Final Drainage Report
Lot 1 Broadmoor Campus Filing No. 2
(Broadmoor Exhibit Hall)
& Amendment to the Master Development Drainage Plan Broadmoor Hotel Complex

Prepared for:

Broadmoor Hotel, Inc.
1 Lake Avenue
Colorado Springs, CO 80906

Prepared by:

Kiowa Engineering Corporation
Celebrating 30 years

1604 South 21st Street
Colorado Springs, Colorado 80904
(719) 630-7342

Kiowa Project No. 18062

April 5, 2019

Signature Page

Lot 1 Broadmoor Campus Filing No. 2 / Broadmoor Exhibit Hall

Engineer's Statement

This report and plan for the drainage design of Lot 1 Broadmoor Campus Filing No. 2 (Broadmoor Exhibit Hall) was prepared by me (or under my direct supervision) and is correct to the best of my knowledge and belief. Said report and plan has been prepared in accordance with the City of Colorado Springs Drainage Criteria Manual and is in conformity with the master plan of the drainage basin. I understand that the City of Colorado Springs does not and will not assume liability for drainage facilities designed by others. I accept responsibility for any liability caused by any negligent acts, errors or omissions on my part in preparing this report.

Signature (Affix Seal): ______________________ April 5, 2019

Colorado P.E. No. 25057 Date

COLORADO LICENSED ANDREW W. McCORD 25057 PROFESSIONAL ENGINEER

Developer's Statement

Broadmoor Hotel, Inc. hereby certifies that the drainage facilities for Lot 1 Broadmoor Campus Filing No. 2 shall be constructed according to the design presented in this report. I understand that the City of Colorado Springs does not and will not assume liability for the drainage facilities designed and/or certified by my engineer and that are submitted to the City of Colorado Springs pursuant to section 7.7.906 of the City Code; and cannot, on behalf of Lot 1 Broadmoor Campus Filing No. 2, guarantee that final drainage design review will absolve Broadmoor Hotel, Inc. and/or their successors and/or assigns of future liability for improper design. I further understand that approval of the final plat does not imply approval of my engineer's drainage design.

Name of Developer: The Broadmoor Hotel

______________________ April 6, 2019

Authorized Signature Date

Printed Name: Robert P. McGrath

Title: Director of Engineering

Address: 1 Lake Avenue, Colorado Springs, Colorado 80906

City of Colorado Springs Statement:

Filed in accordance with Section 7.7.906 of the code of the City of Colorado Springs, 2001, as amended.

______________________ 04/05/2019

For City Engineer Date

Conditions:

I. General Location and Description

Lot 1 Broadmoor Campus Filing No. 2 is located in the southwestern portion of the City of Colorado Springs, El Paso County, Colorado. The area was annexed into the City in 1978 and again in 1980. The site is located in Sections 35 and 36, Township 14 South, Range 67 West of the 6th P.M. The site is roughly bounded to the west by Mesa Avenue, to the north by single-family residences, to the east by Hazel Avenue, and to the south by Lake Circle. A vicinity map showing the location of the site is located in Appendix A.

The property was previously studied in the report entitled *Preliminary Drainage Report Lots 1 and 2 Broadmoor Campus Filing No. 2 and Final Drainage Report Lot 2 Broadmoor Campus Filing No. 2*. The proposed layout of the site has changed from this earlier report and Brownstones Phase II development is no longer proposed for the site.

This Final Drainage Report addresses Lot 1 of Broadmoor Campus Filing No. 2 and No. 6, which has a waiver of replat to treat the parcels as one lot. The purpose of the Final Drainage Report is to comply with City of Colorado Springs standards related to the required Development Plan. The report identifies on-site and off-site drainage patterns due to the proposed development along with identifying storm sewer improvements, both location and sizes, required to safely convey developed runoff to the previously established outfall piping. The property contains approximately 7.25 acres of the northeast portion of the Broadmoor Hotel Campus. The entire Broadmoor property has been masterplanned. Lot 1, Broadmoor Campus Filing No. 2 site currently contains paved and unpaved parking areas and a temporary detention basin. Proposed development of the site includes an Exhibit Hall, parking, sidewalks, and landscaped areas along with a private extended detention basin. To the east of the site lies an existing Event Center with underground parking as well as the Carriage Museum, Hill Climb Museum, and Lot 2 Broadmoor Campus Filing No. 6.

A wall currently separates the Broadmoor property (Holly Avenue and the south end of 1st Street) from the single-family residences to the north. A roundabout has been constructed at the intersection of Mesa Avenue and Lake Circle (southwest of the project site). Holly Avenue will provide access to the proposed parking area, as it currently does in the existing condition. A residential property (Southwesterly 80 feet of Lot 2 Block 8 Broadmoor) was acquired north of Lot 1 Broadmoor Campus Filing No. 2 but is not included with this report or project.

Lot 1 Broadmoor Campus Filing No. 2 lies entirely within the Southwest Area Drainage Basin. According to the Southwest Area DBPS (Drainage Basin Planning Study of Southwest Area Drainage Basin), minimal drainage facilities in the area convey runoff to existing creeks in the basin. Most runoff generated in this basin either travels in gutters or roadside ditches before reaching an outfall. Many culverts convey this runoff under roadways and driveways. In some instances, storm sewer systems route runoff through the area to another ditch or channel. Most improvements proposed in the DBPS consist of upgrading culvert/pipe sizes, lining and reshaping existing channels, and adding storm sewer systems where ditches are not feasible or possible. No specific facilities or improvements are recommended in the DBPS on or near Lot 1 Broadmoor Campus Filing No. 2.

The location of the proposed private full spectrum extended detention basin is shown on Figure 3 in Appendix E. A proposed detention basin was discussed as part of the initial Brownstones Phase II plans for the site (on the same parcel of land) in the Broadmoor Resort Complex Master Drainage and Development Plan (MDDP). The Broadmoor is forgoing the plan to install the Brownstones Phase II development and will instead be constructing a new Exhibit Hall building. The existing temporary detention basin serves the "C" basins as shown in the MDDP, last updated in 2004. The MDDP forms the basis for the hydrologic and hydraulic design that had been shown on the final design plans for The Brownstones Phase II. The existing temporary detention basin will be redesigned as a private full spectrum extended detention basin releasing the developed 100-year runoff at 90 percent of the historic rate.

II. References

1) *Engineering Study of Southwest Area Drainage Basin (DBPS),* prepared by Lincoln Devore, Inc., dated February 29, 1984.

2) *Preliminary Drainage Report for Lots 1 and 2 Broadmoor Campus Filing No. 2 and Final Drainage Report for Lot 2 Broadmoor Campus Filing No. 2*, prepared by Kiowa Engineering Corporation, filed January 29, 2004.

3) *Master Development Drainage Plan Broadmoor Hotel Campus,* prepared by Kiowa Engineering Corporation, dated October 2003 and revised January 2004, filed January 29, 2004.

4) *Preliminary Drainage Report, Lots 1 and 2 Broadmoor Campus Filing No. 2 and Final Drainage Report Lot 2 Broadmoor Campus Filing No.2,* prepared by Kiowa Engineering Corporation, dated November 2003 and revised January 2004, filed January 29, 2004.

5) *Final Drainage Report Lot 1 Broadmoor Campus Filing No. 2 (Brownstones Phase II),* prepared by Kiowa Engineering Corporation, filed October 31, 2005.

6) *Drainage Letter for Ross Subdivision,* prepared by Terra Nova Engineering, Inc., filed January 27, 2003.

7) *Final Drainage Letter, Broadmoor Campus Filing No. 6, Replat of Lot 1 and 2, Broadmoor Campus Filing No. 5,* prepared by Kiowa Engineering Corporation, filed April 16, 2008.

8) *Final Drainage Letter, Pikes Peak Hill Climb Museum, A lot Line Adjustment to Lot 1, Broadmoor Campus Filing No. 6 and Lot 1, Broadmoor Campus Filing No. 2,* prepared by Kiowa Engineering Corporation, dated August 2013.

9) City of Colorado Springs *Drainage Criteria Manual, Volumes 1 and 2,* May 2014.

10) *Soil Survey for El Paso County, Colorado*. U.S. Department of Agriculture, Soil Conservation Service, June 1980.

11) *Geological Hazards Exemption,* prepared by CTL Thompson, January 10, 2019.

III. Drainage Design Criteria

The hydrology for this site was estimated using the methods outlined in the *City of Colorado Springs Drainage Criteria Manual*. The topography for the site was compiled using a one-foot contour interval and is presented at a horizontal scale of 1-inch to 80-feet in Figures 2 and 3which can be found in Appendix E. The hydrologic calculations were made assuming both existing conditions and developed conditions. The existing drainage basins are shown on Figure 2, and the developed drainage basins are shown on Figure 3. Peak flow rates for the drainage basins were estimated by using the Rational Method. Runoff for the 5-year and 100-year recurrence intervals were determined.

The runoff coefficients used for the Rational Method were determined using Table 6-6 of the *City of Colorado Springs, Drainage Criteria Manual*. A copy of Table 6-6 is located in the Appendix B of this report. The hydrological calculations were performed assuming Hydrologic Soil Group B. The hydrological calculations for both existing and developed conditions are included in Appendix B.

UDFCD UD-Sewer software was utilized in part to determine HGL's and EGL's for the proposed private storm sewers. UD-Sewer reports can be found in Appendix C of this report.

IV. Existing Drainage

Currently, the existing site generally slopes from the southwest to the northeast at average slopes of approximately 2.5% to 4%. The existing site is comprised of asphalt and gravel parking areas and small lightly vegetated areas of turf grass and weeds. According to the *Soil Survey for El Paso County, Colorado*, the majority of the site's soil, as shown in Appendix D, consists of Bresser Sandy Loam (#12), which is classified as Hydrologic Soil Group B, and the remaining portion of the site consists of Chaseville-Midway Complex, which is classified as Hydrologic Soil Group D.

The majority of Lot 1 Broadmoor Filing No. 2 drains to the north, into an existing temporary private detention basin. Runoff is also conveyed in Mesa Avenue gutters to the intersection of Mesa Avenue and Heather Drive ultimately discharging into Cheyenne Creek via an existing public storm sewer system in Heather Drive to the north. Runoff generated from the southern portion of the site, facing Lake Circle, gutter flows along Lake Circle to an existing curb inlet that conveys the runoff to an existing storm system in Lake Avenue. From here runoff is conveyed to an existing manhole near the intersection of 1st Street and Lake Avenue, where runoff is conveyed south and east, via an existing public storm system, eventually discharging into Spring Run on 2nd Street between Broadmoor Avenue and Pourtales Road. All runoff reaching either Spring Run or Cheyenne Creek ultimately discharges to Fountain Creek.

No off-site runoff enters the subject property. However, runoff generated from offsite areas combine with on-site runoff from basin A-2 at Mesa Avenue and Heather Drive (Design Point 1) and in the existing public storm sewer system at the intersection of Lake Avenue and 1st Street (Design Point 3).

Basin A-1 contains 4.68 acres and includes part of the existing paved and unpaved employee parking. Runoff from this basin (Q_5=12.4 cfs, Q_{100}=23.8 cfs) sheet flows in a northeasterly direction. Runoff is collected by two area inlets and conveyed by existing private 18-inch CMP storm pipes to the temporary private detention basin in Basin A-3.

Basin A-2 contains 1.38 acres and contains a portion of the gravel employee parking along Mesa Avenue. Runoff from this basin (Q_5=1.0 cfs, Q_{100}=3.5 cfs) sheet flows northwesterly off-site onto Mesa Avenue. From there runoff travels in the gutter along Mesa Avenue in a northeasterly direction to Heather Drive (Design Point 1). From there, runoff is conveyed down Heather Drive to Cheyenne Creek.

Basin A-3 contains 0.87 acres and is located in the north central portion of Lot 1 Broadmoor Filing No. 2. This basin generates runoff of Q_5=0.3 cfs, Q_{100}=2.1 cfs and includes the existing temporary private detention basin, built for the existing parking lot, which will eventually be the site of the proposed private full spectrum extended detention basin after development. Runoff not captured within the temporary private detention basin drains to the north across developed single-family lots before reaching Mesa Avenue (Design Point 1).

Basin A-4 contains 1.37 acres and is located west of the intersection of Holly Avenue and Hazel Avenue. This basin includes a paved parking lot that drains towards the north. Runoff from this basin (Q_5=1.6 cfs, Q_{100}=3.6 cfs) sheet flows to the north and is captured by an existing private 10'

D-10-R inlet that is tied to an existing public 24-inch RCP outfall pipe, for the existing temporary detention basin, which conveys flows to an existing public storm system, eventually discharging into Spring Run on 2nd Street between Broadmoor Avenue and Pourtales Road. .

Basin A-5 contains 0.65 acres and is located along Lake Circle southeast of Mesa Avenue. This basin includes existing curb, gutter, and pavement for Lake Circle. Runoff from this basin (Q_5=0.9 cfs, Q_{100}=1.9 cfs) gutter flows southeast along Lake Circle curb to an existing 10' D-10-R inlet at the northeast corner of Lake Circle and Lake Avenue. From here runoff is conveyed to the existing public 30-inch storm sewer in Lake Avenue which conveys flows to an existing manhole near the intersection of 1st Street and Lake Avenue. From here runoff is conveyed south and east, via an existing public storm system, eventually discharging into Spring Run on 2nd Street between Broadmoor Avenue and Pourtales Road.

Basin OS-1 contains 2.10 acres and contains a portion of the Broadmoor pool area, a playground area, and a portion of Mesa Avenue. Runoff generated from this basin (Q_5=3.8 cfs, Q_{100}=8.9 cfs) sheet flows to Mesa Avenue and is conveyed southeast via Lake Circle curb and gutter to an existing 10' D-10-R inlet at the northwest corner of Lake Circle and Lake Avenue. From here runoff is conveyed to the existing public 30-inch storm sewer in Lake Avenue which conveys flows to the existing manhole near the intersection of 1st Street and Lake Avenue. From here runoff is conveyed south and east, via an existing public storm system, eventually discharging into Spring Run on 2nd Street between Broadmoor Avenue and Pourtales Road.

Basin OS-2 contains 8.61 acres and contains the Broadmoor Power Plant and Dry Cleaners, Broadmoor Northeast and a portion of the Broadmoor Main buildings. Runoff from this basin (Q_5=17.3 cfs, Q_{100}=37.4 cfs) sheet flows southeast via Lake Circle curb and gutter to an existing 10' D-10-R inlet at the northwest corner of Lake Circle and Lake Avenue. From here runoff is conveyed to the existing public 30-inch storm sewer in Lake Avenue which conveys flows to the existing manhole near the intersection of 1st Street and Lake Avenue. From here runoff is conveyed south and east, via an existing public storm system, eventually discharging into Spring Run on 2nd Street between Broadmoor Avenue and Pourtales Road.

Basin OS-3 is an off-site basin to the north of Lot 1 Broadmoor Campus Filing No. 2 that contains 6.90 acres and is developed with single-family residences. Runoff generated from this basin (Q_5=7.0 cfs, Q_{100}=21.6 cfs) sheet flows in a northerly direction to the intersection of Mesa Avenue and Heather Drive (Design Point 1) ultimately discharging into Cheyenne Creek via an existing public storm sewer system in Heather Drive to the north.

The "B" basins are located southeast of Lot 1 Broadmoor Campus Filing No. 2. This area drains to an existing storm manhole near the intersection of 1st Street and Lake Avenue. From here runoff is conveyed south and east, via an existing public storm system, eventually discharging into Spring Run on 2nd Street between Broadmoor Avenue and Pourtales Road.

Basin B-1 contains 6.10 acres and includes the existing Carriage and Hillclimb Museums, and Colorado Exhibit Hall, as well as the northeastern half of Lake Circle. This basin generates runoff of (Q_5=15.5 cfs, Q_{100}=29.8 cfs). Runoff from Lake Circle is captured by an existing 4' D-10-R inlet and conveyed in existing storm sewer piping from Lake Circle to the existing public 30" storm sewer in Lake Avenue. Several private inlets and a roof drains along the north side of the existing Exhibit Hall collect runoff that discharge onto Holly Avenue. Also, an area in the central portion of this basin drains to an existing cross pan located in Holly Avenue in basin B-2 near the intersection of 1st Street and Elm Avenue. This runoff is conveyed east through a concrete drain pan and drainage channel to Elm Avenue. Runoff is then conveyed east in the southern curb of Elm Avenue, eventually discharging into Spring Run.

Basin B-2 contains 0.72 acres and includes a portion of the existing Colorado Exhibit Hall. Runoff from this basin (Q_5=2.5 cfs, Q_{100}=4.8 cfs) sheet flows to the intersection of 1st Street and Elm Avenue and via the existing cross pan and drainage channel, combines with runoff from basin B-1. Runoff is then conveyed east in the southern curb of Elm Avenue, eventually discharging into Spring Run.

Basin B-3 contains 2.61 acres and contains a portion of the existing Colorado Exhibit Hall. This basin generates runoff of Q_5=8.0 cfs, Q_{100}=16.0 cfs. The majority of runoff from this basin sheet flows to Lake Avenue. A system of existing private inlets and pipes collects runoff from roof and landscaped areas around the existing Colorado Exhibit Hall that discharge to an existing public 30-inch storm sewer in Lake Avenue. Runoff from the western portion of the basin drains to a 4' D-10-R curb inlet in Lake Circle. This inlet is connected to the existing public 30-inch storm sewer in Lake Avenue. The remaining eastern portion of this basin sheet flows and gutter flows south to an existing inlet at the northwest corner of 1st Street and Lake Avenue. This inlet is connected to a public 24-inch storm pipe in 1st Street. From here runoff is conveyed to the existing manhole near the intersection of 1st Street and Lake Avenue. From here runoff is conveyed south and east, via an existing public storm system, eventually discharging into Spring Run on 2nd Street between Broadmoor Avenue and Pourtales Road.

Runoff from basin B-3 combines with offsite runoff from basins OS-1 and OS-2 as well as Design Point 2, at an existing manhole near the intersection of 1st Street and Lake Avenue. From here runoff is conveyed south and east, via an existing public storm system, eventually discharging into Spring Run on 2nd Street between Broadmoor Avenue and Pourtales Road.

V. Developed Drainage

With the proposed improvements to Lot 1 Broadmoor Campus Filing No. 2, drainage patterns will not vary significantly from existing conditions. Proposed storm drains will convey collected runoff to a proposed private full spectrum extended detention basin near the north central portion of the property (location of the existing temporary detention basin). All proposed private inlets and pipes have been sized to carry the 100-year storm event. The existing 24" RCP storm sewer system in Holly Avenue and 1st Street is a public system.

No off-site runoff enters the subject property. However, runoff generated from offsite areas combine with on-site runoff from basin A-2 at Mesa Avenue and Heather Drive (Design Point 1) and in the existing public storm sewer system at the intersection of Lake Avenue and 1st Street (Design Point 3).

Basin A-1 contains 1.42 acres and is comprised of a portion of the new Exhibit Hall roof that drains to the south and west of the building as well as concrete pathways also on the south and west sides of the building. Runoff from this basin (Q_5=4.9 cfs, Q_{100}=9.2 cfs) will be collected by five private 2' dia. PVC drain basins (structures 1 thru 7 and 18) along with a series of private trench drains along the west side of the building. Runoff will be routed west along the south side of the building, then north along the west side of the building through private 4' dia. type II manholes (structures 8 & 9), by proposed private 8-inch through 18-inch storm piping (S1 thru S9) which convey flows to a private 4' dia. type II manhole (structure 10/Design Point 4). From here flows will be conveyed northeast to the proposed private extended detention basin via proposed private 18-inch thru 30-inch storm pipes (S10 through S13).

Basin A-2 contains 0.70 acres and includes landscaped areas and sidewalks. Runoff from this basin (Q_5=2.9 cfs, Q_{100}=5.4 cfs) will continue to sheet flow onto Mesa Avenue as in the existing condition.

Basin A-3 contains 0.96 acres and includes parking, drive isles, and landscaped areas. Runoff from this basin (Q_5=4.0 cfs, Q_{100}=7.4 cfs) will sheet flow to a proposed private 4' D-10-R curb inlet (Design Point 5) in sump condition at the northeast corner of the basin. This runoff will combine with runoff from basin A-1 in a proposed private 30-inch storm sewer (S12) and then a proposed private 30-inch storm sewer pipe (S13) will convey flows to the detention basin. Emergency overflow at the proposed private 4' D-10-R curb inlet (Design Point 5) will be routed into the private extended detention basin.

Basin A-4 contains 0.52 acres and is mostly comprised of the proposed private extended detention basin. The majority of runoff from this basin (Q_5=0.3 cfs, Q_{100}=1.4 cfs) will collect in the private extended detention basin. Remaining flows will will continue to sheet flow off-site to the west, north, and east onto adjacent residential areas as in the existing condition.

Basin A-5 contains 0.81 acres and is comprised of sidewalks, parking, drive isles, and landscaped areas north of the new Exhibit Hall. Runoff from this basin (Q_5=3.7 cfs, Q_{100}=6.6 cfs) will sheet flow and gutter flow northeast to a proposed private 10' D-10-R curb inlet (Design Point 6) in sump condition in the northeast corner of the basin. Runoff collected by this inlet will be conveyed via proposed private 18-inch and 30-inch storm sewer pipes (S15 & S13) to the private extended detention basin. Emergency overflow at the proposed private 10' D-10-R curb inlet (Design Point 6) will be routed into the private extended detention basin.

Basin A-6 contains 0.09 acres and is comprised of a loading dock at northeast corner of the new Exhibit Hall. Runoff from this basin (Q_5=0.4 cfs, Q_{100}=0.8 cfs) will sheet flow to a proposed series of private trench drains in sump condition at the bottom of the loading dock (Design Point 8) and routed via a proposed private 12-inch storm sewer pipe (S16) to the proposed private 10' D-10-R curb inlet in sump condition in basin A-5. Runoff will then be conveyed via proposed private 18-inch and 30-inch storm sewer pipes (S15 & S13) to the private extended detention basin.

Basin A-7 contains 1.22 acres and is comprised of sidewalks, parking, drive isles, and landscaped areas north of the new Exhibit Hall. Runoff from this basin (Q_5=3.8 cfs, Q_{100}=7.3 cfs) will sheet flow northeast to a proposed private 4' D-10-R curb inlet (Design Point 7) and drain west via a proposed private 18" storm sewer pipe (S17) to the private extended detention basin. Emergency overflow at the proposed private 4' D-10-R curb inlet (Design Point 7) will be routed off-site to the Hazel Avenue R.O.W.

Basin A-8 contains 0.43 acres and is comprised of a portion of the new Exhibit Hall roof that drains to the north. Runoff from this basin (Q_5=1.6 cfs, Q_{100}=2.9 cfs) will be collected by a roof drain combining into a proposed private 12-inch storm sewer pipe (S16), and then conveyed to the private extended detention basin via proposed private 18-inch and 30-inch storm sewer pipes (S15 & S13).

Basin A-9 contains 0.69 acres and is comprised of a portion of the new Exhibit Hall roof that drains to the north. Runoff from this basin (Q_5=2.5 cfs, Q_{100}=4.7 cfs) will be collected by a roof drain that discharges into a proposed private 4' dia. type II manhole (structure 14) where a proposed private 15-inch storm sewer pipe (S14) will then convey flow to the private extended detention basin via proposed private 30-inch storm sewer pipe (S13).

Basin A-10 contains 0.63 acres and is comprised of a portion of the new Exhibit Hall roof that drains to the north. Runoff from this basin (Q_5=2.4 cfs, Q_{100}=4.4 cfs) will be collected by a roof drain that discharges into a proposed private 4' dia. type II manhole (structure 14) where it will combine with runoff from basin A-9, and a proposed private 15-inch storm sewer pipe (S14) will then be conveyed to the private extended detention basin via proposed private 30-inch storm sewer pipe (S13).

Basin A-11 contains 0.75 acres and is comprised of a portion of the new Exhibit Hall roof that drains to the north. Runoff from this basin (Q_5=2.8 cfs, Q_{100}=5.2 cfs) will be collected by a roof drain that discharges into a proposed private 4' dia. type II manhole (structure 11) where proposed private 24-inch and 30-inch storm sewer pipes (S11, through S13) will convey flows to the private extended detention basin.

Flows at Design Point 1 (Q_5=8.6 cfs, Q_{100}=24.0 cfs) and Design Point 3 (Q_5=30.5 cfs, Q_{100}=65.0 cfs) will remain virtually unchanged from existing condition with the improvements to Lot 1 Broadmoor Campus Filing No. 2.

Basins OS-1 (Q_5=3.8 cfs, Q_{100}=8.9 cfs), OS-2 (Q_5=17.3 cfs, Q_{100}=37.4 cfs), OS-3 (Q_5=7.0 cfs, Q_{100}=21.6 cfs), B-1 (Q_5=12.6 cfs, Q_{100}=24.1 cfs), B-2 (Q_5=2.5 cfs, Q_{100}=4.8 cfs) , and B-3 (Q_5=10.7 cfs, Q_{100}=21.3 cfs) will remain virtually unchanged from existing conditions with the improvements to Lot 1 Broadmoor Campus Filing No. 2.

