:	12/07/18

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JURISDICTIONAL STANDARD	C2	C5	C10	C100	% IMPERV
LANDSCAPE	0.04	0.15	0.25	0.50	0%
ROOF	0.73	0.75	0.77	0.83	90%
ASPHALT/CONCRETE	0.89	0.90	0.92	0.96	100%
DRIVES AND WALKS	0.73	0.75	0.77	0.83	90%

	AREA (ACRES)	C2	C5	C10	C100	PERCENT IMPERVIOUSNESS
TOTAL SITE COMPOSITE	**1.80**	**0.65**	**0.68**	**0.72**	**0.81**	**73.7%**

SUB-BASIN	SURFACE CHARACTERISTICS	AREA	COMPOSITE RUNOFF COEFFICIENTS				PERCENT IMPERVIOUSNESS
		(ACRES)	C2	C5	C10	C100	
1	LANDSCAPE	0.18	0.04	0.15	0.25	0.50	0%
	ROOF	0.53	0.73	0.75	0.77	0.83	90%
	ASPHALT/CONCRETE	0.42	0.89	0.90	0.92	0.96	100%
SUB-BASIN COMPOSITE		**1.13**	**0.68**	**0.71**	**0.74**	**0.83**	**79.4%**

SUB-BASIN	SURFACE CHARACTERISTICS	AREA	COMPOSITE RUNOFF COEFFICIENTS				PERCENT IMPERVIOUSNESS
		(ACRES)	C2	C5	C10	C100	
2	LANDSCAPE	0.14	0.04	0.15	0.25	0.50	0%
	ASPHALT/CONCRETE	0.15	0.89	0.90	0.92	0.96	100%
	ROOF	0.00	0.73	0.75	0.77	0.83	90%
SUB-BASIN COMPOSITE		**0.29**	**0.48**	**0.54**	**0.60**	**0.74**	**51.7%**

SUB-BASIN	SURFACE CHARACTERISTICS	AREA	COMPOSITE RUNOFF COEFFICIENTS				PERCENT IMPERVIOUSNESS
		(ACRES)	C2	C5	C10	C100	
3	LANDSCAPE	0.06	0.04	0.15	0.25	0.50	0%
	ASPHALT/CONCRETE	0.30	0.89	0.90	0.92	0.96	100%
	ROOF	0.01	0.73	0.75	0.77	0.83	90%
SUB-BASIN COMPOSITE		**0.37**	**0.75**	**0.77**	**0.81**	**0.88**	**83.5%**

	AREA (ACRES)	C2	C5	C10	C100	PERCENT IMPERVIOUSNESS
TOTAL SITE COMPOSITE	**1.80**	**0.65**	**0.68**	**0.72**	**0.81**	**73.7%**

CALCULATED BY: MAT
CHECKED BY: LML
DATE: 12/07/18

STANDARD FORM SF-2
TIME OF CONCENTRATION SUMMARY
(RATIONAL METHOD PROCEDURE)

JOB NO: MC18.0436
PROJECT: Dillon Homewood Suites -

SUB-BASIN DATA				INITIAL/OVERLAND TIME (t_i)			TRAVEL TIME (t_t)					t_c CHECK (URBANIZED BASINS)			FINAL t_c	REMARKS
BASIN	DESIGN POINT (1)	C_5 (2)	AREA ac (3)	LENGTH ft (4)	SLOPE ft/ft (5)	t_i min (6)	LENGTH ft (7)	SLOPE ft/ft (8)	C_v (9)	VEL. fps (10)	t_t Min (11)	COMP. t_c (12)	TOT. LENGTH ft (13)	tc=(L/180)+10 min (14)	min (15)	
1	1	0.71	1.13	58	0.0270	3.9	267	0.0280	20	3.35	1.3	5.2	325.0	11.8	5.2	
2	2	0.54	0.29	84	0.0290	6.5	54	0.0100	20	2.00	0.5	7.0	138.0	10.8	7.0	
3	3	0.81	0.37	103	0.0750	2.7	5	0.0750	20	5.48	0.0	2.7	108.0	10.6	5.0	

*Velocity (V) = $C_v S_w 0.5$

TABLE RO-2

Type of Land Surface	Conveyance Coefficient, Cv
Heavy Meadow	2.5
Tillage / Field	5
Short Pasture and Lawns	7
Nearly Bare Ground	10
Grassed Waterway	15
Paved Areas and Shallow Paved Swales	20

**Table RO-2, UDFCD (V.1), Chapter 5, Page RO-6*

in which: Cv = Conveyance Coefficient (See Table Above)
Sw = Watercourse Slope (ft/ft)

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CALCULATED BY:	MAT	**JOB NO:**	MC18.0436
CHECKED BY:	LML	**PROJECT:**	Dillon Homewood Suites -
DATE:	12/07/18	**DESIGN STORM:**	5-YEAR
		ONE-HR PRECIP:	0.85

STANDARD FORM SF-3
STORM DRAINAGE SYSTEM DESIGN
(RATIONAL METHOD PROCEDURE)

BASIN	DESIGN POINT	DIRECT RUNOFF						TOTAL RUNOFF				REMARKS
		AREA (AC)	RUNOFF COEFF	t_c (MIN)	CxA (AC)	I (IN/HR)	Q (CFS)	t_c (MIN)	S(CxA) (AC)	I (IN/HR)	Q (CFS)	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
1	1	1.13	0.71	5.2	0.80	3.08	2.47					
2	2	0.29	0.54	7.0	0.16	2.79	0.44					
3	3	0.37	0.81	5.0	0.30	3.11	0.93					

I. One-Hr Precipitation Values for Dillon

Return Period:	2-YEAR	5-YEAR	10-YEAR	100-YEAR
Depth In Inches:	0.61	0.85	1.10	1.70

**Equation RA-3, UDFCD (V.1), Chapter 4, Page RA-6*

*Rainfall Intensity: $$I = \frac{C_1 P_1}{(C_2 + T_d)^{C_3}}$$

In Which:
I = Rainfall Intensity (Inches Per Hour)
P1 = 1-Hour Point Rainfall Depth (Inches)
tc = Time Of Concentration (Minutes)