The proposed private full spectrum extended detention basin will collect runoff from basins A-1, A-3, A-4, A-5, A-6, A-7, A-8, A-9, A-10 and A-11. These basins have a collective watershed imperviousness of 78.7% (see IRF spreadsheet in Appendix C). The extended detention basin includes a 10' wide × 12-inch thick layer of aggregate base course or crushed gravel, over compacted subgrade, maintenance access drive at a slope of 10 percent as shown on Figure 3. A chain to limit public access shall be provided at the entrance to the access drive. A proposed private outlet structure will be designed to release runoff from the proposed private full spectrum extended detention basin at 90 percent of historic rates to the existing 24-inch storm sewer system in Holly Avenue and 1st Street. This 24-inch storm sewer (private on-site and public off-site) conveys runoff to an existing public 36-inch storm sewer at the intersection of 1st Street and Lake Avenue. From here runoff is conveyed south and east, via an existing public storm sewer system, eventually discharging into Spring Run on 2nd Street between Broadmoor Avenue and Pourtales Road. The outlet structure will consist of two chambers that will release the WQCV and EURV at flowrates and times outlined in the City's *Drainage Criteria Manual*. A 4'×5'-8" sloped grate opening will convey the 100-year storm event. The need to control the five-year release was not needed since the 5-year volume is contained within the EURV storage pool (stage 2). The water quality storage will be controlled by a perforated plate affixed on the inlet side of the proposed outlet structure. The horizontal trash rack that covers the structure will be sized to account for 50 percent blockage. The design 100-year outflow discharge of 9.8 cubic feet per second will be conveyed to the existing private 24-inch RCP outfall pipe. A 10' emergency spillway will be provided at the east side of the private extended detention basin and will route emergency overflows to the Hazel Avenue cul-de-sac to the east via a 6.5'W×1.0'D grass-lined channel at 0.50% slope that has a capacity of 27.3 cubic feet per second. The spillway has the capacity to convey the 100-year design inflow of 27.2 cubic feet per second. The crest of the spillway will be protected by a 24-inch thick layer of soil/riprap (type L) and a concrete cut-off wall. Hydraulic calculations related to the design of the forebays, outlet structure, emergency spillway, riprap, and overflow channel can be found in Appendix C.

Inflow to the detention basin will be controlled by two forebays. The forebays provide a 9-inch vertical drop between invert of the pipe and bottom of the forebays. The forebay volumes and release rates will be controlled by notches in the crest of forebay wall (see Appendix C). The forebays, and 2' wide × 6-inch deep trickle channels have been designed per Volume I of the *City of Colorado Springs Drainage Criteria Manual*. Details of the forebays, trickle channels, outlet structure, emergency spillway, and overflow channel, as well as grading and erosion control measures, will be shown on the Permanent BMP plan of the final design construction drawings.

VI. Water Quality

Surface disturbance associated with the construction of the Exhibit Hall, along with associated drives and parking will be more than 1 acre. Therefore, water quality has been incorporated into this drainage report and plan.

VII. Flood Plain Statement

According to the Federal Emergency Management Agency (FEMA), the proposed development does not lie within a designated floodplain. The Floodplain Insurance Rate Map (FIRM) for El Paso County panel 08041C0736. dated December 7, 2018, was reviewed to determine any potential floodplain delineation. A FEMA National Flood Hazard Layer FIRMette can be found in Appendix D.

VIII. Drainage and Bridge Fees

The Exhibit Hall and The Broadmoor lies wholly within the Southwest Area drainage basin. Drainage and bridge fees have been established for the Southwest Area for assessment against newly platted land within the Southwest Area watershed. There are no public facilities proposed with the development of Lot 1 Broadmoor Campus Filing No. 2.

All drainage facilities, public or private, are subject to final design and approval by the City of Colorado Springs.

The 2019 fees for the Southwest Area drainage basin are as follows:

Drainage Fee:	$13,467 per acre
Bridge Fee:	None
Pond Land Fee:	None
Pond Facility Fee:	None
Surcharge:	None
Total Fee	$13,467 / acre

No drainage basin fees are due for this development as the site has previously been platted.

IX. Construction Cost Estimate

Estimated construction costs for Lot 1 Broadmoor Campus Filing No. 2 are as follows:

ITEM	QUANTITY	UNIT	UNIT COST	TOTAL
2' Dia. PVC drain Basin	8	Ea.	$ 2,500.00	$20,000.00
4' Dia. Type II Manhole	6	Ea.	$ 8,000.00	$48,000.00
5' Dia. Type II Manhole	1	Ea.	$ 9,000.00	$ 9,000.00
4' D-10-R Inlet	2	Ea.	$ 8,000.00	$16,000.00
10' D-10-R Inlet	1	Ea.	$10,000.00	$10,000.00
Outlet Structure	1	Ea.	$ 9,000.00	$ 9,000.00
8-inch PVC Pipe	101	L.F.	$ 30.00	$ 3,030.00
10-inch PVC Pipe	36	L.F.	$ 40.00	$ 1,440.00
12-inch PVC Pipe	214	L.F.	$ 50.00	$10,700.00
15-inch HDPE Pipe	347	L.F.	$ 60.00	$20,820.00
18-inch HDPE Pipe	972	L.F.	$ 70.00	$68,040.00
24-inch HDPE Pipe	152	L.F.	$ 85.00	$12,920.00
30-inch HDPE Pipe	112	L.F.	$ 100.00	$11,200.00
			Estimated Cost	$240,150.00
			Engineering 10%	$ 24,015.00
			Contingency 5%	$ 12,008.00
Total Estimated Private Non-Reimbursable Storm Drainage Facilities Cost				**$276,173.00**

X. Four Step Process

<u>Step 1: Runoff reduction Practices</u>

New construction will utilize existing and proposed grassed areas as buffers, allowing sediment to drop out of the storm runoff and helping to reduce runoff.

<u>Step 2: Implement BMP's that Slowly Release the Water Quality Capture Volume</u>

Treatment and slow release of 40 hours of the water quality capture volume (WQCV) will be accomplished by the implementation of a proposed private extended detention basin.

<u>Step 3: Stabilize Drainageways</u>

There are no major drainageways affected by the development of Lot 1 Broadmoor Campus Filing No. 2. No improvements to any downstream drainageways are required at this time. The project discharges into an existing public underground storm sewer system. Drainage fees were paid when this site was platted to fund channel improvements according to the SW Area Drainage Basin Planning Study.

<u>Step 4: Implement Site Specific & Source Control BMP's</u>

There are no potential sources of contaminants that could be introduced to the City's MS4 that will not be controlled by temporary construction BMPs. Maintenance and sweeping of parking areas will be accomplished by the Broadmoor to limit sediment. Construction BMPs in the form of vehicle tracking control, concrete washout area, inlet protection, rock socks, and silt fences will be utilized to protect receiving waters.

XI. Summary and Conclusions

Hydrology for use in determining the required storage volume and release rates were first established in the MDDP. The hydrology analysis summarized in the most current version of the MDDP is based upon the application of a one-hour rainfall depth distributed over a 2-hour period. Rainfall depths have been derived from *NOAA Precipitation Data for Colorado, (Volume 2)* and as summarized in the City's 2014 DCM. The 2014 *City of Colorado Springs Drainage Criteria Manual* recommends that for watersheds of the size tributary to the extended detention basin to utilize the application of the 1-hour storm. The watershed tributary to the extended detention basin covers an area of approximately 7.52 acres, all within the Broadmoor area. Due to the size of the basin the method outlined in the UDFCD UD-detention was used to estimate the inflow and outflow discharges:

Q_5 Inflow/Outflow	13.6 cfs/0.3 cfs
Q_{100} Inflow/outflow	27.2 cfs/9.8 cfs
Runoff Volume 5yr/100yr	0.73 AF/1.46 AF

The storage, stage and outflow curves for the final design are contained in Appendix E. A portion of Sheet DP-2 from the MDDP that shows the location of the detention basin has been included within Appendix E as well. The final design configuration will maintain the outfall rate to less than the historic flow rate estimated in the MDDP.

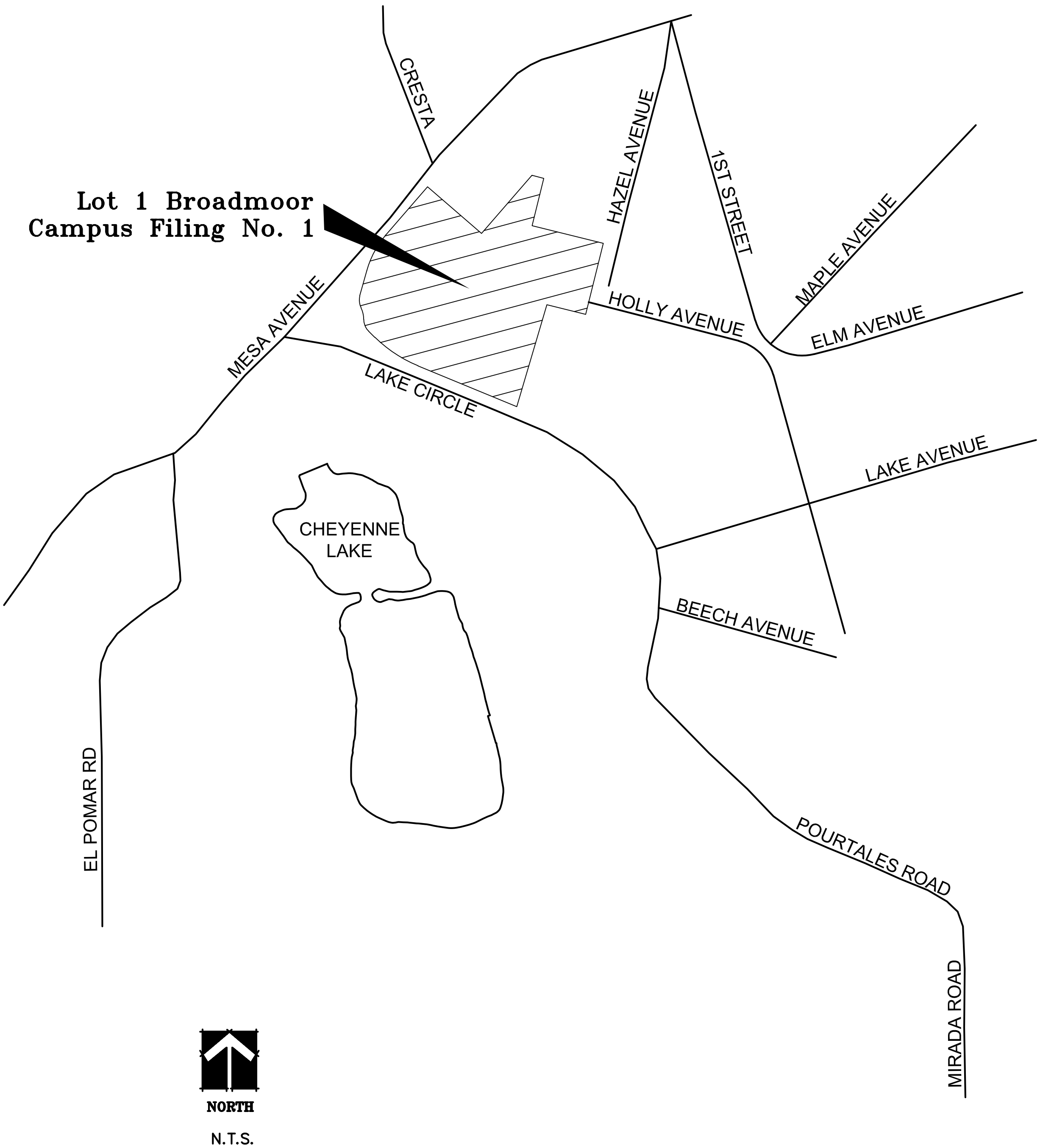
The detention basin will also be designed to operate as a private full spectrum extended detention basin. Using the criteria and methodology put forth in Volumes II and III of *the Urban Drainage and Flood Control District (UDFCD)* and Volume I of the *City of Colorado Springs Drainage Criteria Manual* (DCM). The EURV was estimated for the developed portion of the Exhibit Hall that is tributary to Design Point 2. A total of 7.52 acres of the project area is proposed to outfall to the private extended detention basin. The full spectrum volume calculations for sub-basins are included within Appendix C. The basins used to determine the EURV are shown in Appendix C. Soils in the watershed are all grouped into NRCS Hydrologic Soils Group B for the final design. The NRCS soils report for the land encompassed by private extended detention basin is provided in Appendix D. The required EURV was calculated to be 0.66 acre-feet. Maximum discharge rate from the water quality storage (stage 1) is 0.1 cubic feet per second. Maximum discharge rate for the EURV (stage 2) is 0.2 cubic feet per second. The water quality pool and attendant outlet structure will be designed to release the EURV over a 72-hour period. The water quality capture volume will be released in 40 hours. The UD-Detention spreadsheet can be found in Appendix C.

This report along with its findings are in general conformance with the Southwest Area Drainage Basin Planning Study, the Master Drainage Development Plan for the Broadmoor Hotel campus, and associated drainage studies for the area. The runoff from the proposed Broadmoor Exhibit Hall along with storm drainage facilities and appurtenances will not adversely affect downstream and surrounding developments.

The Grading and Erosion Control Plan for the site has been submitted separately to the City of Colorado Springs. Included with the Grading and Erosion Control Plan are the plan and profiles for the proposed private storm water system proposed for the site.

Appendix A

Vicinity Map



VICINITY MAP

LOT 1 BROADMOOR CAMPUS FILING NO. 2

FIGURE 1

FIGURE 1.dwg/Feb 15, 2019/4:39pm

Appendix B

Hydrologic Calculations
Runoff Coefficient Calculations
Time of Concentration
Runoff Calculations

Table 6-2. Rainfall Depths for Colorado Springs

Return Period	1-Hour Depth	6-Hour Depth	24-Hour Depth
2	1.19	1.70	2.10
5	1.50	2.10	2.70
10	1.75	2.40	3.20
25	2.00	2.90	3.60
50	2.25	3.20	4.20
100	2.52	3.50	4.60

Where Z= 6,840 ft/100

Table 6-7. Conveyance Coefficient, C_v

Type of Land Surface	C_v
Heavy meadow	2.5
Tillage/field	5
Riprap (not buried)*	6.5
Short pasture and lawns	7
Nearly bare ground	10
Grassed waterway	15
Paved areas and shallow paved swales	20

* For buried riprap, select C_v value based on type of vegetative cover.

Table 6-6. Runoff Coefficients for Rational Method

(Source: UDFCD 2001)

Land Use or Surface Characteristics	Percent Impervious	Runoff Coefficients											
		2-year		5-year		10-year		25-year		50-year		100-year	
		HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D
Business													
Commercial Areas	95	0.79	0.80	0.81	0.82	0.83	0.84	0.85	0.87	0.87	0.88	0.88	0.89
Neighborhood Areas	70	0.45	0.49	0.49	0.53	0.53	0.57	0.58	0.62	0.60	0.65	0.62	0.68
Residential													
1/8 Acre or less	65	0.41	0.45	0.45	0.49	0.49	0.54	0.54	0.59	0.57	0.62	0.59	0.65
1/4 Acre	40	0.23	0.28	0.30	0.35	0.36	0.42	0.42	0.50	0.46	0.54	0.50	0.58
1/3 Acre	30	0.18	0.22	0.25	0.30	0.32	0.38	0.39	0.47	0.43	0.52	0.47	0.57
1/2 Acre	25	0.15	0.20	0.22	0.28	0.30	0.36	0.37	0.46	0.41	0.51	0.46	0.56
1 Acre	20	0.12	0.17	0.20	0.26	0.27	0.34	0.35	0.44	0.40	0.50	0.44	0.55
Industrial													
Light Areas	80	0.57	0.60	0.59	0.63	0.63	0.66	0.66	0.70	0.68	0.72	0.70	0.74
Heavy Areas	90	0.71	0.73	0.73	0.75	0.75	0.77	0.78	0.80	0.80	0.82	0.81	0.83
Parks and Cemeteries	7	0.05	0.09	0.12	0.19	0.20	0.29	0.30	0.40	0.34	0.46	0.39	0.52
Playgrounds	13	0.07	0.13	0.16	0.23	0.24	0.31	0.32	0.42	0.37	0.48	0.41	0.54
Railroad Yard Areas	40	0.23	0.28	0.30	0.35	0.36	0.42	0.42	0.50	0.46	0.54	0.50	0.58
Undeveloped Areas													
Historic Flow Analysis-- Greenbelts, Agriculture	2	0.03	0.05	0.09	0.16	0.17	0.26	0.26	0.38	0.31	0.45	0.36	0.51
Pasture/Meadow	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50
Forest	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50
Exposed Rock	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Offsite Flow Analysis (when landuse is undefined)	45	0.26	0.31	0.32	0.37	0.38	0.44	0.44	0.51	0.48	0.55	0.51	0.59
Streets													
Paved	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Gravel	80	0.57	0.60	0.59	0.63	0.63	0.66	0.66	0.70	0.68	0.72	0.70	0.74
Drive and Walks	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Roofs	90	0.71	0.73	0.73	0.75	0.75	0.77	0.78	0.80	0.80	0.82	0.81	0.83
Lawns	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50

Exhibit Hall
Runoff Coeficient and Percent Impervious Calculation
Existing Condition

Basin / DP	Basin or DP Area (DP contributing basins)		Soil Type	PV	Area 1 Land Use			LA	Area 2 Land Use			GR	Area 3 Land Use			RO	Area 4 Land Use			DR	Area 5 Land Use			Basin % Imperv	Basin Runoff Coefficient	
				% Imperv	Land Use Area	% Area	Comp Land Use % Imp	% Imperv	Land Use Area	% Area	Comp Land Use % Imp	% Imperv	Land Use Area	% Area	Comp Land Use % Imp	% Imperv	Land Use Area	% Area	Comp Land Use % Imp	% Imperv	Land Use Area	% Area	Comp Land Use % Imp		C_5	C_{100}
A-1	203,951 sf	4.68ac	B	100%	1.21ac	26%	26%	0%	0.00ac	0%	0%	80%	3.48ac	74%	59%	90%	0.00ac	0%	0%	100%	0.00ac	0%	0%	**85.1%**	**0.67**	**0.77**
A-2	60,171 sf	1.38ac	B	100%	0.00ac	0%	0%	0%	1.04ac	75%	0%	80%	0.35ac	25%	20%	90%	0.00ac	0%	0%	100%	0.00ac	0%	0%	**20.0%**	**0.21**	**0.44**
A-3	37,966 sf	0.87ac	B	100%	0.00ac	0%	0%	0%	0.87ac	100%	0%	80%		0%	0%	90%	0.00ac	0%	0%	100%	0.00ac	0%	0%	**0.0%**	**0.08**	**0.35**
A-4	59,760 sf	1.37ac	B	100%	1.30ac	95%	95%	0%	0.07ac	5%	0%	80%		0%	0%	90%	0.00ac	0%	0%	100%	0.00ac	0%	0%	**95.0%**	**0.35**	**0.45**
A-5	28,515 sf	0.65ac	B	100%	0.59ac	90%	90%	0%	0.07ac	10%	0%	80%		0%	0%	90%	0.00ac	0%	0%	100%	0.00ac	0%	0%	**90.0%**	**0.35**	**0.45**
B-1	265,916 sf	6.10ac	B	100%	2.59ac	43%	43%	0%	0.92ac	15%	0%	80%		0%	0%	90%	2.59ac	43%	38%	100%	0.00ac	0%	0%	**80.8%**	**0.70**	**0.80**
B-2	31,363 sf	0.72ac	B	100%	0.30ac	41%	41%	0%	0.13ac	18%	0%	80%		0%	0%	90%	0.30ac	41%	37%	100%	0.00ac	0%	0%	**77.9%**	**0.68**	**0.79**
B-3	113,692 sf	2.61ac	B	100%	0.98ac	38%	38%	0%	0.65ac	25%	0%	80%		0%	0%	90%	0.98ac	38%	34%	100%	0.00ac	0%	0%	**71.3%**	**0.63**	**0.75**
OS-1	91,476 sf	2.10ac	B	100%	0.53ac	25%	25%	0%	1.05ac	50%	0%	80%		0%	0%	90%	0.53ac	25%	23%	100%	0.00ac	0%	0%	**47.5%**	**0.45**	**0.62**
OS-2	375,075 sf	8.61ac	B	100%	2.58ac	30%	30%	0%	3.44ac	40%	0%	80%		0%	0%	90%	2.58ac	30%	27%	100%	0.00ac	0%	0%	**57.0%**	**0.52**	**0.67**
OS-3	300,564 sf	6.90ac	B	100%	0.86ac	13%	13%	0%	5.18ac	75%	0%	80%		0%	0%	90%	0.86ac	13%	11%	100%	0.00ac	0%	0%	**23.8%**	**0.26**	**0.48**
DP 1	A2, OS3	8.28ac	B	100%	1.45ac	18%	18%	0%	6.28ac	76%	0%	80%		0%	0%	90%	0.86ac	10%	9%	100%	0.00ac	0%	0%	**26.9%**	**0.28**	**0.51**
DP 2	A1, A3, A4	6.93ac	B	100%	2.51ac	36%	36%	0%	0.94ac	14%	0%	80%	3.48ac	50%	40%	90%	0.00ac	0%	0%	100%	0.00ac	0%	0%	**76.4%**	**0.53**	**0.65**
DP 3	B3, OS1, OS2, A-5	13.98ac	B	100%	4.09ac	29%	29%	0%	5.15ac	37%	0%	80%	0.00ac	0%	0%	90%	4.09ac	29%	26%	100%	0.00ac	0%	0%	**55.6%**	**0.51**	**0.65**

Basin Runoff Coefficient is a weighted average

Runoff Coefficients and Percents Impervious (DCM Table 6-6)

Hydrologic Soil Type: | **Runoff Coef Calc Method:** Weighted

Land Use	Abb	%	C_2	C_5	C_{10}	C_{25}	C_{50}	C_{100}
Business: Downtown	BD	95%	0.79	0.81	0.83	0.85	0.87	0.88
Business: Suburban	BS	70%	0.45	0.49	0.53	0.58	0.60	0.62
Drives and Walks	DR	100%	0.89	0.90	0.92	0.94	0.95	0.96
Streets - Gravel (Packed)	GR	80%	0.57	0.59	0.63	0.66	0.68	0.70
Historic Flow Analysis	HI	2%	0.03	0.09	0.17	0.26	0.31	0.36
Lawns	LA	0%	0.02	0.08	0.15	0.25	0.30	0.35
Off-site flow-Undeveloped	OF	45%	0.26	0.32	0.38	0.44	0.48	0.96
Park	PA	7%	0.05	0.12	0.20	0.30	0.34	0.39
Streets - Paved	PV	100%	0.89	0.90	0.92	0.94	0.95	0.96
Roofs	RO	90%	0.71	0.73	0.75	0.78	0.80	0.81

Equation:

$C_c=(C_1A_1+C_2A_2+C_3A_3+...C_i+A_i) / A_t$

(City of Colorado Springs DCM Equation 6-6) Where:

C_c = composite runoff coefficient for total area

C_i = runoff coefficient for subarea (surface type or land use)

A_i = area of surface type corresponding to C_i

A_t = total area of all sub areas

$_i$ = number of surface types in the drainage area

Exhibit Hall
Existing Time of Concentration Calculation
Existing Condition

Sub-Basin Data				Time of Concentration Estimate											Final t_c
				Initial/Overland Time (t_i)			Travel Time (t_t)						Comp.		
Basin / Design Point	Contributing Basins	Area	C_5	Length	Slope	t_i	Length	Slope	Land Type	Cv	Velocity	t_t	t_c		
A-1		4.68ac	0.67	100lf	2.5%	5.8 min.	900lf	3.3%	GW	15	2.7 ft/sec	5.5 min.	11.3 min.		**11.3 min.**
A-2		1.38ac	0.21	100lf	2.0%	13.0 min.	650lf	3.2%	PV	20	3.6 ft/sec	3.0 min.	16.0 min.		**16.0 min.**
A-3		0.87ac	0.08	80lf	7.5%	8.5 min.	375lf	4.0%	GW	15	3.0 ft/sec	2.1 min.	10.6 min.		**10.6 min.**
A-4		1.37ac	0.35	100lf	1.4%	12.3 min.	485lf	1.3%	PV	20	2.2 ft/sec	3.6 min.	15.9 min.		**15.9 min.**
A-5		0.65ac	0.35	35lf	1.5%	7.1 min.	600lf	1.2%	PV	20	2.2 ft/sec	4.6 min.	11.7 min.		**11.7 min.**
B-1		6.10ac	0.70	100lf	2.1%	5.7 min.	1200lf	1.4%	PV	20	2.4 ft/sec	8.5 min.	14.1 min.		**14.1 min.**
B-2		0.72ac	0.68	100lf	5.6%	4.3 min.	160lf	1.3%	PV	20	2.3 ft/sec	1.2 min.	5.5 min.		**5.5 min.**
B-3		2.61ac	0.63	100lf	12.0%	3.8 min.	470lf	2.7%	PV	20	3.3 ft/sec	2.4 min.	6.1 min.		**6.1 min.**
OS-1		2.10ac	0.45	100lf	5.0%	7.0 min.	650lf	2.5%	PV	20	3.2 ft/sec	3.4 min.	10.4 min.		**10.4 min.**
OS-2		8.61ac	0.52	100lf	25.0%	3.6 min.	1230lf	1.5%	PV	20	2.4 ft/sec	8.4 min.	12.0 min.		**12.0 min.**
OS-3		6.90ac	0.26	100lf	3.3%	10.3 min.	260lf	3.0%	GW	15	2.6 ft/sec	1.7 min.	12.0 min.		**12.0 min.**
DP 1	A2, OS3	8.28ac	0.28	100lf	6.0%	8.2 min.	650lf	3.2%	SP	7	1.3 ft/sec	8.7 min.	16.9 min.		**16.9 min.**
DP 2	A1, A3, A4	6.93ac	0.53	100lf	8.0%	5.2 min.	900lf	4.0%	GW	15	3.0 ft/sec	5.0 min.	10.2 min.		**10.2 min.**
DP 3	B3, OS1, OS2, A-5	13.98ac	0.51	100lf	25.0%	3.7 min.	1230lf	2.7%	PV	20	3.3 ft/sec	6.2 min.	10.0 min.		**10.0 min.**