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CALCULATED BY: MAT
CHECKED BY: LML
DATE: 12/07/18

STANDARD FORM SF-3
STORM DRAINAGE SYSTEM DESIGN
(RATIONAL METHOD PROCEDURE)

JOB NO: MC18.0436
PROJECT: Dillon Homewood Suites -
DESIGN STORM: 10-YEAR
ONE-HR PRECIP: 1.1

BASIN	DESIGN POINT	DIRECT RUNOFF						TOTAL RUNOFF				REMARKS
		AREA (AC)	RUNOFF COEFF	t_c (MIN)	CxA (AC)	I (IN/HR)	Q (CFS)	t_c (MIN)	S(CxA) (AC)	I (IN/HR)	Q (CFS)	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
1	1	1.13	0.74	5.2	0.84	3.71	3.10					
2	2	0.29	0.60	7.0	0.17	3.39	0.59					
3	3	0.37	0.84	5.0	0.31	3.74	1.16					

I. **One-Hr Precipitation Values for Dillon**

Return Period:	2-YEAR	5-YEAR	10-YEAR	100-YEAR
Depth In Inches:	0.61	0.85	1.10	1.70

**Equation RA-3, UDFCD (V.1), Chapter 4, Page RA-6*

*Rainfall Intensity: $I = \frac{C_1 P_1}{(C_2 + T_d)^{C_3}}$

In Which:
I = Rainfall Intensity (Inches Per Hour)
P1 = 1-Hour Point Rainfall Depth (Inches)
tc = Time Of Concentration (Minutes)

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CALCULATED BY:	MAT	**JOB NO:**	MC18.0436
CHECKED BY:	LML	**PROJECT:**	Dillon Homewood Suites -
DATE:	12/07/18	**DESIGN STORM:**	100-YEAR
		ONE-HR PRECIP:	1.70

STANDARD FORM SF-3
STORM DRAINAGE SYSTEM DESIGN
(RATIONAL METHOD PROCEDURE)

BASIN	DESIGN POINT	DIRECT RUNOFF						TOTAL RUNOFF				REMARKS
		AREA (AC)	RUNOFF COEFF	t_c (MIN)	CxA (AC)	I (IN/HR)	Q (CFS)	t_c (MIN)	S(CxA) (AC)	I (IN/HR)	Q (CFS)	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
1	1	1.13	0.83	5.2	0.94	5.87	5.51					
2	2	0.29	0.74	7.0	0.21	5.33	1.14					
3	3	0.37	0.91	5.0	0.34	5.94	2.00					

I. One-Hr Precipitation Values for Dillon

Return Period:	2-YEAR	5-YEAR	10-YEAR	100-YEAR
Depth In Inches:	0.61	0.85	1.10	1.70

**Equation RA-3, UDFCD (V.1), Chapter 4, Page RA-6*

*Rainfall Intensity:

$$I = \frac{C_1 P_1}{(C_2 + T_d)^{C_3}}$$

In Which:
I = Rainfall Intensity (Inches Per Hour)
P1 = 1-Hour Point Rainfall Depth (Inches)
tc = Time Of Concentration (Minutes)

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EXISTING

PROJECT INFORMATION

PROJECT NAME: Dillon Homewood Suites - EXIST
PROJECT NO: MC18.0436
DESIGN BY: MAT
REVIEWED BY: LML
JURISDICTION: Town of Dillon
REPORT TYPE: Drainage
DATE: 12/07/18

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JURISDICTIONAL STANDARD	C2	C5	C10	C100	% IMPERV
LANDSCAPE	0.04	0.15	0.25	0.50	0%
ROOF	0.73	0.75	0.77	0.83	90%
ASPHALT/CONCRETE	0.89	0.90	0.92	0.96	100%
DRIVES AND WALKS	0.73	0.75	0.77	0.83	90%

TOTAL SITE COMPOSITE		**0.79**	**0.28**	**0.36**	**0.44**	**0.63**	**28.5%**

SUB-BASIN	SURFACE CHARACTERISTICS	AREA	COMPOSITE RUNOFF COEFFICIENTS				PERCENT IMPERVIOUSNESS
		(ACRES)	C2	C5	C10	C100	
EX. 1	LANDSCAPE	0.56	0.04	0.15	0.25	0.50	0%
	ROOF	0.05	0.73	0.75	0.77	0.83	90%
	ASPHALT/CONCRETE	0.18	0.89	0.90	0.92	0.96	100%
	GRAVEL		0.28	0.35	0.42	0.58	40%
SUB-BASIN COMPOSITE		**0.79**	**0.28**	**0.42**	**0.44**	**0.53**	**28.5%**

SUB-BASIN	SURFACE CHARACTERISTICS	AREA	COMPOSITE RUNOFF COEFFICIENTS				PERCENT IMPERVIOUSNESS
		(ACRES)	C2	C5	C10	C100	
EX. 2	LANDSCAPE	0.13	0.04	0.15	0.25	0.50	0%
	ROOF	0.14	0.73	0.75	0.77	0.83	90%
	ASPHALT/CONCRETE	0.60	0.89	0.90	0.92	0.96	100%
SUB-BASIN COMPOSITE		**0.87**	**0.74**	**0.77**	**0.80**	**0.87**	**83.6%**

TOTAL SITE COMPOSITE		**0.79**	**0.51**	**0.60**	**0.62**	**0.70**	**56.0%**

CALCULATED BY:	MAT	**STANDARD FORM SF-2**	**JOB NO:** MC18.0436
CHECKED BY:	LML	**TIME OF CONCENTRATION SUMMARY**	**PROJECT:** Dillon Homewood Suites -
DATE:	12/07/18	**(RATIONAL METHOD PROCEDURE)**	