Equations:

t_i (Overland) = $0.395(1.1-C_5)L^{0.5} S^{-0.333}$
(DCM Equation 6-8) Where:
- C_5 = Runoff coefficient for 5-year
- L = Length of overland flow (ft)
- S = Average basin slope (ft/ft)

$t_t = L_t / 60KS^{0.5}$ Where:
- t_t = Channelized flow time (travel time)(min.)
- L_t = Waterway length (ft)
- K = Conveyance Factor (see DCM Table 6-7)
- S = Watercourse slope (ft/ft)

t_c (1st DP) = $(18-15i) + L_t / (60 (24i+12)S^{0.5})$ Where:
- t_c (1st DP) = First DP Time of Concentration in urban catchments
- L_t = Length of Flow Path
- i = imperviousness (expressed as a decimal)

City of Colorado Springs DCM Table 6-7

Type of Land Surface	Land Type	K
Grassed Waterway	GW	15
Heavy Meadow	HM	2.5
Nearly Bare Ground	NBG	10
Paved Area/Swales	PV	20
Riprap (Not Buried)	RR	6.5
Short Pasture/Lawns	SP	7
Tillage/Fields	TF	5

Exhibit Hall
Runoff Calculation
Existing Condition

Basin / Design Point	Contributing Basins	Drainage Area	C_5	C_{100}	Time of Concentration	Rainfall Intensity i_5	Rainfall Intensity i_{100}	Runoff Q_5	Runoff Q_{100}	Basin / DP
A-1		4.68 ac	0.67	0.77	11.3 min.	3.9 in/hr	6.6 in/hr	**12.4 cfs**	**23.8 cfs**	A-1
A-2		1.38 ac	0.21	0.44	16.0 min.	3.4 in/hr	5.7 in/hr	**1.0 cfs**	**3.5 cfs**	A-2
A-3		0.87 ac	0.08	0.35	10.6 min.	4.0 in/hr	6.8 in/hr	**0.3 cfs**	**2.1 cfs**	A-3
A-4		1.37 ac	0.35	0.45	15.9 min.	3.4 in/hr	5.8 in/hr	**1.6 cfs**	**3.6 cfs**	A-4
A-5		0.65 ac	0.35	0.45	11.7 min.	3.9 in/hr	6.5 in/hr	**0.9 cfs**	**1.9 cfs**	A-5
B-1		6.10 ac	0.70	0.80	14.1 min.	3.6 in/hr	6.1 in/hr	**15.5 cfs**	**29.8 cfs**	B-1
B-2		0.72 ac	0.68	0.79	5.5 min.	5.0 in/hr	8.5 in/hr	**2.5 cfs**	**4.8 cfs**	B-2
B-3		2.61 ac	0.63	0.75	6.1 min.	4.9 in/hr	8.2 in/hr	**8.0 cfs**	**16.0 cfs**	B-3
OS-1		2.10 ac	0.45	0.62	10.4 min.	4.1 in/hr	6.8 in/hr	**3.8 cfs**	**8.9 cfs**	OS-1
OS-2		8.61 ac	0.52	0.67	12.0 min.	3.9 in/hr	6.5 in/hr	**17.3 cfs**	**37.4 cfs**	OS-2
OS-3		6.90 ac	0.26	0.48	12.0 min.	3.9 in/hr	6.5 in/hr	**7.0 cfs**	**21.6 cfs**	OS-3
DP 1	A2, OS3	8.28 ac	0.28	0.51	16.9 min.	3.3 in/hr	5.6 in/hr	**7.8 cfs**	**23.8 cfs**	DP 1
DP 2	A1, A3, A4	6.93 ac	0.53	0.65	10.2 min.	4.1 in/hr	6.9 in/hr	**15.1 cfs**	**31.1 cfs**	DP 2
DP 3	B3, OS1, OS2, A-5	13.98 ac	0.51	0.65	10.0 min.	4.1 in/hr	6.9 in/hr	**29.2 cfs**	**62.7 cfs**	DP 3

Equations (taken from Fig 6-5, City of Colorado Springs DCM):

i_2=-1.19 ln(T_c) + 6.035

i_5=-1.50 ln(T_c) + 7.583

i_{10}=-1.75 ln(T_c) + 8.847

i_{25}=-2.00 ln(T_c) + 10.111

i_{50}=-2.25 ln(T_c) + 11.375

i_{100}=-2.52 ln(T_c) + 12.735

Q = CiA

Q = Peak Runoff Rate (cubic feet/second)

C = Runoff coef representing a ratio of peak runoff rate to ave rainfall intensity for a duration equal to the runoff time of concentration.

i = average rainfall intensity in inches per hour

A = Drainage area in acres

P1	Inches
WQCV	0.60 in
2 yr	1.19 in
5 yr	1.50 in
10 yr	1.75 in
25 yr	2.00 in
50 yr	2.25 in
100 yr	2.52 in

Exhibit Hall
Runoff Coeficient and Percent Impervious Calculation
Developed Condition

Basin / DP	Basin or DP Area (DP contributing basins)		Soil Type	PV	Area 1 Land Use			LA	Area 2 Land Use			GR	Area 3 Land Use			RO	Area 4 Land Use			DR	Area 5 Land Use			Basin % Imperv	Runoff Coeff.	
				% Imperv	Land Use Area	% Area	Comp Land Use % Imp	% Imperv	Land Use Area	% Area	Comp Land Use % Imp	% Imperv	Land Use Area	% Area	Comp Land Use % Imp	% Imperv	Land Use Area	% Area	Comp Land Use % Imp	% Imperv	Land Use Area	% Area	Comp Land Use % Imp		C_5	C_{100}
A-1/DP-4	61,947 sf	1.42ac	B	100%	0.63ac	44%	44%	0%	0.17ac	12%	0%	80%		0%	0%	90%	0.62ac	44%	39%	100%	0.00ac	0%	0%	83.7%	0.73	0.82
A-2	30,288 sf	0.70ac	B	100%	0.49ac	70%	70%	0%	0.07ac	10%	0%	80%		0%	0%	90%	0.00ac	0%	0%	100%	0.14ac	20%	20%	90.0%	0.82	0.90
A-3/DP-5	41,945 sf	0.96ac	B	100%	0.87ac	90%	90%	0%	0.10ac	10%	0%	80%		0%	0%	90%	0.00ac	0%	0%	100%	0.00ac	0%	0%	90.0%	0.82	0.90
A-4	22,684 sf	0.52ac	B	100%	0.03ac	5%	5%	0%	0.49ac	95%	0%	80%		0%	0%	90%	0.00ac	0%	0%	100%	0.00ac	0%	0%	5.0%	0.12	0.38
A-5/DP-6	35,248 sf	0.81ac	B	100%	0.00ac	0%	0%	0%	0.02ac	2%	0%	80%		0%	0%	90%	0.00ac	0%	0%	100%	0.79ac	98%	98%	97.5%	0.88	0.94
A-6/DP-8	3,955 sf	0.09ac	B	100%	0.00ac	0%	0%	0%	0.00ac	0%	0%	80%		0%	0%	90%	0.00ac	0%	0%	100%	0.09ac	100%	100%	100.0%	0.90	0.96
A-7/DP-7	53,262 sf	1.22ac	B	100%	0.98ac	80%	80%	0%	0.24ac	20%	0%	80%		0%	0%	90%	0.00ac	0%	0%	100%	0.00ac	0%	0%	80.0%	0.74	0.84
A-8	18,648 sf	0.43ac	B	100%	0.00ac	0%	0%	0%	0.00ac	0%	0%	80%		0%	0%	90%	0.43ac	100%	90%	100%	0.00ac	0%	0%	90.0%	0.73	0.81
A-9	29,927 sf	0.69ac	B	100%	0.00ac	0%	0%	0%	0.00ac	0%	0%	80%		0%	0%	90%	0.69ac	100%	90%	100%	0.00ac	0%	0%	90.0%	0.73	0.81
A-10	27,289 sf	0.63ac	B	100%	0.00ac	0%	0%	0%	0.00ac	0%	0%	80%		0%	0%	90%	0.63ac	100%	90%	100%	0.00ac	0%	0%	90.0%	0.73	0.81
A-11	32,777 sf	0.75ac	B	100%	0.00ac	0%	0%	0%	0.00ac	0%	0%	80%		0%	0%	90%	0.75ac	100%	90%	100%	0.00ac	0%	0%	90.0%	0.73	0.81
B-1	214,751 sf	4.93ac	B	100%	2.10ac	43%	43%	0%	0.74ac	15%	0%	80%		0%	0%	90%	2.10ac	43%	38%	100%	0.00ac	0%	0%	80.8%	0.70	0.80
B-2	31,363 sf	0.72ac	B	100%	0.30ac	42%	42%	0%	0.13ac	18%	0%	80%		0%	0%	90%	0.29ac	41%	36%	100%	0.00ac	0%	0%	78.5%	0.69	0.79
B-3	178,334 sf	4.09ac	B	100%	1.54ac	38%	38%	0%	1.02ac	25%	0%	80%		0%	0%	90%	1.54ac	38%	34%	100%	0.00ac	0%	0%	71.3%	0.63	0.75
OS-1	91,476 sf	2.10ac	B	100%	0.53ac	25%	25%	0%	1.05ac	50%	0%	80%		0%	0%	90%	0.53ac	25%	23%	100%	0.00ac	0%	0%	47.5%	0.45	0.62
OS-2	375,052 sf	8.61ac	B	100%	2.58ac	30%	30%	0%	3.44ac	40%	0%	80%		0%	0%	90%	2.58ac	30%	27%	100%	0.00ac	0%	0%	57.0%	0.52	0.67
OS-3	300,564 sf	6.90ac	B	100%	0.86ac	13%	13%	0%	5.18ac	75%	0%	80%		0%	0%	90%	0.86ac	13%	11%	100%	0.00ac	0%	0%	23.8%	0.26	0.48
DP-1	A-2, OS-3	7.60ac	B	100%	1.35ac	18%	18%	0%	5.24ac	69%	0%	80%		0%	0%	90%	0.86ac	11%	10%	100%	0.14ac	2%	2%	29.8%	0.31	0.52
DP-2	A1 A3 A4,A5,A6 A7,A8	7.52ac	B	100%	2.50ac	33%	33%	0%	1.03ac	14%	0%	80%		0%	0%	90%	3.11ac	41%	37%	100%	0.88ac	12%	12%	82.2%	0.48	0.55
DP-3	B-3, OS-1, OS-2	14.80ac	B	100%	4.64ac	31%	31%	0%	5.52ac	37%	0%	80%		0%	0%	90%	4.64ac	31%	28%	100%	0.00ac	0%	0%	59.6%	0.54	0.69

Basin Runoff Coefficient is a weighted average

Runoff Coefficients and Percents Impervious (DCM Table 6-6)

Hydrologic Soil Type:	A	Runoff Coef Calc Method:	Weighted						
Land Use	Abb	%	C_2	C_5	C_{10}	C_{25}	C_{50}	C_{100}	Weighted
Business: Downtown	BD	95%	0.79	0.81	0.83	0.85	0.87	0.88	%Imp
Business: Suburban	BS	70%	0.45	0.49	0.53	0.58	0.60	0.62	
Drives and Walks	DR	100%	0.89	0.90	0.92	0.94	0.95	0.96	A
Streets - Gravel (Packed)	GR	80%	0.57	0.59	0.63	0.66	0.68	0.70	B
Historic Flow Analysis	HI	2%	0.03	0.09	0.17	0.26	0.31	0.36	C
Lawns	LA	0%	0.02	0.08	0.15	0.25	0.30	0.35	D
Off-site flow-Undeveloped	OF	45%	0.26	0.32	0.38	0.44	0.48	0.96	
Park	PA	7%	0.05	0.12	0.20	0.30	0.34	0.39	
Streets - Paved	PV	100%	0.89	0.90	0.92	0.94	0.95	0.96	
Roofs	RO	90%	0.71	0.73	0.75	0.78	0.80	0.81	

Equation:

$C_c=(C_1A_1+C_2A_2+C_3A_3+\ldots C_iA_i) / A_t$

(City of Colorado Springs DCM Equation 6-6) Where:

C_c = composite runoff coefficient for total area

C_i = runoff coefficient for subarea (surface type or land use)

A_i = area of surface type corresponding to C_i

A_t = total area of all sub areas

$_i$ = number of surface types in the drainage area

Exhibit Hall
Time of Concentration Calculation
Developed Condition

Sub-Basin Data				**Time of Concentration Estimate**										Min. Tc in Urban		**Final t_c**
				Initial/Overland Time (t_i)			Travel Time (t_t)						Comp.	Tc Check (urban)		
Basin / Design Point	**Contributing Basins**	**Area**	**C_5**	Length	Slope	t_i	Length	Slope	Land Type	Cv	Velocity	t_t	t_c	Total Length	t_c Check	
A-1/DP-4	A-1	1.42ac	0.73	100lf	1.0%	6.8 min.	0lf	0.0%	PV	20	0.0 ft/sec	0.0 min.	6.8 min.	100lf	10.6 min.	**6.8 min.**
A-2	A-2	0.70ac	0.82	75lf	10.0%	2.1 min.	650lf	3.2%	PV	20	3.6 ft/sec	3.0 min.	5.1 min.	725lf	14.0 min.	**5.1 min.**
A-3/DP-5	A-3	0.96ac	0.82	100lf	3.6%	3.4 min.	300lf	1.7%	PV	20	2.6 ft/sec	1.9 min.	5.3 min.	400lf	12.2 min.	**5.3 min.**
A-4	A-4	0.52ac	0.12	80lf	7.5%	8.2 min.	150lf	4.0%	GW	15	3.0 ft/sec	0.8 min.	9.0 min.	230lf	11.3 min.	**9.0 min.**
A-5/DP-6	A-5	0.81ac	0.88	100lf	2.5%	3.0 min.	220lf	0.9%	PV	20	1.9 ft/sec	2.0 min.	5.0 min.	320lf	11.8 min.	**5.0 min.**
A-6/DP-8	A-6	0.09ac	0.90	25lf	8.0%	0.9 min.	100lf	1.0%	PV	20	2.0 ft/sec	0.8 min.	5.0 min.	125lf	10.7 min.	**5.0 min.**
A-7/DP-7	A-7	1.22ac	0.74	100lf	2.0%	5.3 min.	475lf	1.0%	PV	20	2.0 ft/sec	4.0 min.	9.2 min.	575lf	13.2 min.	**9.2 min.**
A-8	A-8	0.43ac	0.73	100lf	2.0%	5.4 min.	20lf	2.0%	PV	20	2.8 ft/sec	0.1 min.	5.5 min.	120lf	10.7 min.	**5.5 min.**
A-9	A-9	0.69ac	0.73	100lf	2.0%	5.4 min.	0lf	0.0%	PV	20	0.0 ft/sec	0.0 min.	5.4 min.	100lf	10.6 min.	**5.4 min.**
A-10	A-10	0.63ac	0.73	90lf	2.0%	5.1 min.	0lf	0.0%	PV	20	0.0 ft/sec	0.0 min.	5.1 min.	90lf	10.5 min.	**5.1 min.**
A-11	A-11	0.75ac	0.73	100lf	2.0%	5.4 min.	0lf	0.0%	PV	20	0.0 ft/sec	0.0 min.	5.4 min.	100lf	10.6 min.	**5.4 min.**
B-1	B-1	4.93ac	0.70	100lf	2.1%	5.7 min.	1200lf	1.4%	PV	20	2.4 ft/sec	8.5 min.	14.1 min.	1300lf	17.2 min.	**14.1 min.**
B-2	B-2	0.72ac	0.69	100lf	5.6%	4.3 min.	160lf	1.3%	PV	20	2.3 ft/sec	1.2 min.	5.4 min.	260lf	11.4 min.	**5.4 min.**
B-3	B-3	4.09ac	0.63	100lf	2.5%	6.3 min.	600lf	1.9%	PV	20	2.7 ft/sec	3.7 min.	10.0 min.	700lf	13.9 min.	**10.0 min.**
OS-1	OS-1	2.10ac	0.45	100lf	5.0%	7.0 min.	650lf	2.5%	PV	20	3.2 ft/sec	3.4 min.	10.4 min.	750lf	14.2 min.	**10.4 min.**
OS-2	OS-2	8.61ac	0.52	100lf	25.0%	3.6 min.	1230lf	1.5%	PV	20	2.4 ft/sec	8.4 min.	12.0 min.	1330lf	17.4 min.	**12.0 min.**
OS-3	OS-3	6.90ac	0.26	100lf	3.3%	10.3 min.	260lf	3.0%	GW	15	2.6 ft/sec	1.7 min.	12.0 min.	360lf	12.0 min.	**12.0 min.**
DP-1	A-2, OS-3	7.60ac	0.31	100lf	3.3%	9.7 min.	650lf	3.2%	SP	7	1.3 ft/sec	8.7 min.	18.3 min.	750lf	14.2 min.	**14.2 min.**
DP-2	A1 A3 A4,A5,A6 A7,A8	7.52ac	0.48	65lf	2.0%	7.3 min.	1225lf	1.1%	PV	20	2.0 ft/sec	10.0 min.	17.3 min.	1290lf	17.2 min.	**17.2 min.**
DP-3	B-3, OS-1, OS-2	14.80ac	0.54	50lf	6.0%	4.0 min.	1230lf	1.5%	PV	20	2.4 ft/sec	8.4 min.	12.4 min.	1280lf	17.1 min.	**12.4 min.**

Equations:

t_i (Overland) = $0.395(1.1-C_5)L^{0.5} S^{-0.333}$
(DCM Equation 6-8) Where:
C_5 = Runoff coefficient for 5-year
L = Length of overland flow (ft)
S = Average basin slope (ft/ft)

$t_t = L_t / 60KS^{0.5}$ Where:
t_t = Channelized flow time (travel time)(min.)
L_t = Waterway length (ft)
K = Conveyance Factor (see DCM Table 6-7)
S = Watercourse slope (ft/ft)

t_c (1st DP) = $(18-15i) + L_t / (60 (24i+12)S^{0.5})$ Where:
t_c (1st DP) = First DP Time of Concentration in urban catchments
L_t = Length of Flow Path
i = imperviousness (expressed as a decimal)

Table RO-2

Type of Land Surface	**Land Type**	**Cv**
Grassed Waterway	GW	15
Heavy Meadow	HM	2.5
Nearly Bare Ground	NBG	10
Paved Area	PV	20
Riprap (Not Buried)	RR	6.5
Short Pasture/Lawns	SP	7
Tillage/Fields	TF	5

Exhibit Hall
Runoff Calculation
Developed Condition

Basin / Design Point	Contributing Basins	Drainage Area	C_5	C_{100}	Time of Concentration	Rainfall Intensity i_5	i_{100}	Runoff Q_5	Q_{100}	Basin / DP
A-1/DP-4	A-1	1.42 ac	0.73	0.82	6.8 min.	4.7 in/hr	7.9 in/hr	**4.9 cfs**	**9.2 cfs**	A-1/DP-4
A-2	A-2	0.70 ac	0.82	0.90	5.1 min.	5.1 in/hr	8.6 in/hr	**2.9 cfs**	**5.4 cfs**	A-2
A-3/DP-5	A-3	0.96 ac	0.82	0.90	5.3 min.	5.1 in/hr	8.5 in/hr	**4.0 cfs**	**7.4 cfs**	A-3/DP-5
A-4	A-4	0.52 ac	0.12	0.38	9.0 min.	4.3 in/hr	7.2 in/hr	**0.3 cfs**	**1.4 cfs**	A-4
A-5/DP-6	A-5	0.81 ac	0.88	0.94	5.0 min.	5.2 in/hr	8.7 in/hr	**3.7 cfs**	**6.6 cfs**	A-5/DP-6
A-6/DP-8	A-6	0.09 ac	0.90	0.96	5.0 min.	5.2 in/hr	8.7 in/hr	**0.4 cfs**	**0.8 cfs**	A-6/DP-8
A-7/DP-7	A-7	1.22 ac	0.74	0.84	9.2 min.	4.2 in/hr	7.1 in/hr	**3.8 cfs**	**7.3 cfs**	A-7/DP-7
A-8	A-8	0.43 ac	0.73	0.81	5.5 min.	5.0 in/hr	8.4 in/hr	**1.6 cfs**	**2.9 cfs**	A-8
A-9	A-9	0.69 ac	0.73	0.81	5.4 min.	5.1 in/hr	8.5 in/hr	**2.5 cfs**	**4.7 cfs**	A-9
A-10	A-10	0.63 ac	0.73	0.81	5.1 min.	5.1 in/hr	8.6 in/hr	**2.4 cfs**	**4.4 cfs**	A-10
A-11	A-11	0.75 ac	0.73	0.81	5.4 min.	5.1 in/hr	8.5 in/hr	**2.8 cfs**	**5.2 cfs**	A-11
B-1	B-1	4.93 ac	0.70	0.80	14.1 min.	3.6 in/hr	6.1 in/hr	**12.6 cfs**	**24.1 cfs**	B-1
B-2	B-2	0.72 ac	0.69	0.79	5.4 min.	5.0 in/hr	8.5 in/hr	**2.5 cfs**	**4.8 cfs**	B-2
B-3	B-3	4.09 ac	0.63	0.75	10.0 min.	4.1 in/hr	6.9 in/hr	**10.7 cfs**	**21.3 cfs**	B-3
OS-1	OS-1	2.10 ac	0.45	0.62	10.4 min.	4.1 in/hr	6.8 in/hr	**3.8 cfs**	**8.9 cfs**	OS-1
OS-2	OS-2	8.61 ac	0.52	0.67	12.0 min.	3.9 in/hr	6.5 in/hr	**17.3 cfs**	**37.4 cfs**	OS-2
OS-3	OS-3	6.90 ac	0.26	0.48	12.0 min.	3.9 in/hr	6.5 in/hr	**7.0 cfs**	**21.6 cfs**	OS-3
DP-1	A-2, OS-3	7.60 ac	0.31	0.52	14.2 min.	3.6 in/hr	6.1 in/hr	**8.6 cfs**	**24.0 cfs**	DP-1
DP-2	A1 A3 A4,A5,A6 A7,A8	7.52 ac	0.48	0.55	17.2 min.	3.3 in/hr	5.6 in/hr	**11.9 cfs**	**22.9 cfs**	DP-2
DP-3	B-3, OS-1, OS-2	14.80 ac	0.54	0.69	12.4 min.	3.8 in/hr	6.4 in/hr	**30.5 cfs**	**65.0 cfs**	DP-3

Equations (taken from Fig 6-5, City of Colorado Springs DCM):

i_2=-1.19 ln(T_c) + 6.035
i_5=-1.50 ln(T_c) + 7.583
i_{10}=-1.75 ln(T_c) + 8.847
i_{25}=-2.00 ln(T_c) + 10.111
i_{50}=-2.25 ln(T_c) + 11.375
i_{100}=-2.52 ln(T_c) + 12.735

Q = CiA
Q = Peak Runoff Rate (cubic feet/second)
C = Runoff coef representing a ratio of peak runoff rate to ave rainfall intensity for a duration equal to the runoff time of concentration.
i = average rainfall intensity in inches per hour
A = Drainage area in acres

P1	Inches
WQCV	0.60 in
2 yr	1.19 in
5 yr	1.50 in
10 yr	1.75 in
25 yr	2.00 in
50 yr	2.25 in
100 yr	2.52 in

Appendix C

Hydraulic Calculations

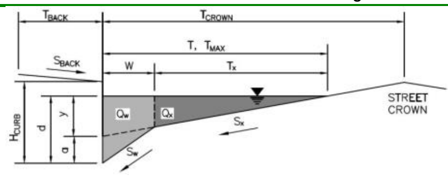
Version 4.05 Released March 2017

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

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

Project: Broadmoor Exhibit Hall

Inlet ID: Design Point 5 Inlet



Gutter Geometry (Enter data in the blue cells)

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =		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} =		
Height of Curb at Gutter Flow Line	H_{CURB} =	12.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	30.0	ft
Gutter Width	W =	1.00	ft
Street Transverse Slope	S_X =	0.040	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} =	30.0	30.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	12.0	12.0	inches
Check boxes are not applicable in SUMP conditions		☐	☐	