SUB-BASIN DATA				INITIAL/OVERLAND TIME (t_i)			TRAVEL TIME (t_t)					t_c CHECK (URBANIZED BASINS)			FINAL t_c	REMARKS
BASIN	DESIGN POINT (1)	C_5 (2)	AREA ac (3)	LENGTH ft (4)	SLOPE ft/ft (5)	t_i min (6)	LENGTH ft (7)	SLOPE ft/ft (8)	C_v (9)	VEL. fps (10)	t_t Min (11)	COMP. t_c (12)	TOT. LENGTH ft (13)	tc=(L/180)+10 min (14)	min (15)	
EX. 1	1	0.36	0.79	300	0.0210	18.1	21	0.0210	10	1.45	0.2	18.4	321.0	11.8	11.8	
EX. 2	2	0.77	0.87	242	0.0330	6.3	0	0.0000	20	0.00	0.0	6.3	242.0	11.3	6.3	

*Velocity (V) = $C_v S_w 0.5$

TABLE RO-2

Type of Land Surface	Conveyance Coefficient, Cv
Heavy Meadow	2.5
Tillage / Field	5
Short Pasture and Lawns	7
Nearly Bare Ground	10
Grassed Waterway	15
Paved Areas and Shallow Paved Swales	20

**Table RO-2, UDFCD (V.1), Chapter 5, Page RO-6*

in which: Cv = Conveyance Coefficient (See Table Above)

Sw = Watercourse Slope (ft/ft)

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CALCULATED BY: MAT
CHECKED BY: LML
DATE: 12/07/18

STANDARD FORM SF-3
STORM DRAINAGE SYSTEM DESIGN
(RATIONAL METHOD PROCEDURE)

JOB NO: MC18.0436
PROJECT: Dillon Homewood Suites -
DESIGN STORM: 5-YEAR
ONE-HR PRECIP: 0.85

BASIN	DESIGN POINT	DIRECT RUNOFF						TOTAL RUNOFF				REMARKS
		AREA (AC)	RUNOFF COEFF	t_c (MIN)	CxA (AC)	I (IN/HR)	Q (CFS)	t_c (MIN)	S(CxA) (AC)	I (IN/HR)	Q (CFS)	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
EX. 1	1	0.79	0.42	11.8	0.33	2.25	0.75					
EX. 2	2	0.87	0.77	6.3	0.67	2.90	1.93					

I. **One-Hr Precipitation Values for Dillon**

Return Period:	2-YEAR	5-YEAR	10-YEAR	100-YEAR
Depth In Inches:	0.61	0.85	1.10	1.70

**Equation RA-3, UDFCD (V.1), Chapter 4, Page RA-6*

*Rainfall Intensity: $$I = \frac{C_1 P_1}{(C_2 + T_d)^{C_3}}$$

In Which:
I = Rainfall Intensity (Inches Per Hour)
P1 = 1-Hour Point Rainfall Depth (Inches)
tc = Time Of Concentration (Minutes)

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CALCULATED BY:	MAT	**STANDARD FORM SF-3**	**JOB NO:** MC18.0436
CHECKED BY:	LML	**STORM DRAINAGE SYSTEM DESIGN**	**PROJECT:** Dillon Homewood Suites -
DATE:	12/07/18	**(RATIONAL METHOD PROCEDURE)**	**DESIGN STORM:** 10-YEAR
			ONE-HR PRECIP: 1.1

BASIN	DESIGN POINT	DIRECT RUNOFF						TOTAL RUNOFF				REMARKS
		AREA (AC)	RUNOFF COEFF	t_c (MIN)	CxA (AC)	I (IN/HR)	Q (CFS)	t_c (MIN)	S(CxA) (AC)	I (IN/HR)	Q (CFS)	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
EX. 1	1	0.79	0.44	11.8	0.35	2.77	0.96					
EX. 2	2	0.87	0.80	6.3	0.69	3.51	2.43					

I. **One-Hr Precipitation Values for Dillon**

Return Period:	2-YEAR	5-YEAR	10-YEAR	100-YEAR
Depth In Inches:	0.61	0.85	1.10	1.70

**Equation RA-3, UDFCD (V.1), Chapter 4, Page RA-6*

*Rainfall Intensity: $I = \frac{C_1 P_1}{(C_2 + T_d)^{C_3}}$

In Which: I = Rainfall Intensity (Inches Per Hour)
P1 = 1-Hour Point Rainfall Depth (Inches)
tc = Time Of Concentration (Minutes)

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CALCULATED BY:	MAT	**JOB NO:**	MC18.0436
CHECKED BY:	LML	**PROJECT:**	Dillon Homewood Suites -
DATE:	12/07/18	**DESIGN STORM:**	100-YEAR
		ONE-HR PRECIP:	1.70

STANDARD FORM SF-3

STORM DRAINAGE SYSTEM DESIGN

(RATIONAL METHOD PROCEDURE)

BASIN	DESIGN POINT	DIRECT RUNOFF						TOTAL RUNOFF				REMARKS
		AREA (AC)	RUNOFF COEFF	t_c (MIN)	CxA (AC)	I (IN/HR)	Q (CFS)	t_c (MIN)	S(CxA) (AC)	I (IN/HR)	Q (CFS)	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
EX. 1	1	0.79	0.53	11.8	0.42	4.31	1.81					
EX. 2	2	0.87	0.87	6.3	0.75	5.53	4.16					

I. **One-Hr Precipitation Values for Dillon**

Return Period:	2-YEAR	5-YEAR	10-YEAR	100-YEAR
Depth In Inches:	0.61	0.85	1.10	1.70

**Equation RA-3, UDFCD (V.1), Chapter 4, Page RA-6*

*Rainfall Intensity:

$$I = \frac{C_1 P_1}{(C_2 + T_d)^{C_3}}$$

In Which:

I = Rainfall Intensity (Inches Per Hour)

P1 = 1-Hour Point Rainfall Depth (Inches)

tc = Time Of Concentration (Minutes)

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Appendix C
Hydraulic Calculations