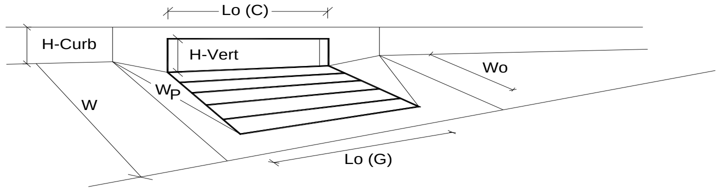
Maximum Capacity for 1/2 Street based On Allowable Spread		Minor Storm	Major Storm	
Water Depth without Gutter Depression (Eq. ST-2)	y =	14.40	14.40	inches
Vertical Depth between Gutter Lip and Gutter Flowline (usually 2")	d_C =	1.0	1.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	0.52	0.52	inches
Water Depth at Gutter Flowline	d =	14.92	14.92	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	29.0	29.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.089	0.089	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	0.0	0.0	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	0.0	0.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Spread	**Q_T =**	**SUMP**	**SUMP**	**cfs**
Flow Velocity within the Gutter Section	V =	0.0	0.0	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	0.0	0.0	

Maximum Capacity for 1/2 Street based on Allowable Depth		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	23.9	23.9	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	22.9	22.9	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.111	0.111	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	0.0	0.0	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	0.0	0.0	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	0.0	0.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	0.0	0.0	cfs
Average Flow Velocity Within the Gutter Section	V =	0.0	0.0	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	0.0	0.0	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d $\geq$ 6") Storm	R =	SUMP	SUMP	
Max Flow Based on Allowable Depth (Safety Factor Applied)	**Q_d =**	**SUMP**	**SUMP**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =			inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =			inches

		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

Version 4.05 Released March 2017



Design Information (Input)	Colorado Springs D-10-R		MINOR	MAJOR	
Type of Inlet		Type =	Colorado Springs D-10-R		
Local Depression (additional to continuous gutter depression 'a' from above)		a_{local} =	4.00	4.00	inches
Number of Unit Inlets (Grate or Curb Opening)		No =	1	1	
Water Depth at Flowline (outside of local depression)		Ponding Depth =	12.0	12.0	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) =	4.00	4.00	feet
Height of Vertical Curb Opening in Inches		H_{vert} =	8.00	8.00	inches
Height of Curb Orifice Throat in Inches		H_{throat} =	8.00	8.00	inches
Angle of Throat (see USDCM Figure ST-5)		Theta =	81.00	81.00	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) =	3.60	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} =	0.92	0.92	ft
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	1.00	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} =	N/A	N/A	

		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	**12.6**	**12.6**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	4.0	7.4	cfs

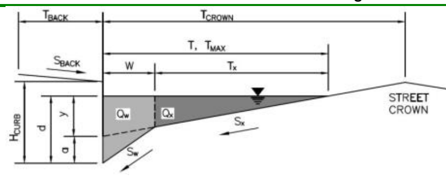
Version 4.05 Released March 2017

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

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

Project: **Broadmoor Exhibit Hall**

Inlet ID: **Design Point 6 Inlet**



Gutter Geometry (Enter data in the blue cells)

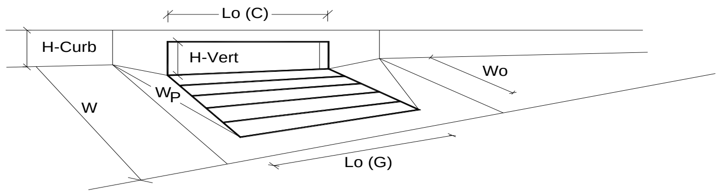
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =		ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =		ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =		
Height of Curb at Gutter Flow Line	H_{CURB} =	12.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	30.0	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 =	0.000	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} =	30.0	30.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	12.0	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

Version 4.05 Released March 2017



Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	Colorado Springs D-10-R		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	4.00	4.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1	1	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	8.0	8.0	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) =	10.00	10.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	8.00	8.00	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	8.00	8.00	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	81.00	81.00	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) =	3.60	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} =	0.58	0.58	ft
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	0.75	0.75	
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 =	**17.6**	**17.6**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	9.5	17.5	cfs

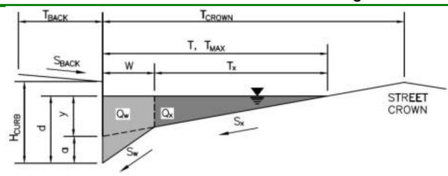
Version 4.05 Released March 2017

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

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

Project: **Broadmoor Exhibit Hall**

Inlet ID: **Design Point 7 Inlet**



Gutter Geometry (Enter data in the blue cells)

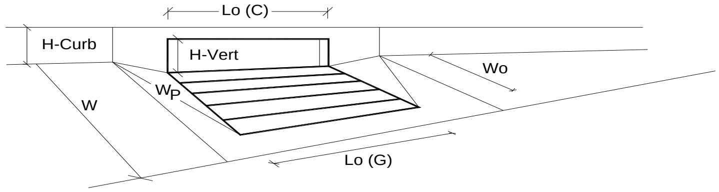
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =		ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =		ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =		
Height of Curb at Gutter Flow Line	H_{CURB} =	12.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	30.0	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 =	0.000	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} =	30.0	30.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	12.0	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

Version 4.05 Released March 2017



Design Information (Input)		MINOR	MAJOR	
Type of Inlet (Colorado Springs D-10-R)	Type =	Colorado Springs D-10-R		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	4.00	4.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1	1	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	8.0	8.0	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) =	4.00	4.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	8.00	8.00	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	8.00	8.00	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	81.00	81.00	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) =	3.60	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} =	0.58	0.58	ft
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	1.00	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} =	N/A	N/A	

		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	**8.1**	**8.1**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	3.8	7.3	cfs

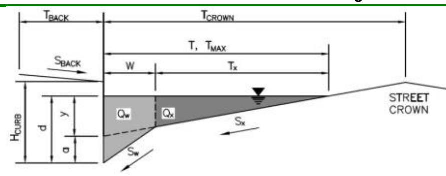
Version 4.05 Released March 2017

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

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

Project: **Broadmoor Exhibit Hall**

Inlet ID: **Design Point 4 Inlet**



Gutter Geometry (Enter data in the blue cells)

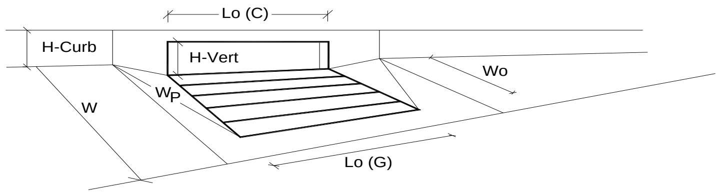
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =		ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =		ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =		
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	10.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.005	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} =	10.0	10.0	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

Version 4.05 Released March 2017



Design Information (Input)		MINOR	MAJOR	
Type of Inlet — Slotted Inlet Parallel to Flow	Type =	Slotted Inlet Parallel to Flow		
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 =	2.5	2.5	inches
Grate Information		MINOR	MAJOR	Override Depths
Length of a Unit Grate	L_o (G) =	240.00	240.00	feet
Width of a Unit Grate	W_o =	0.21	0.21	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	0.90	0.90	
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) =	2.48	2.48	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	0.80	0.80	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	N/A	N/A	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	N/A	N/A	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	N/A	N/A	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	N/A	N/A	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	N/A	N/A	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	N/A	N/A	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	N/A	N/A	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	N/A	N/A	

Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	0.355	0.355	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	N/A	N/A	ft
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	N/A	N/A	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	N/A	N/A	
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	0.23	0.23	

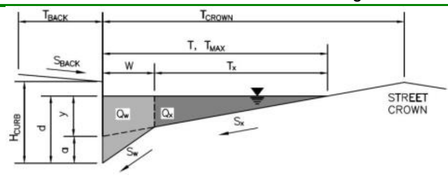
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	11.2	11.2	cfs
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	3.7	6.9	cfs

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

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

Project: Broadmoor Exhibit Hall

Inlet ID: Design Point 8 Inlet



Gutter Geometry (Enter data in the blue cells)

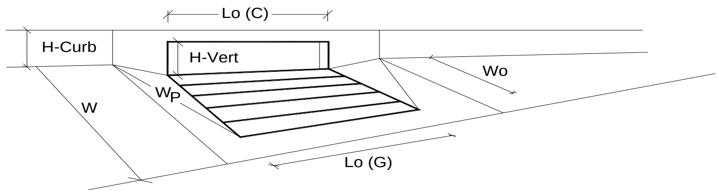
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =		ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =		ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =		
Height of Curb at Gutter Flow Line	H_{CURB} =	48.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	40.0	ft
Gutter Width	W =	40.00	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 =	0.000	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} =	40.0	40.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	40.0	40.0	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

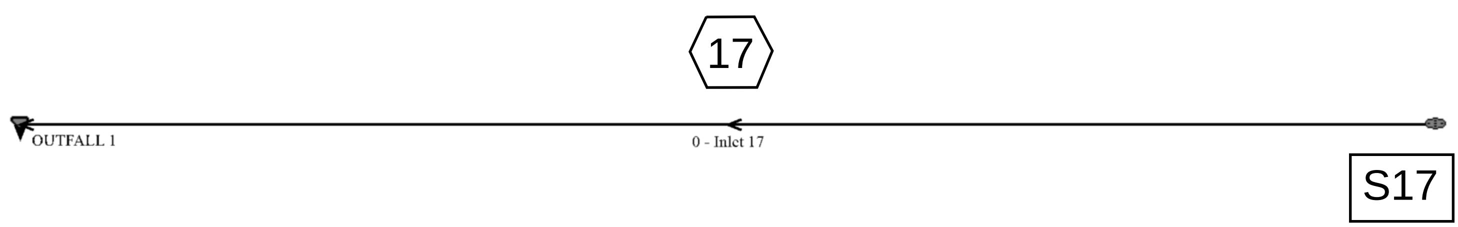
Version 4.05 Released March 2017



Design Information (Input)			MINOR	MAJOR	
Type of Inlet	Slotted Inlet Normal to Flow	Type =	Slotted Inlet Normal to Flow		
Local Depression (additional to continuous gutter depression 'a' from above)		a_{local} =	0.00	0.00	inches
Number of Unit Inlets (Grate or Curb Opening)		No =	1	1	
Water Depth at Flowline (outside of local depression)		Ponding Depth =	39.8	39.8	inches
Grate Information			MINOR	MAJOR	Override Depths
Length of a Unit Grate		L_o (G) =	0.21	0.21	feet
Width of a Unit Grate		W_o =	40.00	40.00	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)		A_{ratio} =	0.90	0.90	
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) =	2.48	2.48	
Grate Orifice Coefficient (typical value 0.60 - 0.80)		C_o (G) =	0.80	0.80	
Curb Opening Information			MINOR	MAJOR	
Length of a Unit Curb Opening		L_o (C) =	N/A	N/A	feet
Height of Vertical Curb Opening in Inches		H_{vert} =	N/A	N/A	inches
Height of Curb Orifice Throat in Inches		H_{throat} =	N/A	N/A	inches
Angle of Throat (see USDCM Figure ST-5)		Theta =	N/A	N/A	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)		W_p =	N/A	N/A	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)		C_f (C) =	N/A	N/A	
Curb Opening Weir Coefficient (typical value 2.3-3.7)		C_w (C) =	N/A	N/A	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)		C_o (C) =	N/A	N/A	

Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	1.660	1.660	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	N/A	N/A	ft
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	N/A	N/A	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	N/A	N/A	
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	1.00	1.00	

		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	**31.0**	**31.0**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	0.4	0.8	cfs



UD-Sewer Plan View - Northeast Storm Sewer

System Description

Title: Lot 1 Broadmoor Campus Filing No. 2

Description: Northeast 5-Year Design Flows

General System Parameters

Minimum Buried Depth (ft): 2.00
Minimum Pipe Size (in): 18.00
Maximum Sewer Velocity (fps): 18.0
Minimum Sewer Velocity (fps): 2.0
Maximum Flow Depth to Sewer Size Ratio (x:1): 1.00
Minimum Trench Width (ft): 2.00
Trench Side Slope (1V:zH): 1.0
Maximum Rural Overland Flow Length (ft): 0
Maximum Urban Overland Flow Length (ft): 100
Urban Flow Factor: 0.74

Rainfall Parameters

Rainfall calculation Method: Formula
Rainfall Return Period (years): 5
Total Rainfall Depth: 1.50
Emperical Consatnts:
A: 28.5
B: 10
C: 0.786

Total Number of Manholes: 2

Manhole Network Data

ID	Output	Input 1	Input 2	Input 3	Input 4
0	0	17	0	0	0
17	17	0	0	0	0

Manhole Flow Data

ID	Elevation	Known Flow	Local Flow	Drain Area	Runoff Cof	5yr Coeff.
0	6209.25	0.00	0.00	0.000	0.00	0.00
17	6212.97	3.80	0.00	0.000	0.00	0.00

Manhole Sub Basin Data

ID	Ol. Length	Ol. Slope	Gutter Lngth	Gutter Vel.
0	0	0.0	0	0.00
17	0	0.0	0	0.00

Total Number of Sewers
1

Sewer Design Data

ID	Length	Slope	Upper Elev	Mannings N	Bend Loss	Lat. Loss
17	205.25	0.5	6208.78	0.013	0.38	0.00

Sewer Geometry

ID	Shape	Dia. or Height	Span or Width
17	Round	18.00	18.00

UDSewer Results Summary

Project Title: Lot 1 Broadmoor Campus Filing No. 2
Project Description: Northeast 5-Year Design Flows

System Input Summary

Rainfall Parameters

Rainfall Return Period: 5
Rainfall Calculation Method: Formula

One Hour Depth (in): 1.50
Rainfall Constant "A": 28.5
Rainfall Constant "B": 10
Rainfall Constant "C": 0.786

Rational Method Constraints

Minimum Urban Runoff Coeff.: 0.74
Maximum Rural Overland Len. (ft): 0
Maximum Urban Overland Len. (ft): 100
Used UDFCD Tc. Maximum: No

Sizer Constraints

Minimum Sewer Size (in): 18.00
Maximum Depth to Rise Ratio: 1.00
Maximum Flow Velocity (fps): 18.0
Minimum Flow Velocity (fps): 2.0

Backwater Calculations:

Tailwater Elevation (ft): 6208.50

Manhole Input Summary:

		Given Flow		Sub Basin Information						
Element Name	**Ground Elevation (ft)**	**Total Known Flow (cfs)**	**Local Contribution (cfs)**	**Drainage Area (Ac.)**	**Runoff Coefficient**	**5yr Coefficient**	**Overland Length (ft)**	**Overland Slope (%)**	**Gutter Length (ft)**	**Gutter Velocity (fps)**
OUTFALL 1	6209.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0 - Inlet 17	6212.97	3.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Manhole Output Summary:

	Local Contribution					Total Design Flow				
Element Name	**Overland Time (min)**	**Gutter Time (min)**	**Basin Tc (min)**	**Intensity (in/hr)**	**Local Contrib (cfs)**	**Coeff. Area**	**Intensity (in/hr)**	**Manhole Tc (min)**	**Peak Flow (cfs)**	**Comment**
OUTFALL 1	0.00	0.00	0.00	0.00	0.00	0.61	6.23	1.59	3.80	
0 - Inlet 17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.80	

Sewer Input Summary:

		Elevation			Loss Coefficients			Given Dimensions		
Element Name	**Sewer Length (ft)**	**Downstream Invert (ft)**	**Slope (%)**	**Upstream Invert (ft)**	**Mannings n**	**Bend Loss**	**Lateral Loss**	**Cross Section**	**Rise (ft or in)**	**Span (ft or in)**
0 - Inlet 17	205.25	6207.75	0.5	6208.78	0.013	0.38	0.00	CIRCULAR	18.00 in	18.00 in

Sewer Flow Summary:

	Full Flow Capacity		Critical Flow		Normal Flow						
Element Name	**Flow (cfs)**	**Velocity (fps)**	**Depth (in)**	**Velocity (fps)**	**Depth (in)**	**Velocity (fps)**	**Froude Number**	**Flow Condition**	**Flow (cfs)**	**Surcharged Length (ft)**	**Comment**
0 - Inlet 17	7.45	4.21	8.94	4.34	9.11	4.24	0.97	Subcritical	3.80	0.00	

- A Froude number of 0 indicates that pressured flow occurs (adverse slope or undersized pipe).
- If the sewer is not pressurized, full flow represents the maximum gravity flow in the sewer.
- If the sewer is pressurized, full flow represents the pressurized flow conditions.

Sewer Sizing Summary:

			Existing		Calculated		Used			
Element Name	Peak Flow (cfs)	Cross Section	Rise	Span	Rise	Span	Rise	Span	Area (ft^2)	Comment
0 - Inlet 17	3.80	CIRCULAR	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	1.77	

- Calculated diameter was determined by sewer hydraulic capacity rounded up to the nearest commercially available size.
- Sewer sizes should not decrease downstream.
- All hydraulics where calculated using the 'Used' parameters.

Grade Line Summary:

Tailwater Elevation (ft): 6208.50

	Invert Elev.		Downstream Manhole Losses		HGL		EGL		
Element Name	Downstream (ft)	Upstream (ft)	Bend Loss (ft)	Lateral Loss (ft)	Downstream (ft)	Upstream (ft)	Downstream (ft)	Friction Loss (ft)	Upstream (ft)
0 - Inlet 17	6207.75	6208.78	0.00	0.00	6208.50	6209.55	6208.79	1.03	6209.82

- Bend and Lateral losses only apply when there is an outgoing sewer. The system outfall, sewer #0, is not considered a sewer.
- Bend loss = Bend K * V_fi ^ 2/(2*g)
- Lateral loss = V_fo ^ 2/(2*g)- Junction Loss K * V_fi ^ 2/(2*g).
- Friction loss is always Upstream EGL - Downstream EGL.

Excavation Estimate:

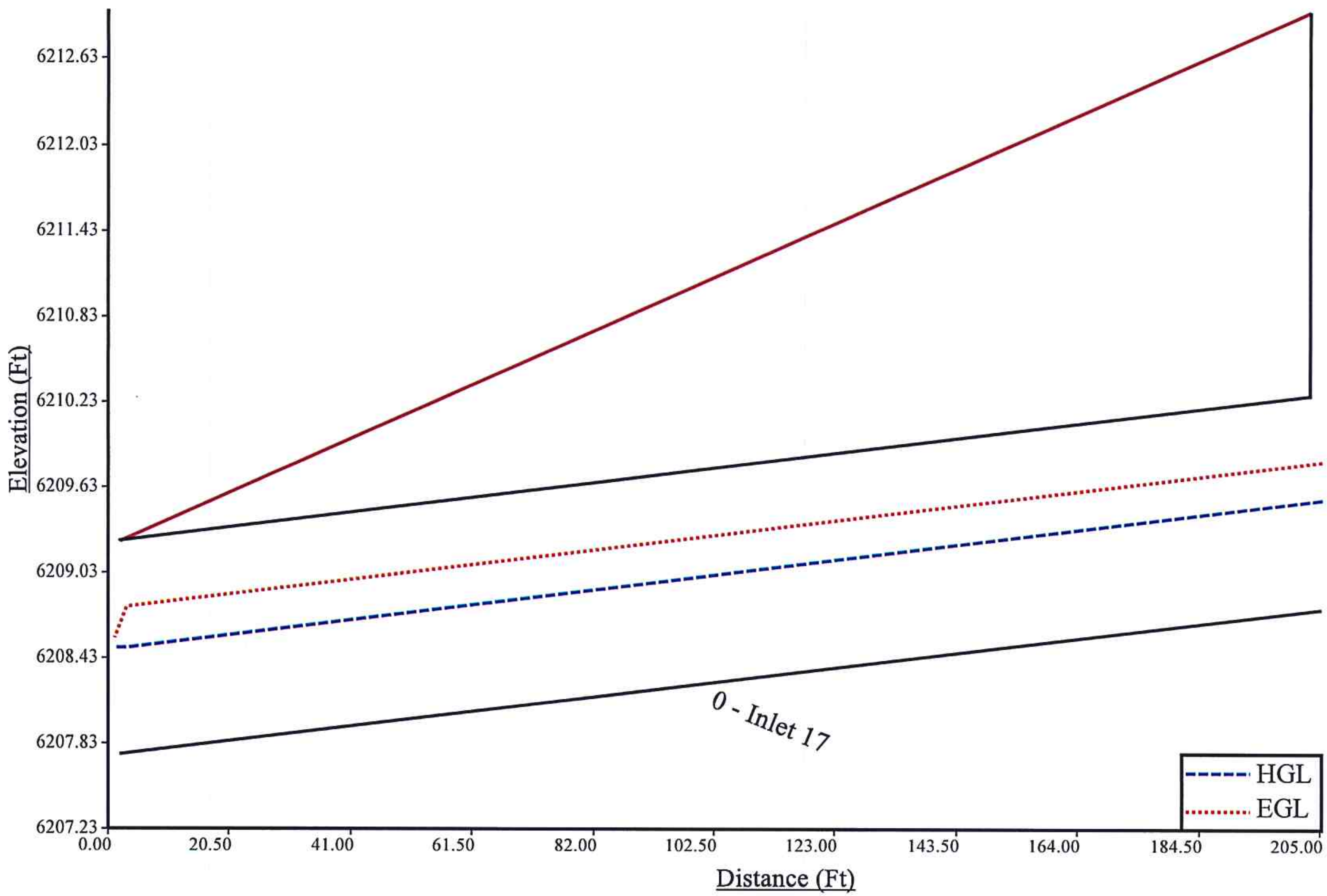
The trench side slope is 1.0 ft/ft
The minimum trench width is 2.00 ft

					Downstream			Upstream				
Element Name	Length (ft)	Wall (in)	Bedding (in)	Bottom Width (ft)	Top Width (ft)	Trench Depth (ft)	Cover (ft)	Top Width (ft)	Trench Depth (ft)	Cover (ft)	Volume (cu. yd)	Comment
0 - Inlet 17	205.25	2.50	4.00	4.92	0.00	2.04	0.00	7.88	4.73	2.48	134.85	Sewer Too Shallow

Total earth volume for sewer trenches = 135 cubic yards.

- The trench was estimated to have a bottom width equal to the outer pipe diameter plus 36 inches.
- If the calculated width of the trench bottom is less than the minimum acceptable width, the minimum acceptable width was used.
- The sewer wall thickness is equal to: (equivalent diameter in inches/12)+1 inches
- The sewer bedding thickness is equal to:
  - Four inches for pipes less than 33 inches.
  - Six inches for pipes less than 60 inches.
  - Eight inches for all larger sizes.

Northeast 0 - Inlet 17 (5-Year Design Flow)



System Description

Title: Lot 1 Broadmoor Campus Filing No. 2

Description: Northeast Storm Sewer 100-Year Design Flows

General System Parameters

Minimum Buried Depth (ft): 2.00

Minimum Pipe Size (in): 18.00

Maximum Sewer Velocity (fps): 18.0

Minimum Sewer Velocity (fps): 2.0

Maximum Flow Depth to Sewer Size Ratio (x:1): 1.00

Minimum Trench Width (ft): 2.00

Trench Side Slope (1V:zH): 1.0

Maximum Rural Overland Flow Length (ft): 0

Maximum Urban Overland Flow Length (ft): 100

Urban Flow Factor: 0.20

Rainfall Parameters

Rainfall calculation Method: Formula

Rainfall Return Period (years): 100

Total Rainfall Depth: 2.52

Emperical Consatnts:

A: 28.5

B: 10

C: 0.786

Total Number of Manholes: 2

Manhole Network Data

ID	Output	Input 1	Input 2	Input 3	Input 4
17	17	0	0	0	0
0	0	17	0	0	0

Manhole Flow Data

ID	Elevation	Known Flow	Local Flow	Drain Area	Runoff Cof	5yr Coeff.
17	6212.97	7.30	0.00	0.000	0.00	0.00
0	6209.25	0.00	0.00	0.000	0.00	0.00

Manhole Sub Basin Data

ID	Ol. Length	Ol. Slope	Gutter Lngth	Gutter Vel.
17	0	0.0	0	0.00
0	0	0.0	0	0.00

Total Number of Sewers

1

Sewer Design Data

ID	Length	Slope	Upper Elev	Mannings N	Bend Loss	Lat. Loss
17	205.25	0.5	6208.78	0.013	0.38	0.00

Sewer Geometry

ID	Shape	Dia. or Height	Span or Width
17	Round	18.00	18.00

UDSewer Results Summary

Project Title: Lot 1 Broadmoor Campus Filing No. 2
Project Description: Northeast Storm Sewer 100-Year Design Flows

System Input Summary

Rainfall Parameters

Rainfall Return Period: 100
Rainfall Calculation Method: Formula

One Hour Depth (in): 2.52
Rainfall Constant "A": 28.5
Rainfall Constant "B": 10
Rainfall Constant "C": 0.786

Rational Method Constraints

Minimum Urban Runoff Coeff.: 0.20
Maximum Rural Overland Len. (ft): 0
Maximum Urban Overland Len. (ft): 100
Used UDFCD Tc. Maximum: No

Sizer Constraints

Minimum Sewer Size (in): 18.00
Maximum Depth to Rise Ratio: 1.00
Maximum Flow Velocity (fps): 18.0
Minimum Flow Velocity (fps): 2.0

Backwater Calculations:

Tailwater Elevation (ft): 6208.80

Manhole Input Summary:

		Given Flow		Sub Basin Information						
Element Name	Ground Elevation (ft)	Total Known Flow (cfs)	Local Contribution (cfs)	Drainage Area (Ac.)	Runoff Coefficient	5yr Coefficient	Overland Length (ft)	Overland Slope (%)	Gutter Length (ft)	Gutter Velocity (fps)
OUTFALL 1	6209.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Inlet 17 - 0	6212.97	7.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Manhole Output Summary:

	Local Contribution					Total Design Flow				
Element Name	Overland Time (min)	Gutter Time (min)	Basin Tc (min)	Intensity (in/hr)	Local Contrib (cfs)	Coeff. Area	Intensity (in/hr)	Manhole Tc (min)	Peak Flow (cfs)	Comment
OUTFALL 1	0.00	0.00	0.00	0.00	0.00	0.66	11.04	0.83	7.30	
Inlet 17 - 0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.30	

Sewer Input Summary:

		Elevation			Loss Coefficients			Given Dimensions		
Element Name	Sewer Length (ft)	Downstream Invert (ft)	Slope (%)	Upstream Invert (ft)	Mannings n	Bend Loss	Lateral Loss	Cross Section	Rise (ft or in)	Span (ft or in)
Inlet 17 - 0	205.25	6207.75	0.5	6208.78	0.013	0.38	0.00	CIRCULAR	18.00 in	18.00 in

Sewer Flow Summary:

	Full Flow Capacity		Critical Flow		Normal Flow						
Element Name	Flow (cfs)	Velocity (fps)	Depth (in)	Velocity (fps)	Depth (in)	Velocity (fps)	Froude Number	Flow Condition	Flow (cfs)	Surcharged Length (ft)	Comment
Inlet 17 - 0	7.45	4.21	12.56	5.55	14.44	4.80	0.75	Subcritical	7.30	0.00	

- A Froude number of 0 indicates that pressured flow occurs (adverse slope or undersized pipe).
- If the sewer is not pressurized, full flow represents the maximum gravity flow in the sewer.
- If the sewer is pressurized, full flow represents the pressurized flow conditions.