REQUIRED POND VOLUME

PROJECT INFORMATION

PROJECT NAME:	Dillon Homewood Suites
PROJECT #:	MC18.0436
POND NAME:	Basin 1 Pond
DATE:	12/07/18

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Maximum Unit Flow Release Rates (cfs/acre) from On-Site Detention Facilities

Design Return Period (Years)	**NRCS Hydrologic Soil Group** A	B	C & D
5	0.07	0.13	0.17
10	0.13	0.23	0.30
100	0.50	0.85	1.00

**Table SO-1, UDFCD (V.2) Chapter 10, Page SO-8*

NRCS Hydrologic Soil Group: **B**

Max 5-Year Release Rate =	**0.5**	**(cfs)**
Max 10-Year Release Rate =	**0.6**	**(cfs)**
Max 100-Year Release Rate =	**0.7**	**(cfs)**

One-Hr Precipitation Values for the City and County of Denver

Return Period:	2	5	10	100
Depth In Inches:	0.61	0.85	1.10	1.70

*Rainfall Intensity

$$I = \frac{(28.5 \times P1)}{(10 + t_c)^{0.786}}$$

In Which: I = Rainfall Intensity (Inches Per Hour)
P1 = 1-Hour Point Rainfall Depth (Inches)
t_c = Time Of Concentration (Minutes)

Site Composite Surface Characteristics:

Characteristic:	**Acres**	**C_2**	**C_5**	**C_{10}**	**C_{100}**	**% Imp.**	**t_c**
Values:	1.13	0.68	0.71	0.74	0.83	79.4%	5.2

5-Year Storage Volume =	**1087**	**(ft³)**
	0.025	**(ac-ft)**
10-Year Storage Volume =	**1591**	**(ft³)**
	0.037	**(ac-ft)**
100-Year Storage Volume =	**3344**	**(ft³)**
	0.077	**(ac-ft)**

POND WATER SURFACE ELEV.'S & POND VOLUME CALCULATION

PROJECT INFORMATION

PROJECT NAME:	Dillon Homewood Suites
PROJECT #:	MC18.0436
POND NAME:	Basin 1 Pond
DATE:	12/07/18

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CONSULTING ENGINEERS

Required 5-Year Volume = 1087 (ft³)
0.025 (ac-ft)
5-Year Water Surface Elevation = 9107.55 **(Water Quality Not Inclusive)**

Required 10-Year Volume = 1591 (ft³)
0.037 (ac-ft)
10-Year Water Surface Elevation = 9107.96 **(Water Quality Not Inclusive)**

Required 100-Year Volume = 3344 (ft³)
0.077 (ac-ft)
100-Year Water Surface Elevation = 9109.09 **(Water Quality Not Inclusive)**

Total Pond Volume = 3722 **(ft³)**
0.085 **(ac-ft)**

Incremental Volume= $\frac{1}{3}(ELEV\ 2 - ELEV\ 1) \times (AREA\ 1 + AREA\ 2 + (AREA\ 1 \times AREA\ 2)^{1/2})$

Contour Elevation	Contour Area (ft²)	Volume (ft³)	Cumulative Volume (ft³)	Cumulative Volume (acre-ft)
9106.00	0.0	0	0	0.00
9106.10	38.392	1	1	0.00
9106.20	119.807	8	9	0.00
9106.30	246.337	18	27	0.00
9106.40	390.79	32	58	0.00
9106.50	525.97	46	104	0.00
9106.60	651.879	59	163	0.00
9106.70	768.517	71	234	0.01
9106.80	870.534	82	316	0.01
9106.90	928.351	90	406	0.01
9107.00	962.072	95	500	0.01
9107.10	996.338	98	598	0.01
9107.20	1,031.15	101	699	0.02
9107.30	1,066.51	105	804	0.02
9107.40	1,102.41	108	913	0.02
9107.50	1,138.85	112	1025	0.02
9107.60	1,175.85	116	1140	0.03
9107.70	1,213.38	119	1260	0.03
9107.80	1,251.47	123	1383	0.03
9107.90	1,290.09	127	1510	0.03
9108.00	1,329.27	131	1641	0.04
9108.10	1,368.98	135	1776	0.04
9108.20	1,409.25	139	1915	0.04
9108.30	1,450.05	143	2058	0.05
9108.40	1,491.41	147	2205	0.05
9108.50	1,533.30	151	2356	0.05
9108.60	1,575.75	155	2512	0.06
9108.70	1,618.74	160	2671	0.06
9108.80	1,662.27	164	2835	0.07
9108.90	1,706.35	168	3004	0.07
9109.00	1,751.00	173	3177	0.07
9109.10	1,796.00	177	3354	0.08
9109.20	1,841.00	182	3536	0.08
9109.30	1,888.00	186	3722	0.09

Worksheet for 5-YR Orifice

Project Description

Solve For	Discharge

Input Data

Headwater Elevation	9107.55	ft
Centroid Elevation	9106.13	ft
Tailwater Elevation	9104.73	ft
Discharge Coefficient	0.60	
Diameter	0.33	ft

Results

Discharge	0.49	ft³/s
Headwater Height Above Centroid	1.42	ft
Tailwater Height Above Centroid	-1.40	ft
Flow Area	0.09	ft²
Velocity	5.74	ft/s

Worksheet for 10-YR Orifice

Project Description

Solve For	Discharge

Input Data

Headwater Elevation	9107.96	ft
Centroid Elevation	9106.13	ft
Tailwater Elevation	9104.74	ft
Discharge Coefficient	0.60	
Diameter	0.33	ft

Results

Discharge	0.56	ft³/s
Headwater Height Above Centroid	1.83	ft
Tailwater Height Above Centroid	-1.39	ft
Flow Area	0.09	ft²
Velocity	6.51	ft/s

Worksheet for 100-YR Orifice

Project Description

Solve For	Diameter

Input Data

Discharge	0.71	ft³/s
Headwater Elevation	9109.09	ft
Centroid Elevation	9106.13	ft
Tailwater Elevation	9104.76	ft
Discharge Coefficient	0.60	