Sewer Sizing Summary:

			Existing		Calculated		Used			
Element Name	**Peak Flow (cfs)**	**Cross Section**	**Rise**	**Span**	**Rise**	**Span**	**Rise**	**Span**	**Area (ft^2)**	**Comment**
Inlet 17 - 0	7.30	CIRCULAR	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	1.77	

- Calculated diameter was determined by sewer hydraulic capacity rounded up to the nearest commercially available size.
- Sewer sizes should not decrease downstream.
- All hydraulics where calculated using the 'Used' parameters.

Grade Line Summary:

Tailwater Elevation (ft): 6208.80

	Invert Elev.		Downstream Manhole Losses		HGL		EGL		
Element Name	**Downstream (ft)**	**Upstream (ft)**	**Bend Loss (ft)**	**Lateral Loss (ft)**	**Downstream (ft)**	**Upstream (ft)**	**Downstream (ft)**	**Friction Loss (ft)**	**Upstream (ft)**
Inlet 17 - 0	6207.75	6208.78	0.00	0.00	6208.80	6210.13	6209.28	1.14	6210.42

- Bend and Lateral losses only apply when there is an outgoing sewer. The system outfall, sewer #0, is not considered a sewer.
- Bend loss = Bend K * V_fi ^ 2/(2*g)
- Lateral loss = V_fo ^ 2/(2*g)- Junction Loss K * V_fi ^ 2/(2*g).
- Friction loss is always Upstream EGL - Downstream EGL.

Excavation Estimate:

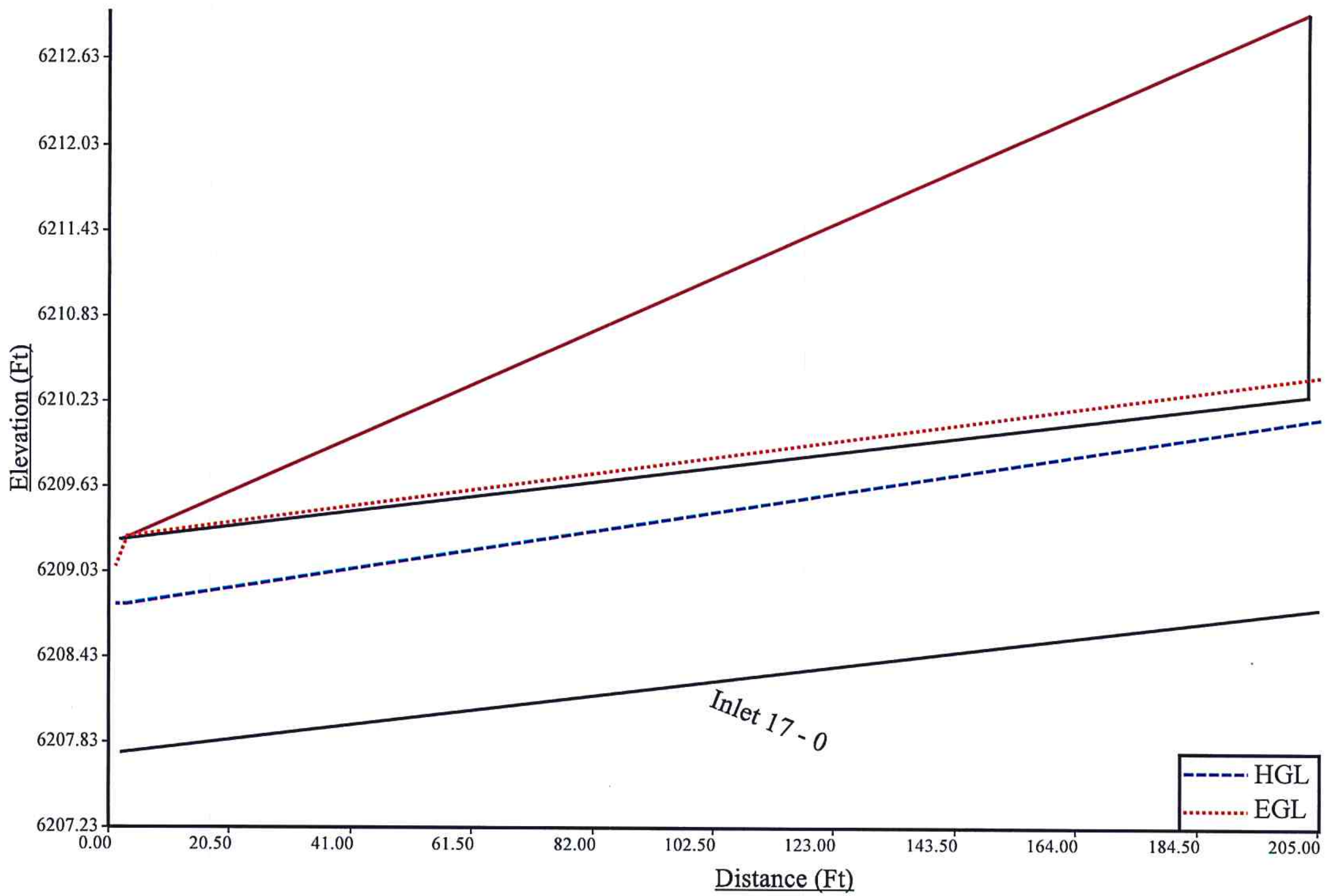
The trench side slope is 1.0 ft/ft
The minimum trench width is 2.00 ft

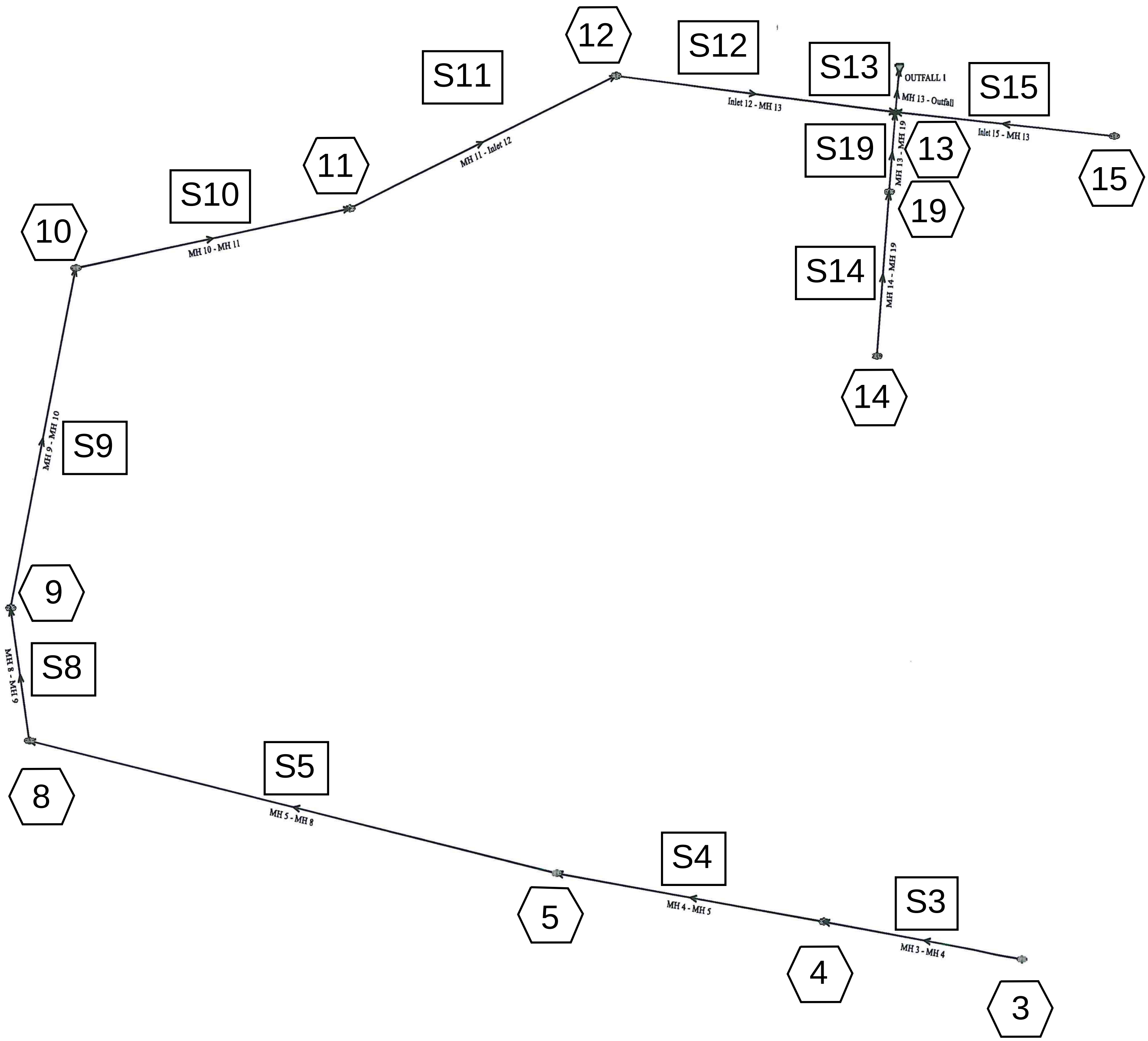
					Downstream			Upstream				
Element Name	**Length (ft)**	**Wall (in)**	**Bedding (in)**	**Bottom Width (ft)**	**Top Width (ft)**	**Trench Depth (ft)**	**Cover (ft)**	**Top Width (ft)**	**Trench Depth (ft)**	**Cover (ft)**	**Volume (cu. yd)**	**Comment**
Inlet 17 - 0	205.25	2.50	4.00	4.92	0.00	2.04	0.00	7.88	4.73	2.48	134.85	Sewer Too Shallow

Total earth volume for sewer trenches = 135 cubic yards.

- The trench was estimated to have a bottom width equal to the outer pipe diameter plus 36 inches.
- If the calculated width of the trench bottom is less than the minimum acceptable width, the minimum acceptable width was used.
- The sewer wall thickness is equal to: (equivalent diameter in inches/12)+1 inches
- The sewer bedding thickness is equal to:
  - Four inches for pipes less than 33 inches.
  - Six inches for pipes less than 60 inches.
  - Eight inches for all larger sizes.

Northeast 0 - Inlet 17 (100-Year Design Flows)





UD-Sewer Plan View - Outfall Through MH 16, and MH 19

System Description
Title: Lot 1 Broadmoor Campus Filing No. 2
Description: 5-Year Design Flows

General System Parameters
Minimum Buried Depth (ft): 1.20
Minimum Pipe Size (in): 6.00
Maximum Sewer Velocity (fps): 18.0
Minimum Sewer Velocity (fps): 1.6
Maximum Flow Depth to Sewer Size Ratio (x:1): 1.00
Minimum Trench Width (ft): 2.00
Trench Side Slope (1V:zH): 1.0
Maximum Rural Overland Flow Length (ft): 0
Maximum Urban Overland Flow Length (ft): 100
Urban Flow Factor: 0.74

Rainfall Parameters
Rainfall calculation Method: Formula
Rainfall Return Period (years): 5
Total Rainfall Depth: 1.50
Emperical Consatnts:
A: 28.5
B: 10
C: 0.786

Total Number of Manholes: 14

Manhole Network Data

ID	Output	Input 1	Input 2	Input 3	Input 4
13	13	12	15	19	0
11	11	10	0	0	0
9	9	8	0	0	0
0	0	13	0	0	0
19	19	14	0	0	0
4	4	3	0	0	0
10	10	9	0	0	0
5	5	4	0	0	0
16	16	0	0	0	0
12	12	11	0	0	0
14	14	0	0	0	0
15	15	16	0	0	0
3	3	0	0	0	0
8	8	5	0	0	0

Manhole Flow Data

ID	Elevation	Known Flow	Local Flow	Drain Area	Runoff Cof	5yr Coeff.
13	6214.50	22.70	0.00	0.000	0.00	0.00
11	6219.10	8.10	0.00	0.000	0.00	0.00
9	6219.60	4.40	0.00	0.000	0.00	0.00
0	6211.00	0.00	0.00	0.000	0.00	0.00

19	6215.90	4.90	0.00	0.000	0.00	0.00
4	6219.50	0.00	0.00	0.548	0.72	0.72
10	6219.60	5.30	0.00	0.000	0.00	0.00
5	6219.50	3.90	0.00	0.000	0.00	0.00
16	6216.70	2.00	0.00	0.000	0.00	0.00
12	6215.00	12.10	0.00	0.000	0.00	0.00
14	6217.65	4.90	0.00	0.000	0.00	0.00
15	6214.89	5.70	0.00	0.000	0.00	0.00
3	6219.50	1.40	0.00	0.450	0.57	0.57
8	6219.50	3.90	0.00	0.000	0.00	0.00

Manhole Sub Basin Data

ID	Ol. Length	Ol. Slope	Gutter Lngth	Gutter Vel.
13	0	0.0	0	0.00
11	0	0.0	0	0.00
9	0	0.0	0	0.00
0	0	0.0	0	0.00
19	0	0.0	0	0.00
4	100	1.0	0	0.00
10	0	0.0	0	0.00
5	0	0.0	0	0.00
16	0	0.0	0	0.00
12	0	0.0	0	0.00
14	0	0.0	0	0.00
15	0	0.0	0	0.00
3	50	1.5	0	0.00
8	0	0.0	0	0.00

Total Number of Sewers
13

Sewer Design Data

ID	Length	Slope	Upper Elev	Mannings N	Bend Loss	Lat. Loss
13	8.31	1.1	6207.84	0.013	0.03	0.00
11	151.80	0.5	6209.72	0.013	0.22	0.00
9	157.53	0.7	6212.02	0.013	0.52	0.00
19	37.12	7.1	6211.72	0.013	0.05	0.00
4	110.88	0.7	6215.79	0.013	0.05	0.00
10	119.53	0.5	6210.82	0.013	0.05	0.00
5	284.54	0.7	6214.76	0.013	0.37	0.00

16	137.99	1.6	6214.17	0.013	1.27	0.00
12	103.55	0.5	6208.66	0.013	1.32	0.00
14	81.11	3.4	6214.61	0.013	0.05	0.00
15	126.68	2.0	6211.33	0.013	1.32	0.00
3	76.43	0.7	6216.58	0.013	0.05	0.00
8	78.27	0.7	6212.67	0.013	0.37	0.00

Sewer Geometry

ID	Shape	Dia. or Height	Span or Width
13	Round	30.00	30.00
11	Round	24.00	24.00
9	Round	18.00	18.00
19	Round	15.00	15.00
4	Round	14.50	14.50
10	Round	18.00	18.00
5	Round	18.00	18.00
16	Round	12.00	12.00
12	Round	30.00	30.00
14	Round	15.00	15.00
15	Round	18.00	18.00
3	Round	12.00	12.00
8	Round	18.00	18.00

UDSewer Results Summary

Project Title: Lot 1 Broadmoor Campus Filing No. 2
Project Description: 5-Year Design Flows

System Input Summary

Rainfall Parameters

Rainfall Return Period: 5
Rainfall Calculation Method: Formula

One Hour Depth (in): 1.50
Rainfall Constant "A": 28.5
Rainfall Constant "B": 10
Rainfall Constant "C": 0.786

Rational Method Constraints

Minimum Urban Runoff Coeff.: 0.74
Maximum Rural Overland Len. (ft): 0
Maximum Urban Overland Len. (ft): 100
Used UDFCD Tc. Maximum: No

Sizer Constraints

Minimum Sewer Size (in): 6.00
Maximum Depth to Rise Ratio: 1.00
Maximum Flow Velocity (fps): 18.0
Minimum Flow Velocity (fps): 1.6

Backwater Calculations:

Tailwater Elevation (ft): 6209.37

Manhole Input Summary:

		Given Flow		Sub Basin Information						
Element Name	**Ground Elevation (ft)**	**Total Known Flow (cfs)**	**Local Contribution (cfs)**	**Drainage Area (Ac.)**	**Runoff Coefficient**	**5yr Coefficient**	**Overland Length (ft)**	**Overland Slope (%)**	**Gutter Length (ft)**	**Gutter Velocity (fps)**
OUTFALL 1	6211.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MH 13 - Outfall	6214.50	22.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Inlet 12 - MH 13	6215.00	12.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MH 11 - Inlet 12	6219.10	8.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MH 10 - MH 11	6219.60	5.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MH 9 - MH 10	6219.60	4.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MH 8 - MH 9	6219.50	3.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MH 5 - MH 8	6219.50	3.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MH 4 - MH 5	6219.50	0.00	0.00	0.55	0.72	0.72	100.00	1.00	0.00	0.00
MH 3 - MH 4	6219.50	1.40	0.00	0.45	0.57	0.57	50.00	1.50	0.00	0.00
Inlet 15 - MH 13	6214.89	5.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MH 16 - Inlet 15	6216.70	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MH 13 - MH 19	6215.90	4.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MH 14 - MH 19	6217.65	4.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Manhole Output Summary:

	Local Contribution					Total Design Flow				
Element Name	**Overland Time (min)**	**Gutter Time (min)**	**Basin Tc (min)**	**Intensity (in/hr)**	**Local Contrib (cfs)**	**Coeff. Area**	**Intensity (in/hr)**	**Manhole Tc (min)**	**Peak Flow (cfs)**	**Comment**
OUTFALL 1	0.00	0.00	0.00	0.00	0.00	0.65	34.87	-8.70	22.70	
MH 13 - Outfall	0.00	0.00	0.00	0.00	0.00	0.65	34.87	-8.70	22.70	
Inlet 12 - MH 13	0.00	0.00	0.00	0.00	0.00	0.65	18.59	-7.11	12.10	
MH 11 - Inlet 12	0.00	0.00	0.00	0.00	0.00	0.65	12.44	-5.19	8.10	
MH 10 - MH 11	0.00	0.00	0.00	0.00	0.00	0.65	8.14	-1.75	5.30	
MH 9 - MH 10	0.00	0.00	0.00	0.00	0.00	0.65	6.76	0.45	4.40	
MH 8 - MH 9	0.00	0.00	0.00	0.00	0.00	0.65	5.99	2.19	3.90	
MH 5 - MH 8	0.00	0.00	0.00	0.00	0.00	0.65	5.99	2.19	3.90	
MH 4 - MH 5	0.00	0.00	10.00	4.06	1.60	0.65	4.06	10.00	2.64	Used Minimum Tc
MH 3 - MH 4	0.00	0.00	10.00	4.06	1.04	0.26	5.46	3.72	1.40	Used Minimum Tc
Inlet 15 - MH 13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.70	
MH 16 - Inlet 15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	
MH 13 - MH 19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.90	
MH 14 - MH 19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.90	

Sewer Input Summary:

		Elevation			Loss Coefficients			Given Dimensions		
Element Name	Sewer Length (ft)	Downstream Invert (ft)	Slope (%)	Upstream Invert (ft)	Mannings n	Bend Loss	Lateral Loss	Cross Section	Rise (ft or in)	Span (ft or in)
MH 13 - Outfall	8.31	6207.75	1.1	6207.84	0.013	0.03	0.00	CIRCULAR	30.00 in	30.00 in
Inlet 12 - MH 13	103.55	6208.14	0.5	6208.66	0.013	1.32	0.00	CIRCULAR	30.00 in	30.00 in
MH 11 - Inlet 12	151.80	6208.96	0.5	6209.72	0.013	0.22	0.00	CIRCULAR	24.00 in	24.00 in
MH 10 - MH 11	119.53	6210.22	0.5	6210.82	0.013	0.05	0.00	CIRCULAR	18.00 in	18.00 in
MH 9 - MH 10	157.53	6210.92	0.7	6212.02	0.013	0.52	0.00	CIRCULAR	18.00 in	18.00 in
MH 8 - MH 9	78.27	6212.12	0.7	6212.67	0.013	0.37	0.00	CIRCULAR	18.00 in	18.00 in
MH 5 - MH 8	284.54	6212.77	0.7	6214.76	0.013	0.37	0.00	CIRCULAR	18.00 in	18.00 in
MH 4 - MH 5	110.88	6215.01	0.7	6215.79	0.013	0.05	0.00	CIRCULAR	14.50 in	14.50 in
MH 3 - MH 4	76.43	6216.04	0.7	6216.58	0.013	0.05	0.00	CIRCULAR	12.00 in	12.00 in
Inlet 15 - MH 13	126.68	6208.80	2.0	6211.33	0.013	1.32	0.00	CIRCULAR	18.00 in	18.00 in
MH 16 - Inlet 15	137.99	6211.96	1.6	6214.17	0.013	1.27	0.00	CIRCULAR	12.00 in	12.00 in
MH 13 - MH 19	37.12	6209.09	7.1	6211.72	0.013	0.05	0.00	CIRCULAR	15.00 in	15.00 in
MH 14 - MH 19	81.11	6211.82	3.4	6214.61	0.013	0.05	0.00	CIRCULAR	15.00 in	15.00 in

Sewer Flow Summary:

	Full Flow Capacity		Critical Flow		Normal Flow						
Element Name	Flow (cfs)	Velocity (fps)	Depth (in)	Velocity (fps)	Depth (in)	Velocity (fps)	Froude Number	Flow Condition	Flow (cfs)	Surcharged Length (ft)	Comment
MH 13 - Outfall	43.13	8.79	19.45	6.74	15.46	8.90	1.55	Supercritical	22.70	0.00	
Inlet 12 - MH 13	29.08	5.92	14.00	5.39	13.49	5.65	1.07	Supercritical	12.10	0.00	
MH 11 - Inlet 12	16.04	5.11	12.16	5.07	12.07	5.12	1.01	Supercritical	8.10	0.00	
MH 10 - MH 11	7.45	4.21	10.64	4.87	11.22	4.58	0.90	Subcritical	5.30	0.00	
MH 9 - MH 10	8.81	4.99	9.65	4.56	8.99	4.98	1.15	Supercritical	4.40	0.00	
MH 8 - MH 9	8.81	4.99	9.06	4.37	8.38	4.83	1.16	Supercritical	3.90	0.00	
MH 5 - MH 8	8.81	4.99	9.06	4.37	8.38	4.83	1.16	Supercritical	3.90	0.00	
MH 4 - MH 5	4.95	4.32	7.90	4.13	7.54	4.39	1.09	Supercritical	2.64	0.00	
MH 3 - MH 4	2.99	3.81	6.01	3.56	5.78	3.74	1.08	Supercritical	1.40	0.00	
Inlet 15 - MH 13	14.90	8.43	11.05	5.01	7.72	7.87	1.98	Supercritical Jump	5.70	1.31	
MH 16 - Inlet 15	4.52	5.75	7.24	4.04	5.59	5.58	1.64	Supercritical	2.00	0.00	
MH 13 - MH 19	17.24	14.05	10.77	5.20	5.47	12.10	3.68	Supercritical	4.90	0.00	
MH 14 - MH 19	12.01	9.79	10.77	5.20	6.67	9.29	2.51	Supercritical	4.90	0.00	

- A Froude number of 0 indicates that pressured flow occurs (adverse slope or undersized pipe).
- If the sewer is not pressurized, full flow represents the maximum gravity flow in the sewer.
- If the sewer is pressurized, full flow represents the pressurized flow conditions.