Results

Diameter	0.33	ft
Headwater Height Above Centroid	2.96	ft
Tailwater Height Above Centroid	-1.37	ft
Flow Area	0.09	ft²
Velocity	8.28	ft/s

100-YEAR RESTRICTOR PLATE

PROJECT INFORMATION

PROJECT NAME:	Dillon Homewood Suit
PROJECT #:	MC18.0436
POND NAME:	Basin 1 Pond
DATE:	43441

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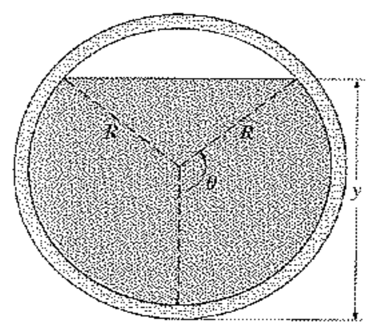
CONSULTING ENGINEERS

Max 100-Year Release Rate =	0.8	(cfs)	
Outlet Pipe Invert Elevation =	9104.56	(ft)	**MINIMUM 3" BELOW LOWEST PERF.**
10-Year WSEL =	9107.96	(ft)	
Inlet Grate Elevation =	9109.09	(ft)	
100-Year WSEL =	9109.09	(ft)	

Orifice Equation: $Q = CA\sqrt{2gH}$ **Equation SO-15, UDFCD (V.2), Chapter 10, Page SO-20*

Q = Flow Rate Through Orifice (cfs)
C = Discharge Coefficient (0.40-0.65)
A = Area Of Orifice (ft²)
H = Effective Head On Orifice Opening (ft)
g = Gravitational Acceleration (32.2 ft/sec²)

Minimum Opening Area =	0.11	(ft²)
H =	4.40	(ft)
g =	32.2	(ft/sec²)
C =	0.40	**(0.40-0.65)**
Outlet Pipe Diameter =	10	(in)
	0.83	(ft)
R =	0.42	(ft)
θ =	1.07	(rad)
"y" Invert To Plate =	**0.21**	**(ft)**
=	**2.6**	**(in)**
A =	0.11	(ft²)
Centroid Elevation =	9104.69	(ft)
Velocity =	6.74	(ft/s)



$A_c = R^2(\theta - \sin\theta\cos\theta)$

$p = 2R\theta$

$R_h = \frac{A_c}{p} = \frac{\theta - \sin\theta\cos\theta}{2\theta}R$

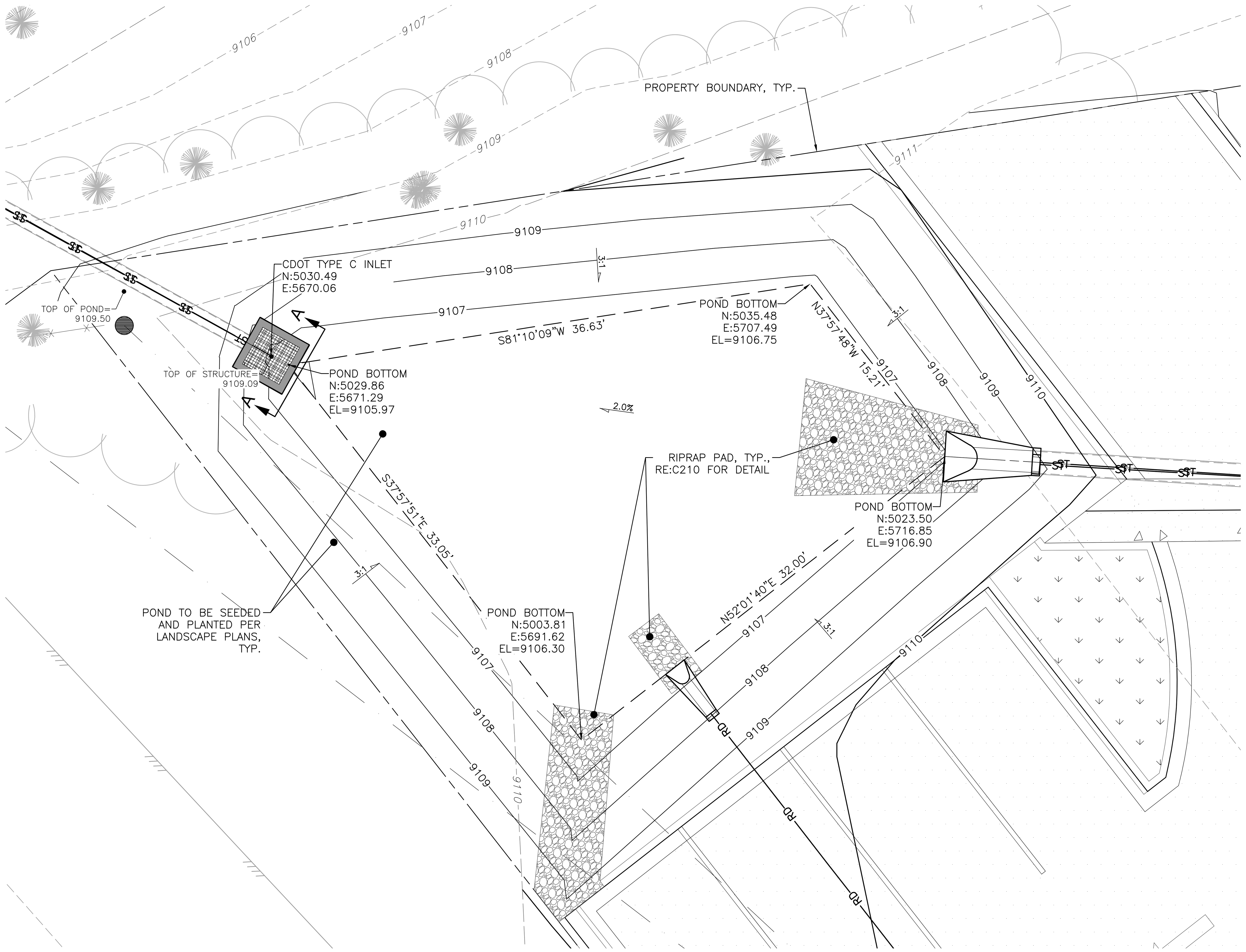
(a) Circular channel (θ in rad)

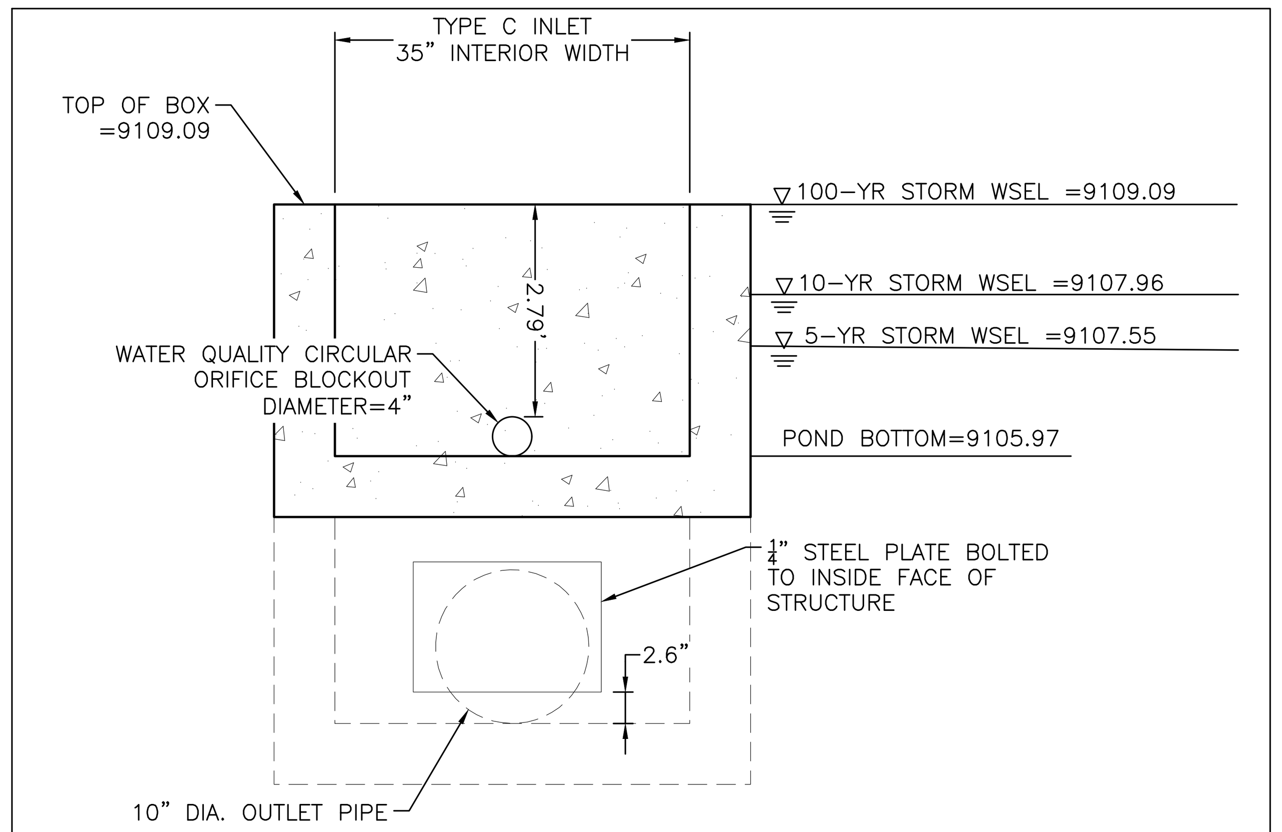
POND MAINTENANCE NOTES:

1. POND AND SITE STORM SEWER SYSTEM MAINTENANCE IS THE RESPONSIBILITY OF THE PROPERTY OWNER (DILLON HOMEWOOD SUITES) AND SHALL INCLUDE BUT IS NOT LIMITED TO THE FOLLOWING:
   - 1.1. VISUAL INSPECTION TO DETERMINE IF THE POND IS DRAINING AFTER A SERIES OF RAINFALLS IS ENCOURAGED.
   - 1.2. TRASH REMOVAL ON A SEMI-ANNUAL BASIS.
   - 1.3. DEBRIS AND SEDIMENT REMOVAL AT THE POND INLET, IN THE POND BOTTOM, AND AT THE OUTLET STRUCTURE ON A BI-ANNUAL BASIS.
   - 1.4. NUISANCE VEGETATION REMOVAL ON A BI-ANNUAL BASIS.
   - 1.5. WATER JETTING OF THE STORM SEWER ON AN AS NEEDED BASIS.
   - 1.6. CLEANING OF GRATE INLETS ON AN AS NEEDED BASIS.
   - 1.7. SEDIMENT REMOVAL FROM INLET SUMPS ON AN AS NEEDED BASIS. AT A MINIMUM SEDIMENT SHOULD BE REMOVED PRIOR TO FILLING UP TO THE LOWEST PIPE INVERT.
2. ACCESS TO THE POND DUE TO SIZE CAN BE ACHIEVED FROM THE ADJACENT ASPHALT PAVEMENT.
3. COSTS ASSOCIATED WITH POND MAINTENANCE ARE THE RESPONSIBILITY OF THE OWNER AND MAY VARY BASED ON THE FREQUENCY OF THE MAINTENANCE ACTIVITIES LISTED ABOVE. HIRING A LICENSED CONTRACTOR TO REMOVE SEDIMENT WITHIN THE BASIN MAY BE REQUIRED IF REGULAR MAINTENANCE ACTIVITIES ARE NOT PRACTICED.