Sewer Sizing Summary:

			Existing		Calculated		Used			
Element Name	Peak Flow (cfs)	Cross Section	Rise	Span	Rise	Span	Rise	Span	Area (ft^2)	Comment
MH 13 - Outfall	22.70	CIRCULAR	30.00 in	30.00 in	24.00 in	24.00 in	30.00 in	30.00 in	4.91	
Inlet 12 - MH 13	12.10	CIRCULAR	30.00 in	30.00 in	24.00 in	24.00 in	30.00 in	30.00 in	4.91	
MH 11 - Inlet 12	8.10	CIRCULAR	24.00 in	24.00 in	21.00 in	21.00 in	24.00 in	24.00 in	3.14	
MH 10 - MH 11	5.30	CIRCULAR	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	1.77	
MH 9 - MH 10	4.40	CIRCULAR	18.00 in	18.00 in	15.00 in	15.00 in	18.00 in	18.00 in	1.77	
MH 8 - MH 9	3.90	CIRCULAR	18.00 in	18.00 in	15.00 in	15.00 in	18.00 in	18.00 in	1.77	
MH 5 - MH 8	3.90	CIRCULAR	18.00 in	18.00 in	15.00 in	15.00 in	18.00 in	18.00 in	1.77	
MH 4 - MH 5	2.64	CIRCULAR	14.50 in	14.50 in	12.00 in	12.00 in	14.50 in	14.50 in	1.15	
MH 3 - MH 4	1.40	CIRCULAR	12.00 in	12.00 in	12.00 in	12.00 in	12.00 in	12.00 in	0.79	
Inlet 15 - MH 13	5.70	CIRCULAR	18.00 in	18.00 in	15.00 in	15.00 in	18.00 in	18.00 in	1.77	
MH 16 - Inlet 15	2.00	CIRCULAR	12.00 in	12.00 in	9.00 in	9.00 in	12.00 in	12.00 in	0.79	
MH 13 - MH 19	4.90	CIRCULAR	15.00 in	15.00 in	12.00 in	12.00 in	15.00 in	15.00 in	1.23	
MH 14 - MH 19	4.90	CIRCULAR	15.00 in	15.00 in	12.00 in	12.00 in	15.00 in	15.00 in	1.23	

- Calculated diameter was determined by sewer hydraulic capacity rounded up to the nearest commercially available size.
- Sewer sizes should not decrease downstream.
- All hydraulics where calculated using the 'Used' parameters.

Grade Line Summary:

Tailwater Elevation (ft): 6209.37

Element Name	Invert Elev. Downstream (ft)	Invert Elev. Upstream (ft)	Downstream Manhole Losses Bend Loss (ft)	Downstream Manhole Losses Lateral Loss (ft)	HGL Downstream (ft)	HGL Upstream (ft)	EGL Downstream (ft)	EGL Friction Loss (ft)	EGL Upstream (ft)
MH 13 - Outfall	6207.75	6207.84	0.00	0.00	6209.37	6209.80	6210.27	0.00	6210.27
Inlet 12 - MH 13	6208.14	6208.66	0.12	0.00	6210.28	6210.28	6210.39	0.09	6210.48
MH 11 - Inlet 12	6208.96	6209.72	0.02	0.00	6210.30	6210.73	6210.50	0.63	6211.13
MH 10 - MH 11	6210.22	6210.82	0.01	0.00	6211.11	6211.80	6211.48	0.61	6212.09
MH 9 - MH 10	6210.92	6212.02	0.05	0.00	6211.97	6212.82	6212.14	1.01	6213.15
MH 8 - MH 9	6212.12	6212.67	0.03	0.00	6212.85	6213.43	6213.18	0.54	6213.72
MH 5 - MH 8	6212.77	6214.76	0.03	0.00	6213.47	6215.52	6213.83	1.98	6215.81
MH 4 - MH 5	6215.01	6215.79	0.00	0.00	6215.64	6216.45	6215.94	0.77	6216.71
MH 3 - MH 4	6216.04	6216.58	0.00	0.00	6216.53	6217.08	6216.74	0.53	6217.28
Inlet 15 - MH 13	6208.80	6211.33	0.21	0.00	6210.32	6212.25	6210.48	2.16	6212.64
MH 16 - Inlet 15	6211.96	6214.17	0.13	0.00	6212.43	6214.77	6212.91	2.12	6215.03
MH 13 - MH 19	6209.09	6211.72	0.01	0.00	6209.81	6212.62	6211.82	1.22	6213.04
MH 14 - MH 19	6211.82	6214.61	0.01	0.00	6212.63	6215.51	6213.72	2.21	6215.93

- Bend and Lateral losses only apply when there is an outgoing sewer. The system outfall, sewer #0, is not considered a sewer.
- Bend loss = Bend K * V_fi ^ 2/(2*g)
- Lateral loss = V_fo ^ 2/(2*g)- Junction Loss K * V_fi ^ 2/(2*g).
- Friction loss is always Upstream EGL - Downstream EGL.

Excavation Estimate:

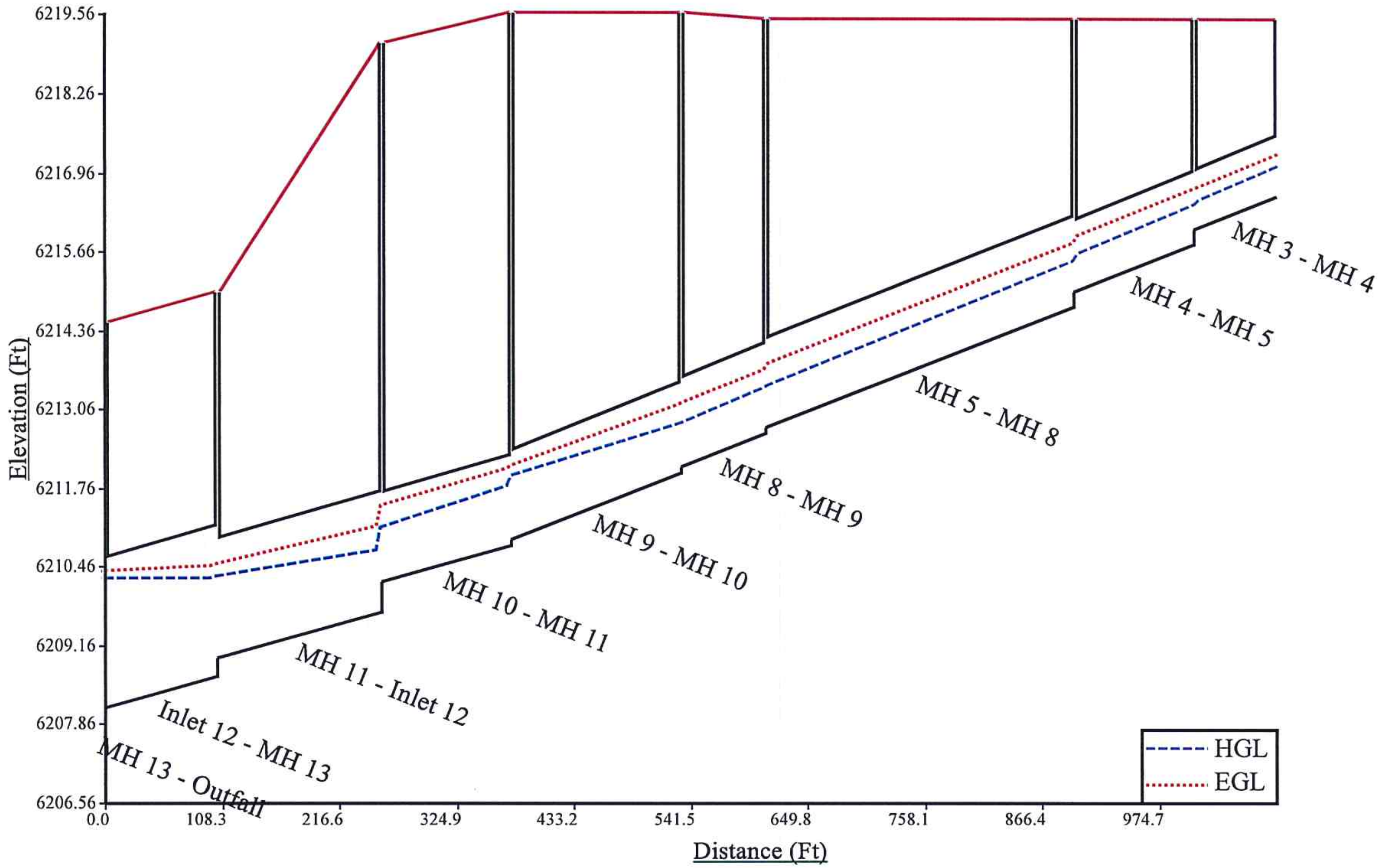
The trench side slope is 1.0 ft/ft
The minimum trench width is 2.00 ft

Element Name	Length (ft)	Wall (in)	Bedding (in)	Bottom Width (ft)	Downstream Top Width (ft)	Downstream Trench Depth (ft)	Downstream Cover (ft)	Upstream Top Width (ft)	Upstream Trench Depth (ft)	Upstream Cover (ft)	Volume (cu. yd)	Comment
MH 13 - Outfall	8.31	3.50	6.00	6.08	0.00	4.04	0.46	11.82	7.45	3.87	11.60	Sewer Too Shallow
Inlet 12 - MH 13	103.55	3.50	6.00	6.08	11.22	7.15	3.57	11.18	7.13	3.55	191.67	
MH 11 - Inlet 12	151.80	3.00	4.00	5.50	11.08	6.62	3.79	17.76	9.96	7.13	383.93	
MH 10 - MH 11	119.53	2.50	4.00	4.92	17.26	9.42	7.17	17.06	9.32	7.07	369.81	
MH 9 - MH 10	157.53	2.50	4.00	4.92	16.87	9.22	6.97	14.66	8.12	5.87	422.15	
MH 8 - MH 9	78.27	2.50	4.00	4.92	14.46	8.02	5.77	13.16	7.37	5.12	167.28	
MH 5 - MH 8	284.54	2.50	4.00	4.92	12.96	7.27	5.02	8.98	5.28	3.03	432.32	
MH 4 - MH 5	110.88	2.21	4.00	4.58	8.76	5.00	3.09	7.21	4.23	2.32	99.31	
MH 3 - MH 4	76.43	2.00	4.00	4.33	6.91	3.96	2.29	5.84	3.42	1.75	48.39	
Inlet 15 - MH 13	126.68	2.50	4.00	4.92	10.91	6.25	4.00	6.62	4.10	1.85	142.09	
MH 16 - Inlet 15	137.99	2.00	4.00	4.33	5.86	3.43	1.76	5.06	3.03	1.36	73.33	
MH 13 - MH 19	37.12	2.25	4.00	4.63	10.57	5.93	3.97	8.11	4.70	2.74	41.96	
MH 14 - MH 19	81.11	2.25	4.00	4.63	7.91	4.60	2.64	5.83	3.56	1.60	61.30	

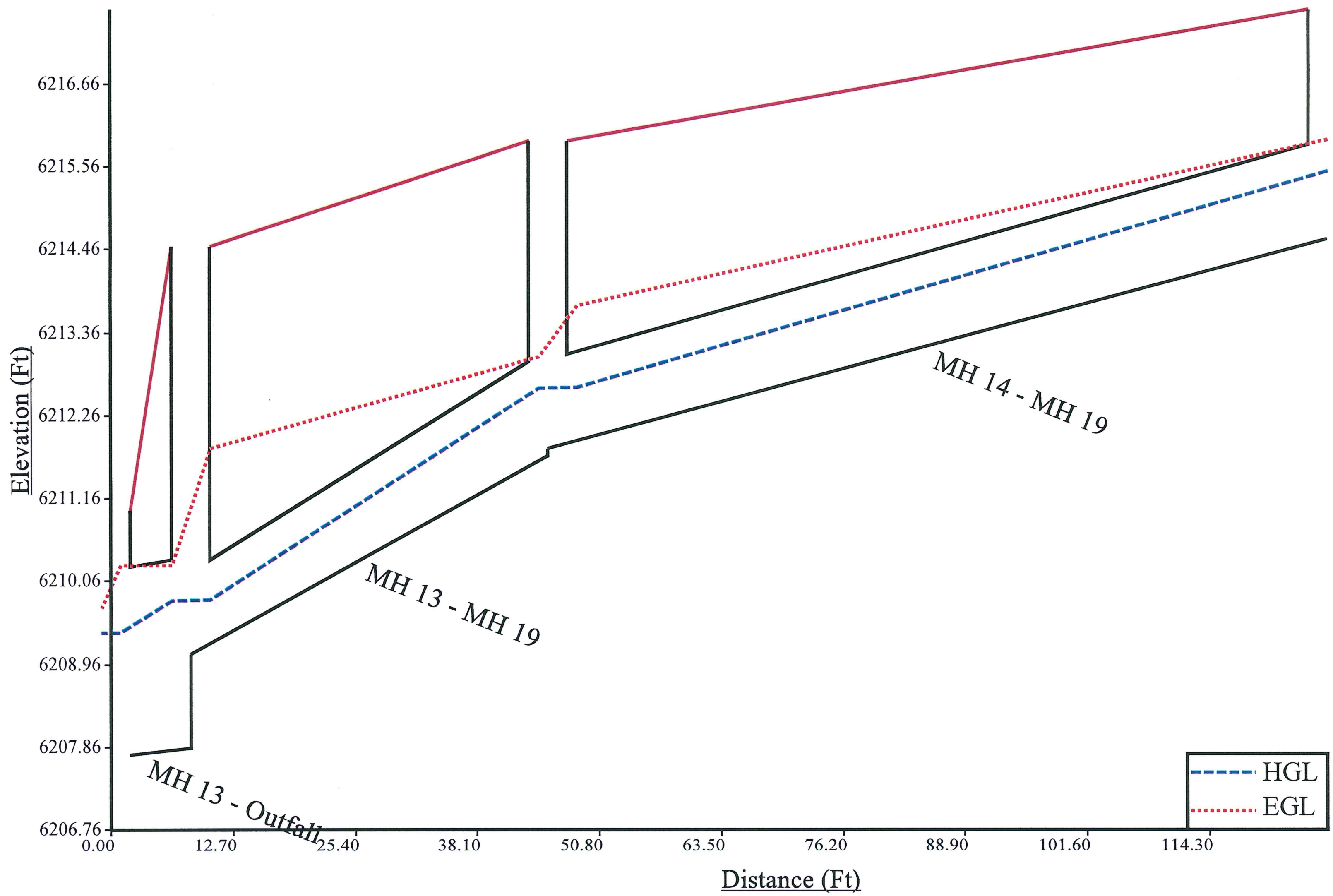
Total earth volume for sewer trenches = 2445 cubic yards.

- The trench was estimated to have a bottom width equal to the outer pipe diameter plus 36 inches.
- If the calculated width of the trench bottom is less than the minimum acceptable width, the minimum acceptable width was used.
- The sewer wall thickness is equal to: (equivalent diameter in inches/12)+1 inches
- The sewer bedding thickness is equal to:
  - Four inches for pipes less than 33 inches.
  - Six inches for pipes less than 60 inches.
  - Eight inches for all larger sizes.

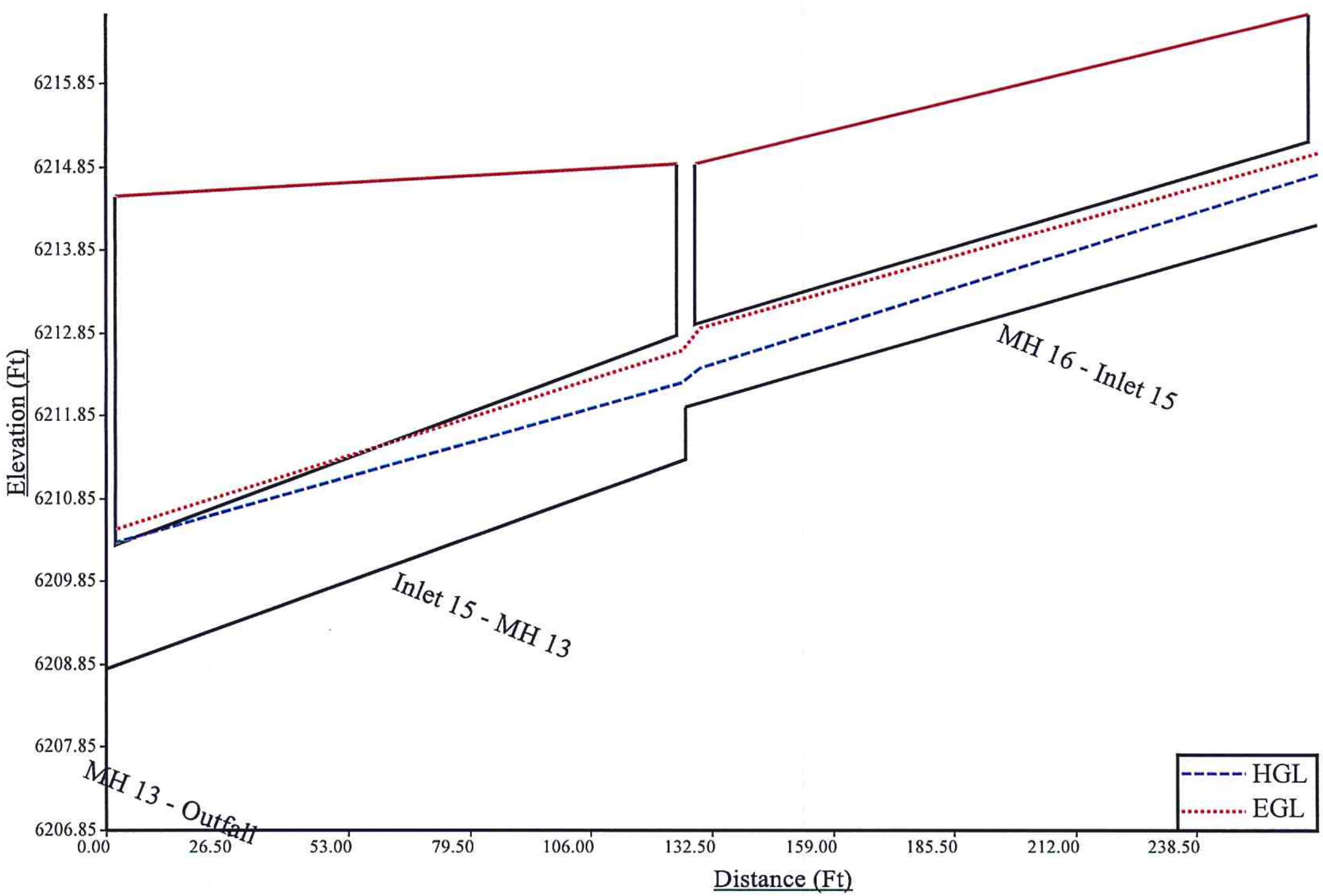
MH 13 - Mh 3 (5-Year Design Flows)



Outfall - MH 14 (5-Year Design Flows)



MH 13 - Mh 16 (5-Year Design Flows)



System Description

Title: Lot 1 Broadmoor Campus Filing No. 2

Description: 100-Year Design Flows

General System Parameters

Minimum Buried Depth (ft): 1.20

Minimum Pipe Size (in): 6.00

Maximum Sewer Velocity (fps): 18.0

Minimum Sewer Velocity (fps): 1.6

Maximum Flow Depth to Sewer Size Ratio (x:1): 1.00

Minimum Trench Width (ft): 2.00

Trench Side Slope (1V:zH): 1.0

Maximum Rural Overland Flow Length (ft): 0

Maximum Urban Overland Flow Length (ft): 100

Urban Flow Factor: 0.82

Rainfall Parameters

Rainfall calculation Method: Formula

Rainfall Return Period (years): 100

Total Rainfall Depth: 2.52

Emperical Consatnts:

A: 28.5

B: 10

C: 0.786

Total Number of Manholes: 14

Manhole Network Data

ID	Output	Input 1	Input 2	Input 3	Input 4
15	15	16	0	0	0
0	0	13	0	0	0
13	13	12	19	15	0
12	12	11	0	0	0
4	4	3	0	0	0
16	16	0	0	0	0
19	19	14	0	0	0
9	9	8	0	0	0
3	3	0	0	0	0
11	11	10	0	0	0
8	8	5	0	0	0
14	14	0	0	0	0
5	5	4	0	0	0
10	10	9	0	0	0

Manhole Flow Data

ID	Elevation	Known Flow	Local Flow	Drain Area	Runoff Cof	5yr Coeff.
15	6214.89	10.30	0.00	0.000	0.00	0.00
0	6210.25	0.00	0.00	0.000	0.00	0.00
13	6214.50	42.10	0.00	0.000	0.00	0.00
12	6215.00	22.70	0.00	0.000	0.00	0.00

4	6219.50	3.40	0.00	0.000	0.00	0.00
16	6216.70	3.70	0.00	0.000	0.00	0.00
19	6215.90	9.10	0.00	0.000	0.00	0.00
9	6219.60	8.40	0.00	0.000	0.00	0.00
3	6219.50	2.60	0.00	0.000	0.00	0.00
11	6219.10	15.30	0.00	0.000	0.00	0.00
8	6219.60	7.40	0.00	0.000	0.00	0.00
14	6217.65	9.10	0.00	0.000	0.00	0.00
5	6219.50	7.40	0.00	0.000	0.00	0.00
10	6219.60	10.10	0.00	0.000	0.00	0.00

Manhole Sub Basin Data

ID	Ol. Length	Ol. Slope	Gutter Lngth	Gutter Vel.
15	0	0.0	0	0.00
0	0	0.0	0	0.00
13	0	0.0	0	0.00
12	0	0.0	0	0.00
4	0	0.0	0	0.00
16	0	0.0	0	0.00
19	0	0.0	0	0.00
9	0	0.0	0	0.00
3	0	0.0	0	0.00
11	0	0.0	0	0.00
8	0	0.0	0	0.00
14	0	0.0	0	0.00
5	0	0.0	0	0.00
10	0	0.0	0	0.00

Total Number of Sewers
13

Sewer Design Data

ID	Length	Slope	Upper Elev	Mannings N	Bend Loss	Lat. Loss
15	126.69	2.0	6211.33	0.013	1.32	0.00
13	8.31	1.1	6207.84	0.013	0.03	0.00
12	103.55	0.5	6208.66	0.013	1.32	0.00
4	110.88	0.7	6215.79	0.013	0.05	0.00
16	137.99	1.6	6214.17	0.013	1.27	0.00
19	37.12	7.1	6211.72	0.013	0.05	0.00
9	157.53	0.7	6212.02	0.013	0.52	0.00

3	76.43	0.7	6216.58	0.013	0.05	0.00
11	151.80	0.5	6209.72	0.013	0.22	0.00
8	78.27	0.7	6212.67	0.013	0.37	0.00
14	81.11	3.4	6214.61	0.013	0.05	0.00
5	284.54	0.7	6214.76	0.013	0.37	0.00
10	119.53	0.5	6210.82	0.013	0.05	0.00

Sewer Geometry

ID	Shape	Dia. or Height	Span or Width
15	Round	18.00	18.00
13	Round	30.00	30.00
12	Round	30.00	30.00
4	Round	15.00	15.00
16	Round	12.00	12.00
19	Round	15.00	15.00
9	Round	18.00	18.00
3	Round	12.00	12.00
11	Round	24.00	24.00
8	Round	18.00	18.00
14	Round	15.00	15.00
5	Round	18.00	18.00
10	Round	18.00	18.00

UDSewer Results Summary

Project Title: Lot 1 Broadmoor Campus Filing No. 2
Project Description: 100-Year Design Flows

System Input Summary

Rainfall Parameters

Rainfall Return Period: 100
Rainfall Calculation Method: Formula

One Hour Depth (in): 2.52
Rainfall Constant "A": 28.5
Rainfall Constant "B": 10
Rainfall Constant "C": 0.786

Rational Method Constraints

Minimum Urban Runoff Coeff.: 0.82
Maximum Rural Overland Len. (ft): 0
Maximum Urban Overland Len. (ft): 100
Used UDFCD Tc. Maximum: No

Sizer Constraints

Minimum Sewer Size (in): 6.00
Maximum Depth to Rise Ratio: 1.00
Maximum Flow Velocity (fps): 18.0
Minimum Flow Velocity (fps): 1.6

Backwater Calculations:

Tailwater Elevation (ft): 6209.92

Manhole Input Summary:

		Given Flow		Sub Basin Information						
Element Name	**Ground Elevation (ft)**	**Total Known Flow (cfs)**	**Local Contribution (cfs)**	**Drainage Area (Ac.)**	**Runoff Coefficient**	**5yr Coefficient**	**Overland Length (ft)**	**Overland Slope (%)**	**Gutter Length (ft)**	**Gutter Velocity (fps)**
OUTFALL 1	6210.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MH 13 - Outfall	6214.50	42.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Inlet 12 - MH 13	6215.00	22.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MH 11 - Inlet 12	6219.10	15.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MH 10 - MH 11	6219.60	10.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MH 9 - MH 10	6219.60	8.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MH 8 - MH 9	6219.60	7.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MH 5 - MH 8	6219.50	7.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MH 4 - MH 5	6219.50	3.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MH 3 - MH 4	6219.50	2.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MH 13 - MH 19	6215.90	9.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MH 14 - MH 19	6217.65	9.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Inlet 15 - MH 13	6214.89	10.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MH 16 - Inlet 15	6216.70	3.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Manhole Output Summary:

	Local Contribution					Total Design Flow				
Element Name	**Overland Time (min)**	**Gutter Time (min)**	**Basin Tc (min)**	**Intensity (in/hr)**	**Local Contrib (cfs)**	**Coeff. Area**	**Intensity (in/hr)**	**Manhole Tc (min)**	**Peak Flow (cfs)**	**Comment**
OUTFALL 1	0.00	0.00	0.00	0.00	0.00	3.59	11.74	0.02	42.10	
MH 13 - Outfall	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	42.10	
Inlet 12 - MH 13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	22.70	
MH 11 - Inlet 12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.30	
MH 10 - MH 11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.10	
MH 9 - MH 10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.40	
MH 8 - MH 9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.40	
MH 5 - MH 8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.40	
MH 4 - MH 5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.40	
MH 3 - MH 4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.60	
MH 13 - MH 19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.10	
MH 14 - MH 19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.10	
Inlet 15 - MH 13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.30	
MH 16 - Inlet 15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.70	

Sewer Input Summary:

		Elevation			Loss Coefficients			Given Dimensions		
Element Name	Sewer Length (ft)	Downstream Invert (ft)	Slope (%)	Upstream Invert (ft)	Mannings n	Bend Loss	Lateral Loss	Cross Section	Rise (ft or in)	Span (ft or in)
MH 13 - Outfall	8.31	6207.75	1.1	6207.84	0.013	0.03	0.00	CIRCULAR	30.00 in	30.00 in
Inlet 12 - MH 13	103.55	6208.14	0.5	6208.66	0.013	1.32	0.00	CIRCULAR	30.00 in	30.00 in
MH 11 - Inlet 12	151.80	6208.96	0.5	6209.72	0.013	0.22	0.00	CIRCULAR	24.00 in	24.00 in
MH 10 - MH 11	119.53	6210.22	0.5	6210.82	0.013	0.05	0.00	CIRCULAR	18.00 in	18.00 in
MH 9 - MH 10	157.53	6210.92	0.7	6212.02	0.013	0.52	0.00	CIRCULAR	18.00 in	18.00 in
MH 8 - MH 9	78.27	6212.12	0.7	6212.67	0.013	0.37	0.00	CIRCULAR	18.00 in	18.00 in
MH 5 - MH 8	284.54	6212.77	0.7	6214.76	0.013	0.37	0.00	CIRCULAR	18.00 in	18.00 in
MH 4 - MH 5	110.88	6215.01	0.7	6215.79	0.013	0.05	0.00	CIRCULAR	15.00 in	15.00 in
MH 3 - MH 4	76.43	6216.04	0.7	6216.58	0.013	0.05	0.00	CIRCULAR	12.00 in	12.00 in
MH 13 - MH 19	37.12	6209.09	7.1	6211.72	0.013	0.05	0.00	CIRCULAR	15.00 in	15.00 in
MH 14 - MH 19	81.11	6211.82	3.4	6214.61	0.013	0.05	0.00	CIRCULAR	15.00 in	15.00 in
Inlet 15 - MH 13	126.69	6208.80	2.0	6211.33	0.013	1.32	0.00	CIRCULAR	18.00 in	18.00 in
MH 16 - Inlet 15	137.99	6211.96	1.6	6214.17	0.013	1.27	0.00	CIRCULAR	12.00 in	12.00 in

Sewer Flow Summary:

	Full Flow Capacity		Critical Flow		Normal Flow						
Element Name	Flow (cfs)	Velocity (fps)	Depth (in)	Velocity (fps)	Depth (in)	Velocity (fps)	Froude Number	Flow Condition	Flow (cfs)	Surcharged Length (ft)	Comment
MH 13 - Outfall	43.13	8.79	26.07	9.30	23.96	10.01	1.22	Supercritical	42.10	0.00	
Inlet 12 - MH 13	29.08	5.92	19.45	6.74	19.94	6.55	0.95	Pressurized	22.70	103.55	
MH 11 - Inlet 12	16.04	5.11	16.92	6.46	18.75	5.81	0.81	Pressurized	15.30	151.80	
MH 10 - MH 11	7.45	4.21	18.00	5.72	18.00	5.72	0.00	Pressurized	10.10	119.53	
MH 9 - MH 10	8.81	4.99	13.47	5.92	14.05	5.68	0.92	Pressurized	8.40	157.53	
MH 8 - MH 9	8.81	4.99	12.64	5.58	12.63	5.59	1.00	Pressurized	7.40	78.27	
MH 5 - MH 8	8.81	4.99	12.64	5.58	12.63	5.59	1.00	Pressurized	7.40	284.54	
MH 4 - MH 5	5.42	4.42	8.92	4.47	8.61	4.66	1.07	Pressurized	3.40	110.88	
MH 3 - MH 4	2.99	3.81	8.29	4.49	8.66	4.29	0.92	Pressurized	2.60	76.43	
MH 13 - MH 19	17.24	14.05	13.91	7.67	7.74	14.24	3.51	Supercritical	9.10	0.00	
MH 14 - MH 19	12.01	9.79	13.91	7.67	9.76	10.76	2.25	Supercritical	9.10	0.00	
Inlet 15 - MH 13	14.90	8.43	14.82	6.62	11.01	9.10	1.82	Supercritical Jump	10.30	117.53	
MH 16 - Inlet 15	4.52	5.75	9.83	5.37	8.26	6.42	1.43	Supercritical Jump	3.70	71.27	

- A Froude number of 0 indicates that pressured flow occurs (adverse slope or undersized pipe).
- If the sewer is not pressurized, full flow represents the maximum gravity flow in the sewer.
- If the sewer is pressurized, full flow represents the pressurized flow conditions.

Sewer Sizing Summary:

			Existing		Calculated		Used			
Element Name	Peak Flow (cfs)	Cross Section	Rise	Span	Rise	Span	Rise	Span	Area (ft^2)	Comment
MH 13 - Outfall	42.10	CIRCULAR	30.00 in	30.00 in	30.00 in	30.00 in	30.00 in	30.00 in	4.91	
Inlet 12 - MH 13	22.70	CIRCULAR	30.00 in	30.00 in	30.00 in	30.00 in	30.00 in	30.00 in	4.91	
MH 11 - Inlet 12	15.30	CIRCULAR	24.00 in	24.00 in	24.00 in	24.00 in	24.00 in	24.00 in	3.14	
MH 10 - MH 11	10.10	CIRCULAR	18.00 in	18.00 in	21.00 in	21.00 in	18.00 in	18.00 in	1.77	Existing height is smaller than the suggested height. Existing width is smaller than the suggested width.
MH 9 - MH 10	8.40	CIRCULAR	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	1.77	
MH 8 - MH 9	7.40	CIRCULAR	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	1.77	
MH 5 - MH 8	7.40	CIRCULAR	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	1.77	
MH 4 - MH 5	3.40	CIRCULAR	15.00 in	15.00 in	15.00 in	15.00 in	15.00 in	15.00 in	1.23	
MH 3 - MH 4	2.60	CIRCULAR	12.00 in	12.00 in	12.00 in	12.00 in	12.00 in	12.00 in	0.79	
MH 13 - MH 19	9.10	CIRCULAR	15.00 in	15.00 in	12.00 in	12.00 in	15.00 in	15.00 in	1.23	
MH 14 - MH 19	9.10	CIRCULAR	15.00 in	15.00 in	15.00 in	15.00 in	15.00 in	15.00 in	1.23	
Inlet 15 - MH 13	10.30	CIRCULAR	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	1.77	
MH 16 - Inlet 15	3.70	CIRCULAR	12.00 in	12.00 in	12.00 in	12.00 in	12.00 in	12.00 in	0.79	

- Calculated diameter was determined by sewer hydraulic capacity rounded up to the nearest commercially available size.
- Sewer sizes should not decrease downstream.
- All hydraulics where calculated using the 'Used' parameters.

Grade Line Summary:

Tailwater Elevation (ft): 6209.92

	Invert Elev.		Downstream Manhole Losses		HGL		EGL		
Element Name	**Downstream (ft)**	**Upstream (ft)**	**Bend Loss (ft)**	**Lateral Loss (ft)**	**Downstream (ft)**	**Upstream (ft)**	**Downstream (ft)**	**Friction Loss (ft)**	**Upstream (ft)**
MH 13 - Outfall	6207.75	6207.84	0.00	0.00	6209.92	6210.01	6211.30	0.05	6211.35
Inlet 12 - MH 13	6208.14	6208.66	0.44	0.00	6211.46	6211.78	6211.79	0.32	6212.11
MH 11 - Inlet 12	6208.96	6209.72	0.08	0.00	6211.86	6212.55	6212.22	0.69	6212.92
MH 10 - MH 11	6210.22	6210.82	0.03	0.00	6212.57	6213.67	6213.08	1.10	6214.18
MH 9 - MH 10	6210.92	6212.02	0.18	0.00	6214.01	6215.01	6214.36	1.00	6215.36
MH 8 - MH 9	6212.12	6212.67	0.10	0.00	6215.19	6215.58	6215.46	0.39	6215.85
MH 5 - MH 8	6212.77	6214.76	0.10	0.00	6215.68	6217.08	6215.95	1.40	6217.36
MH 4 - MH 5	6215.01	6215.79	0.01	0.00	6217.24	6217.55	6217.36	0.31	6217.67
MH 3 - MH 4	6216.04	6216.58	0.01	0.00	6217.56	6217.96	6217.73	0.40	6218.13
MH 13 - MH 19	6209.09	6211.72	0.04	0.00	6210.05	6212.88	6212.88	0.91	6213.79
MH 14 - MH 19	6211.82	6214.61	0.04	0.00	6212.92	6215.77	6214.43	2.25	6216.68
Inlet 15 - MH 13	6208.80	6211.33	0.70	0.00	6211.52	6212.56	6212.05	1.19	6213.24
MH 16 - Inlet 15	6211.96	6214.17	0.44	0.00	6213.34	6214.99	6213.68	1.75	6215.44

- Bend and Lateral losses only apply when there is an outgoing sewer. The system outfall, sewer #0, is not considered a sewer.
- Bend loss = Bend K * V_fi ^ 2/(2*g)
- Lateral loss = V_fo ^ 2/(2*g)- Junction Loss K * V_fi ^ 2/(2*g).
- Friction loss is always Upstream EGL - Downstream EGL.

Excavation Estimate:

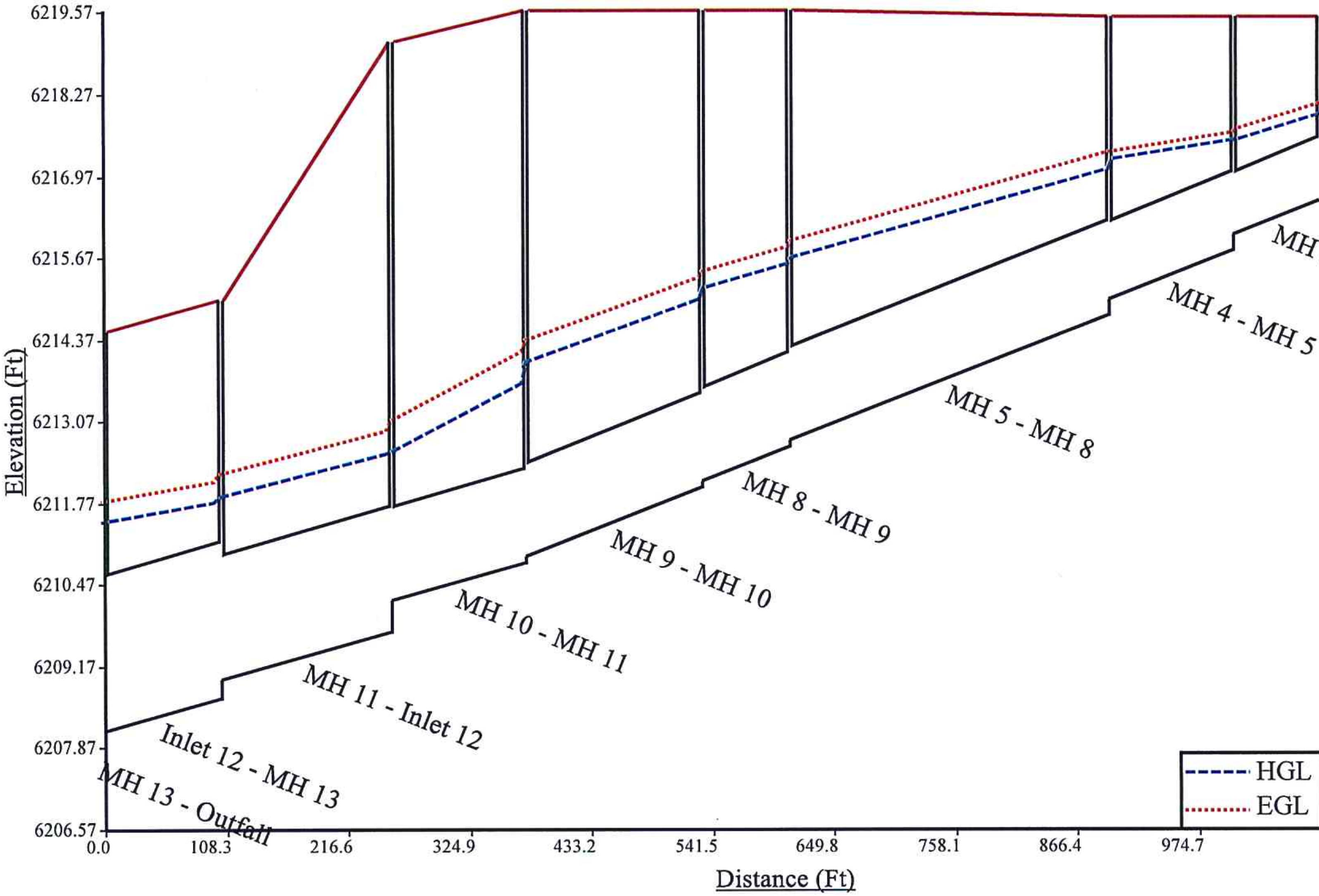
The trench side slope is 1.0 ft/ft
The minimum trench width is 2.00 ft

					Downstream			Upstream				
Element Name	**Length (ft)**	**Wall (in)**	**Bedding (in)**	**Bottom Width (ft)**	**Top Width (ft)**	**Trench Depth (ft)**	**Cover (ft)**	**Top Width (ft)**	**Trench Depth (ft)**	**Cover (ft)**	**Volume (cu. yd)**	**Comment**
MH 13 - Outfall	8.31	3.50	6.00	6.08	0.00	3.29	0.00	11.82	7.45	3.87	11.32	Sewer Too Shallow
Inlet 12 - MH 13	103.55	3.50	6.00	6.08	11.22	7.15	3.57	11.18	7.13	3.55	191.67	
MH 11 - Inlet 12	151.80	3.00	4.00	5.50	11.08	6.62	3.79	17.76	9.96	7.13	383.93	
MH 10 - MH 11	119.53	2.50	4.00	4.92	17.26	9.42	7.17	17.06	9.32	7.07	369.81	
MH 9 - MH 10	157.53	2.50	4.00	4.92	16.87	9.22	6.97	14.66	8.12	5.87	422.15	
MH 8 - MH 9	78.27	2.50	4.00	4.92	14.46	8.02	5.77	13.36	7.47	5.22	169.20	
MH 5 - MH 8	284.54	2.50	4.00	4.92	13.16	7.37	5.12	8.98	5.28	3.03	439.20	
MH 4 - MH 5	110.88	2.25	4.00	4.63	8.72	5.01	3.05	7.17	4.23	2.27	99.67	
MH 3 - MH 4	76.43	2.00	4.00	4.33	6.91	3.96	2.29	5.84	3.42	1.75	48.39	
MH 13 - MH 19	37.12	2.25	4.00	4.63	10.57	5.93	3.97	8.11	4.70	2.74	41.96	
MH 14 - MH 19	81.11	2.25	4.00	4.63	7.91	4.60	2.64	5.83	3.56	1.60	61.30	
Inlet 15 - MH 13	126.69	2.50	4.00	4.92	10.91	6.25	4.00	6.62	4.10	1.85	142.11	
MH 16 - Inlet 15	137.99	2.00	4.00	4.33	5.86	3.43	1.76	5.06	3.03	1.36	73.33	

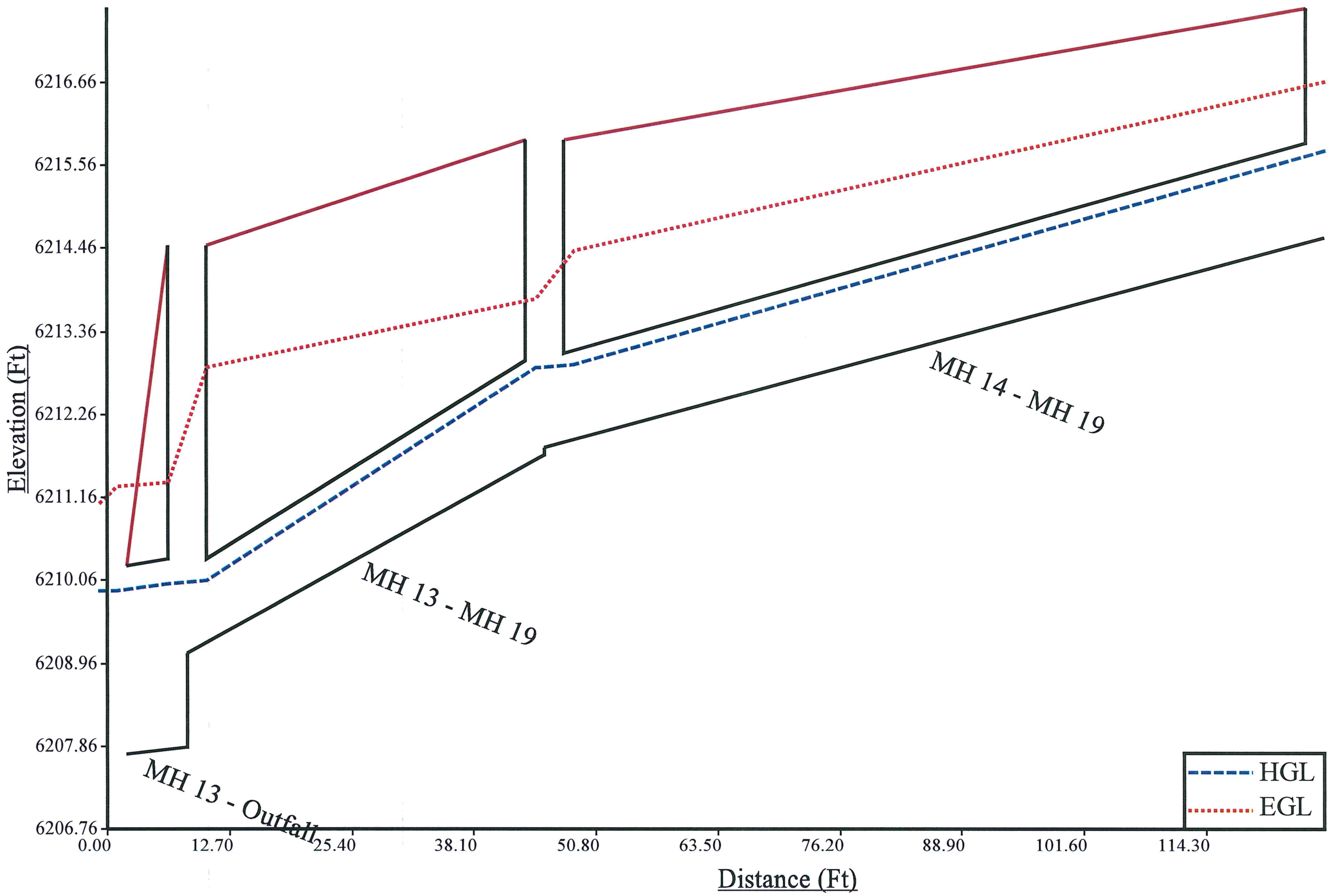
Total earth volume for sewer trenches = 2454 cubic yards.

- The trench was estimated to have a bottom width equal to the outer pipe diameter plus 36 inches.
- If the calculated width of the trench bottom is less than the minimum acceptable width, the minimum acceptable width was used.
- The sewer wall thickness is equal to: (equivalent diameter in inches/12)+1 inches
- The sewer bedding thickness is equal to:
  - Four inches for pipes less than 33 inches.
  - Six inches for pipes less than 60 inches.
  - Eight inches for all larger sizes.

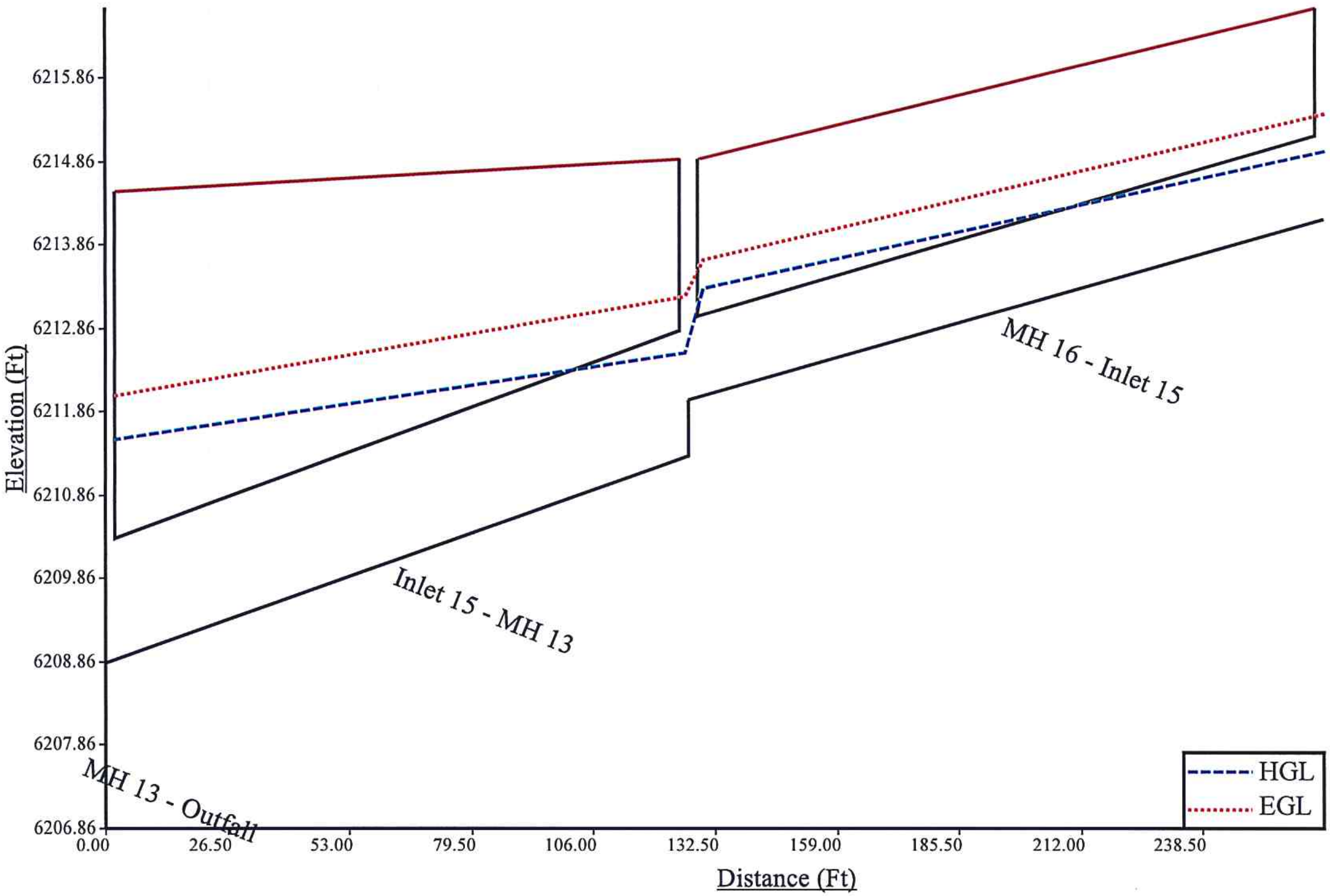
MH 13 - MH 3 (100-Year Design Flows)

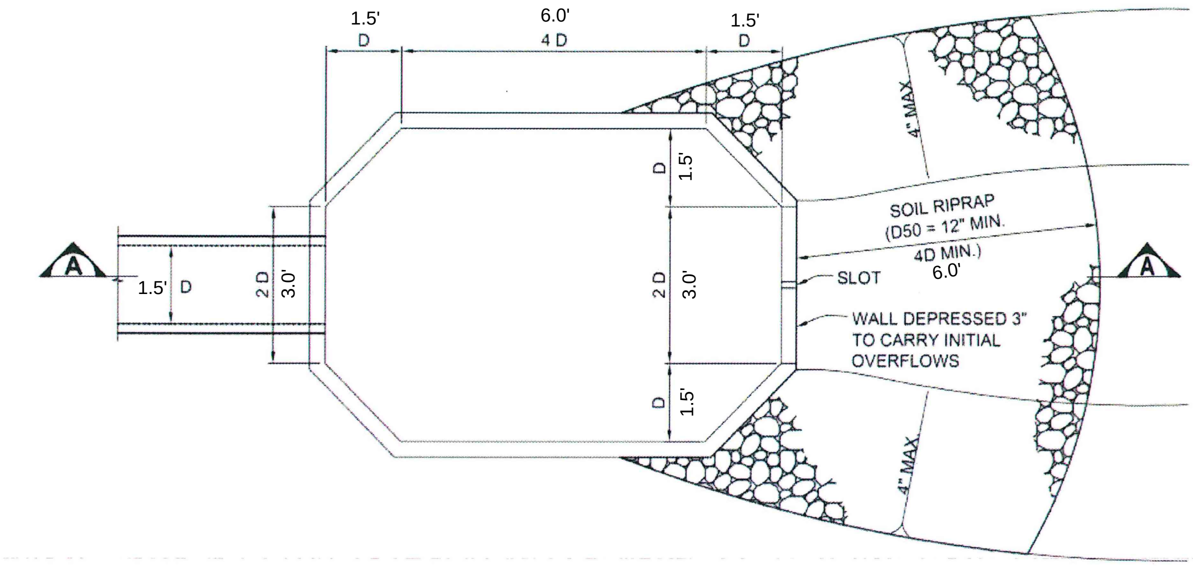


Outfall - MH 14 (100-Year Design Flows)

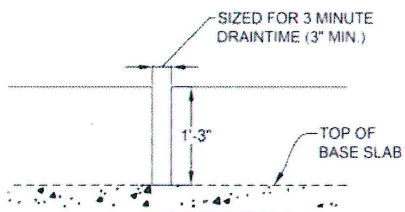


MH 13 - MH 16 (100-Year Design Flows)





PLAN



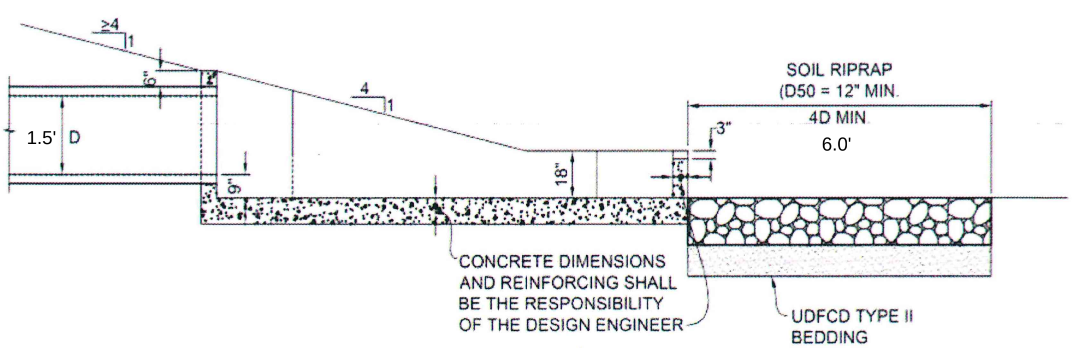
SLOT DETAIL

Volume to drain in 3 minutes = 61.88 cu.ft.