LEGEND

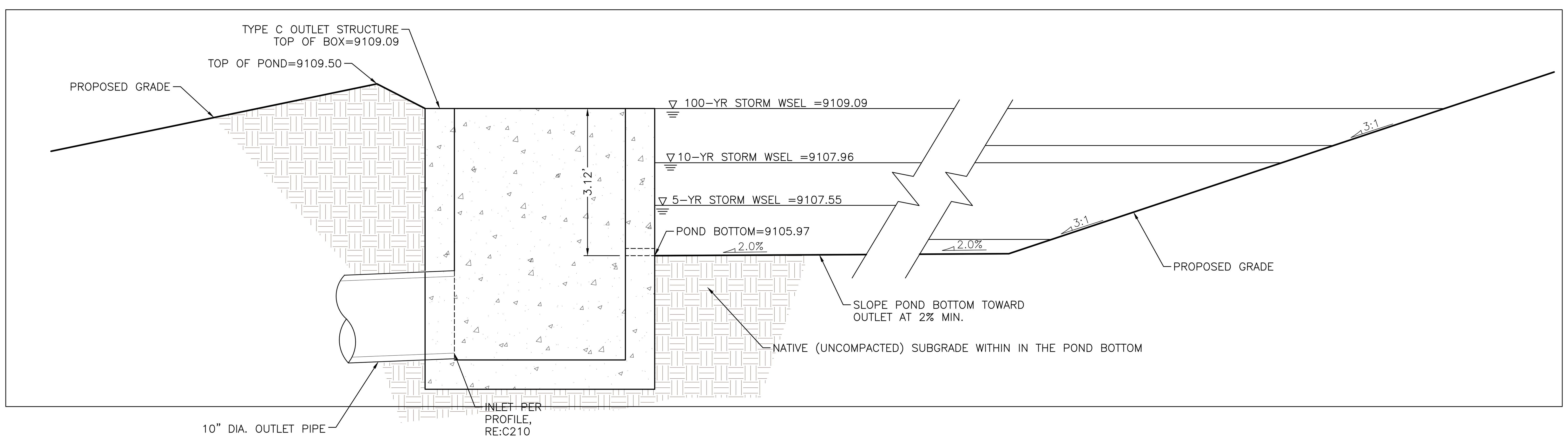
EXISTING		PROPOSED
	PROPERTY LINE	
	RIGHT-OF-WAY LINE	
	SECTION LINE	
	EASEMENT	
	RETAINING WALL	
	CURB & GUTTER	
5750	CONTOURS	5750
ST	STORM SEWER	ST
	STORM MANHOLE	
RD	ROOF DRAIN	RD
	INLET	
	FLARED END SECTION	
	SIGN	
	GRADING ARROW	
	DECIDUOUS TREE	
	EVERGREEN TREE	
	BUSH/SHRUB	
DRIVE	DESCRIPTIONS	DRIVE
ELEV.	SPOT ELEVATIONS	ELEV.





TYPE C OUTLET SECTION A-A
(OUTLET ORIFICE CONFIGURATION)
N.T.S.

SCALE: 1"=5'
ALL DIMENSIONS SHOWN ARE U.S. SURVEY FEET



SCHEMATIC POND SECTION
N.T.S.

CALL 811 2-BUSINESS DAYS IN ADVANCE BEFORE YOU DIG, GRADE OR EXCAVATE FOR MARKING OF UNDERGROUND MEMBER UTILITIES

MARTIN/MARTIN ASSUMES NO RESPONSIBILITY FOR UTILITY LOCATIONS. THE UTILITIES SHOWN ON THIS DRAWING HAVE BEEN PLOTTED FROM (PROVIDED) ASCE (38) UTILITY QUALITY LEVEL D (Q_{LD}) AVAILABLE INFORMATION. IT IS, HOWEVER, THE CONTRACTORS RESPONSIBILITY TO FIELD VERIFY THE SIZE, MATERIAL, HORIZONTAL AND VERTICAL LOCATION OF ALL UTILITIES (DEPICTED OR NOT DEPICTED) PRIOR TO THE COMMENCEMENT OF ANY CONSTRUCTION.

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PRICING SUBMITTAL

HOMEWOOD SUITES
TOWN OF DILLON

POND DETAIL

No.	Issue / Revision	Date	Name
1	PROGRESS PRINT	07/30/18	M/M
2	PRELIM PRICING PLANS	08/15/18	M/M
3	PRICING SUBMITTAL	09/10/18	M/M

Job Number	MC18.0436
Project Manager	LML
Design By	MAT
Drawn By	MAT
Principal In Charge	LML

Sheet Number:
C213

PLOT DATE: Friday, December 7, 2018 12:19 PM LAST SAVED BY: MTALKINGTON
DRAWING LOCATION: H:\MC18.0436-Dillon Homewood Suites\PLANS\SD SUBMITTAL\POND DETAIL.dwg

Worksheet for 100-YR OUTLET PIPE

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.012	
Channel Slope	0.04120	ft/ft
Diameter	0.83	ft
Discharge	0.71	ft^3/s

Results

Normal Depth	0.22	ft
Flow Area	0.11	ft^2
Wetted Perimeter	0.89	ft
Hydraulic Radius	0.13	ft
Top Width	0.73	ft
Critical Depth	0.37	ft
Percent Full	26.0	%
Critical Slope	0.00533	ft/ft
Velocity	6.32	ft/s
Velocity Head	0.62	ft
Specific Energy	0.84	ft
Froude Number	2.84	
Maximum Discharge	5.18	ft^3/s
Discharge Full	4.81	ft^3/s
Slope Full	0.00090	ft/ft
Flow Type	SuperCritical	

10" PIPE MAX FLOW GREATER THAN 0.71CFS

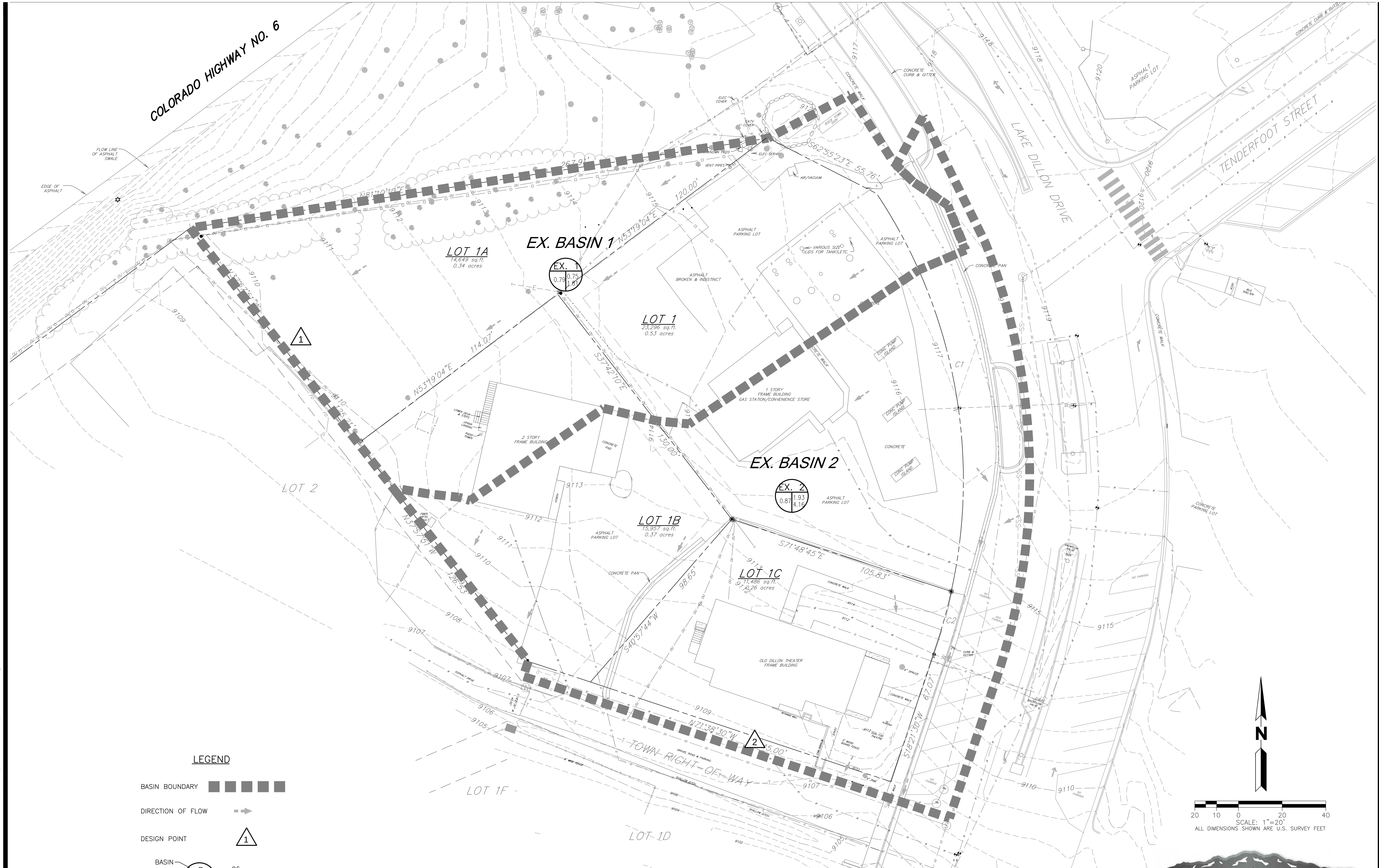
GVF Input Data

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
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	25.95	%
Downstream Velocity	Infinity	ft/s

Appendix D
Drainage Maps



LEGEND

BASIN BOUNDARY

DIRECTION OF FLOW

DESIGN POINT

BASIN, AREA IN ACRES, Q5, Q100

CALL 811 2–BUSINESS DAYS IN ADVANCE
BEFORE YOU DIG, GRADE OR EXCAVATE FOR
MARKING OF UNDERGROUND MEMBER UTILITIES

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HOMEWOOD SUITES
TOWN OF DILLON

EXISTING BASIN MAP

No.	Issue / Revision	Date	Name
1	PROGRESS PRINT	07/30/18	M/M
2	PRELIM PRICING PLANS	08/15/18	M/M
3	PRICING SUBMITTAL	09/10/18	M/M

Job Number	MC18.0436
Project Manager	LML
Design By	MAT
Drawn By	MAT
Principal In Charge	LML

Sheet Number:

D1

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COLORADO 811 KNOW WHAT'S BELOW. CALL BEFORE YOU DIG.

CALL 811 2-BUSINESS DAYS IN ADVANCE BEFORE YOU DIG, GRADE OR EXCAVATE FOR MARKING OF UNDERGROUND MEMBER UTILITIES

MARTIN/MARTIN ASSUMES NO RESPONSIBILITY FOR UTILITY LOCATIONS. THE UTILITIES SHOWN ON THIS DRAWING HAVE BEEN PLOTTED FROM (PROVIDED) ASCE (38) UTILITY QUALITY LEVEL D (Q_D) AVAILABLE INFORMATION. IT IS, HOWEVER, THE CONTRACTORS RESPONSIBILITY TO FIELD VERIFY THE SIZE, MATERIAL, HORIZONTAL AND VERTICAL LOCATION OF ALL UTILITIES (DEPICTED OR NOT DEPICTED) PRIOR TO THE COMMENCEMENT OF ANY CONSTRUCTION.

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PRICING SUBMITTAL

HOMEWOOD SUITES
TOWN OF DILLON

PROPOSED BASIN MAP

No.	Issue / Revision	Date	Name
1	PROGRESS PRINT	07/30/18	M/M
2	PRELIM PRICING PLANS	08/15/18	M/M
3	PRICING SUBMITTAL	09/10/18	M/M

Job Number: MC18.0436
Project Manager: LML
Design By: MAT
Drawn By: MAT
Principal In Charge: LML

Sheet Number:

D2

PLOT DATE: Friday, December 7, 2018 10:58 AM LAST SAVED BY: MTALKINGTON
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