Q = 61.88 cu.ft. / 180 sec. = 0.344 cfs

Length of notch (3" min.) = 0.344 cfs / ($3 \times 1.25^{1.5}$) = 0.082 ft. = 63/64 in.

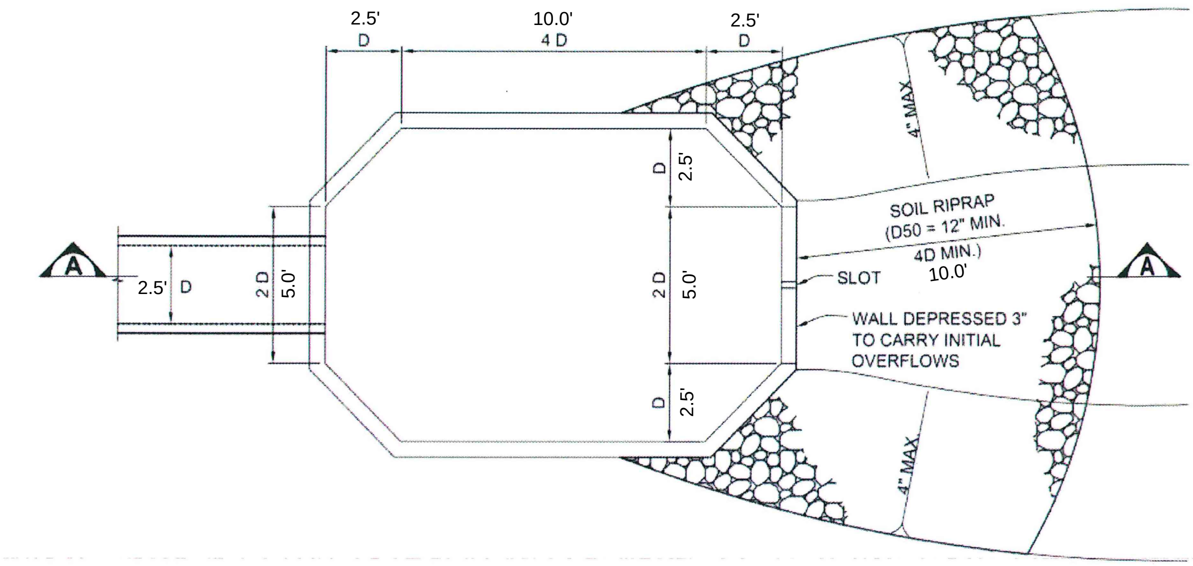
Use 3" for Length of Notch



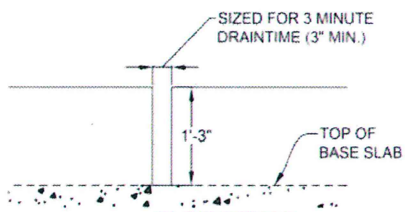
SECTION A

EAST FOREBAY

NTS



PLAN



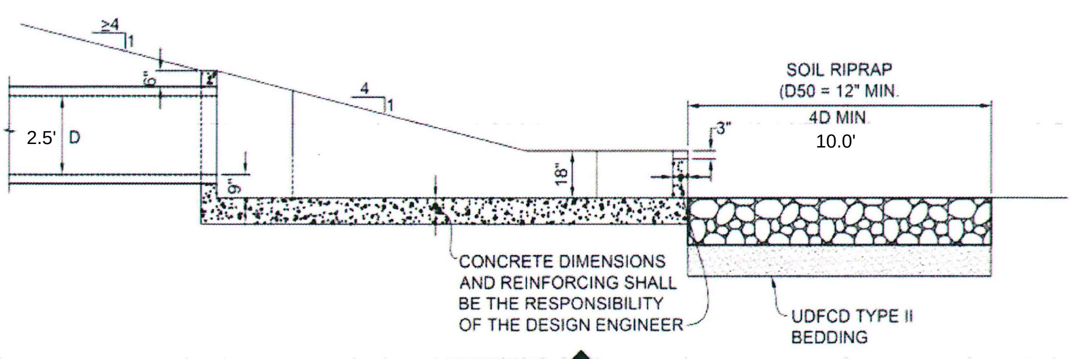
SLOT DETAIL

Volume to drain in 3 minutes = 171.88 cu.ft.

Q = 171.88 cu.ft. / 180 sec. = 0.955 cfs

Length of notch (3" min.) = 0.955 cfs / ($3 \times 1.25^{1.5}$) = 0.228 ft. = 2-47/64 in.

Use 3" for Length of Notch



SECTION A

SOUTH FOREBAY

NTS

Worksheet Protected

Site-Level Low Impact Development (LID) Design Effective Impervious Calculator

LID Credit by Impervious Reduction Factor (IRF) Method

UD-BMP (Version 3.06, November 2016)

User Input

Calculated cells

***Design Storm: 1-Hour Rain Depth	WQCV Event	0.60	inches
***Minor Storm: 1-Hour Rain Depth	10-Year Event	1.75	inches
***Major Storm: 1-Hour Rain Depth	100-Year Event	2.52	inches
Optional User Defined Storm	CUHP		
(CUHP) NOAA 1 Hour Rainfall Depth and Frequency for User Defined Storm	100-Year Event		
Max Intensity for Optional User Defined Storm	0		

Designer: NRK
Company: Kiowa Engineering
Date: March 13, 2019
Project: Lot 1 Broadmoor Campus Filing No. 2
Location: Broadmoor Hotel Hall

SITE INFORMATION (USER-INPUT)

Sub-basin Identifier	**A-1**	**A-2**	**A-3**	**A-4**	**A-5**	**A-6**	**A-7**	**A-8**	**A-9**	**A-10**	**A-11**			
Receiving Pervious Area Soil Type	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam			
Total Area (ac., Sum of DCIA, UIA, RPA, & SPA)	1.420	0.700	0.960	0.520	0.810	0.090	1.220	0.430	0.690	0.630	0.750			
Directly Connected Impervious Area (DCIA, acres)	1.250	0.000	0.860	0.000	0.790	0.090	0.980	0.430	0.690	0.630	0.750			
Unconnected Impervious Area (UIA, acres)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000			
Receiving Pervious Area (RPA, acres)	0.000	0.700	0.000	0.520	0.000	0.000	0.000	0.000	0.000	0.000	0.000			
Separate Pervious Area (SPA, acres)	0.170	0.000	0.100	0.000	0.020	0.000	0.240	0.000	0.000	0.000	0.000			
RPA Treatment Type: Conveyance (C), Volume (V), or Permeable Pavement (PP)	V	C	V	C	V	V	V	V	V	V	V			

CALCULATED RESULTS (OUTPUT)

Total Calculated Area (ac, check against input)	1.420	0.700	0.960	0.520	0.810	0.090	1.220	0.430	0.690	0.630	0.750			
Directly Connected Impervious Area (DCIA, %)	88.0%	0.0%	89.6%	0.0%	97.5%	100.0%	80.3%	100.0%	100.0%	100.0%	100.0%			
Unconnected Impervious Area (UIA, %)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%			
Receiving Pervious Area (RPA, %)	0.0%	100.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%			
Separate Pervious Area (SPA, %)	12.0%	0.0%	10.4%	0.0%	2.5%	0.0%	19.7%	0.0%	0.0%	0.0%	0.0%			
A_R (RPA / UIA)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000			
I_a Check	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000			
f / I for WQCV Event:	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7			
f / I for 10-Year Event:	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5			
f / I for 100-Year Event:	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3			
f / I for Optional User Defined Storm CUHP:														
IRF for WQCV Event:	0.00	1.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			
IRF for 10-Year Event:	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
IRF for 100-Year Event:	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
IRF for Optional User Defined Storm CUHP:														
Total Site Imperviousness: I_{total}	88.0%	0.0%	89.6%	0.0%	97.5%	100.0%	80.3%	100.0%	100.0%	100.0%	100.0%			
Effective Imperviousness for WQCV Event:	88.0%	0.0%	89.6%	0.0%	97.5%	100.0%	80.3%	100.0%	100.0%	100.0%	100.0%			
Effective Imperviousness for 10-Year Event:	88.0%	0.0%	89.6%	0.0%	97.5%	100.0%	80.3%	100.0%	100.0%	100.0%	100.0%			
Effective Imperviousness for 100-Year Event:	88.0%	0.0%	89.6%	0.0%	97.5%	100.0%	80.3%	100.0%	100.0%	100.0%	100.0%			
Effective Imperviousness for Optional User Defined Storm CUHP:														

LID / EFFECTIVE IMPERVIOUSNESS CREDITS

WQCV Event CREDIT: Reduce Detention By:	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
10-Year Event CREDIT**: Reduce Detention By:	0.0%	N/A	0.0%	N/A	0.0%	0.4%	0.0%	0.1%	0.1%	0.1%	0.0%	N/A	N/A	N/A
100-Year Event CREDIT**: Reduce Detention By:	0.0%	N/A	0.0%	N/A	0.0%	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	N/A	N/A	N/A
User Defined CUHP CREDIT: Reduce Detention By:														

Total Site Imperviousness:	**78.7%**
Total Site Effective Imperviousness for WQCV Event:	**78.7%**
Total Site Effective Imperviousness for 10-Year Event:	**78.7%**
Total Site Effective Imperviousness for 100-Year Event:	**78.7%**
Total Site Effective Imperviousness for Optional User Defined Storm CUHP:	

Notes:

* Use Green-Ampt average infiltration rate values from Table 3-3.

** Flood control detention volume credits based on empirical equations from Storage Chapter of USDCM.

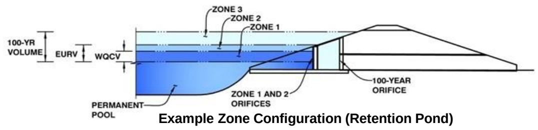
*** Method assumes that 1-hour rainfall depth is equivalent to 1-hour intensity for calculation purposed

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: Lot 1 Broadmoor Campus Filing No. 2 (Broadmoor Exhibit Hall)

Basin ID: Proposed Private Full Spectrum Extended Detention Basin



Example Zone Configuration (Retention Pond)

Required Volume Calculation

			Optional User Override 1-hr Precipitation	
Selected BMP Type =	**EDB**			
Watershed Area =	7.52	acres		
Watershed Length =	570	ft		
Watershed Slope =	0.011	ft/ft		
Watershed Imperviousness =	78.70%	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		
Desired WQCV Drain Time =	40.0	hours		
Location for 1-hr Rainfall Depths =	User Input			
Water Quality Capture Volume (WQCV) =	0.201	acre-feet		
Excess Urban Runoff Volume (EURV) =	0.656	acre-feet		
2-yr Runoff Volume (P1 = 1.19 in.) =	0.553	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.728	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.905	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	1.107	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	1.261	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	1.463	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.2 in.) =	1.933	acre-feet	3.20	inches
Approximate 2-yr Detention Volume =	0.519	acre-feet		
Approximate 5-yr Detention Volume =	0.685	acre-feet		
Approximate 10-yr Detention Volume =	0.852	acre-feet		
Approximate 25-yr Detention Volume =	0.913	acre-feet		
Approximate 50-yr Detention Volume =	0.949	acre-feet		
Approximate 100-yr Detention Volume =	1.001	acre-feet		

Stage-Storage Calculation

Zone 1 Volume (WQCV) =	0.201	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.455	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.345	acre-feet
Total Detention Basin Volume =	1.001	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	**user**	acre-feet

Depth Increment = 1 ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	75	0.002		
6207	--	1.00	--	--	--	2,390	0.055	1,209	0.028
6208	--	2.00	--	--	--	3,574	0.082	4,179	0.096
6209	--	3.00	--	--	--	4,771	0.110	8,387	0.193
6210	--	4.00	--	--	--	6,290	0.144	13,917	0.320
6211	--	5.00	--	--	--	7,774	0.178	20,949	0.481
6212	--	6.00	--	--	--	9,538	0.219	29,605	0.680
6213	--	7.00	--	--	--	11,474	0.263	40,111	0.921
6213.5	--	7.50	--	--	--	12,515	0.287	46,109	1.059
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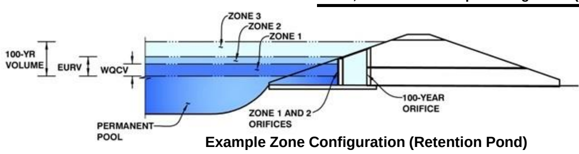
Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: Tuscany Plaza

Basin ID: Lot 1, Broadmoor Campus Filing No. 2 (Broadmoor Exhibit Hall)



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	3.08	0.201	Orifice Plate
Zone 2 (EURV)	5.90	0.455	Orifice Plate
Zone 3 (100-year)	7.30	0.345	Weir&Pipe (Restrict)
		1.001	Total

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 Diameter =	N/A	inches

Calculated Parameters for Underdrain

Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Centroid =	N/A	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)

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	5.99	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	23.96	inches
Orifice Plate: Orifice Area per Row =	N/A	inches

Calculated Parameters for Plate

WQ Orifice Area per Row =	N/A	ft^2
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
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	2.00	4.00					
Orifice Area (sq. inches)	1.17	1.17	1.23					

	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)

	Not Selected	Not Selected	
Invert of Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =	N/A	N/A	inches

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected	
Vertical Orifice Area =	N/A	N/A	ft^2
Vertical Orifice Centroid =	N/A	N/A	feet

User Input: Overflow Weir (Dropbox) and Grate (Flat or Sloped)

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	6.00	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	4.00	N/A	feet
Overflow Weir Slope =	4.00	N/A	H:V (enter zero for flat grate)
Horiz. Length of Weir Sides =	5.67	N/A	feet
Overflow Grate Open Area % =	70%	N/A	%, grate open area/total area
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	7.42	N/A	feet
Over Flow Weir Slope Length =	5.84	N/A	feet
Grate Open Area / 100-yr Orifice Area =	21.54	N/A	should be ≥ 4
Overflow Grate Open Area w/o Debris =	16.36	N/A	ft^2
Overflow Grate Open Area w/ Debris =	8.18	N/A	ft^2

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

	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.35	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	24.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	6.98		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	0.76	N/A	ft^2
Outlet Orifice Centroid =	0.34	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	1.14	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	7.50	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	10.00	feet
Spillway End Slopes =	3.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

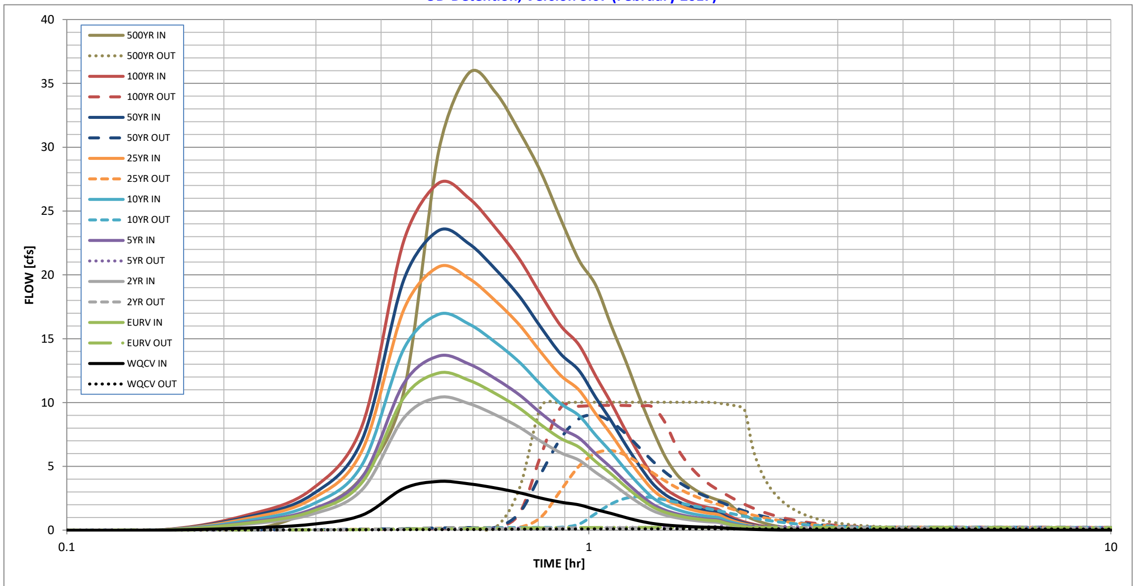
Spillway Design Flow Depth=	0.82	feet
Stage at Top of Freeboard =	9.32	feet
Basin Area at Top of Freeboard =	0.29	acres

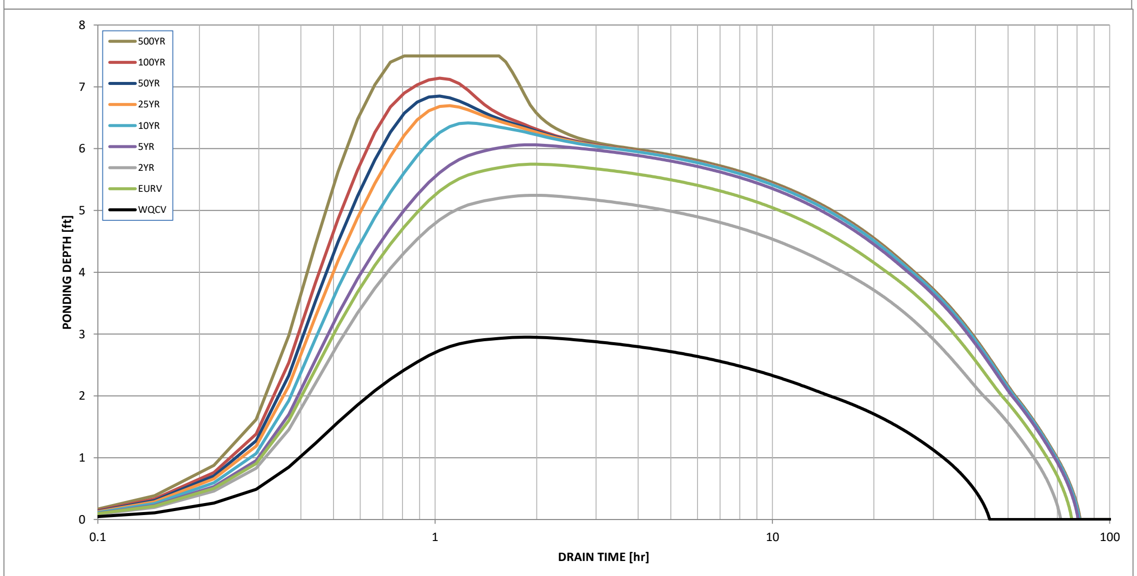
Routed Hydrograph Results

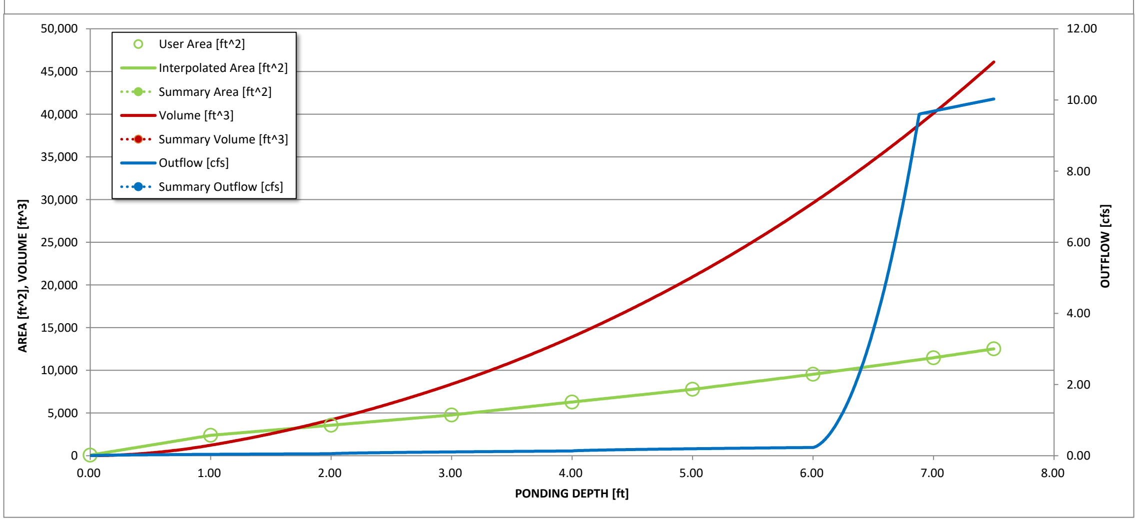
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	3.20
Calculated Runoff Volume (acre-ft) =	0.201	0.656	0.553	0.728	0.905	1.107	1.261	1.463	1.933
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	0.200	0.655	0.553	0.727	0.903	1.105	1.259	1.461	1.931
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.01	0.02	0.24	0.77	1.06	1.42	2.13
Predevelopment Peak Q (cfs) =	0.0	0.0	0.1	0.2	1.8	5.8	8.0	10.7	16.0
Peak Inflow Q (cfs) =	3.8	12.3	10.4	13.6	16.9	20.6	23.5	27.2	35.8
Peak Outflow Q (cfs) =	0.1	0.2	0.2	0.3	2.6	6.2	9.0	9.8	10.0
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	1.9	1.5	1.1	1.1	0.9	0.6
Structure Controlling Flow =	Plate	Plate	Plate	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Outlet Plate 1	N/A
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	0.0	0.1	0.4	0.5	0.6	0.6
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) =	40	68	64	71	70	68	67	65	62
Time to Drain 99% of Inflow Volume (hours) =	**42**	73	68	76	76	75	75	74	73
Maximum Ponding Depth (ft) =	2.95	5.75	5.25	6.06	6.42	6.69	6.85	7.14	7.50
Area at Maximum Ponding Depth (acres) =	0.11	0.21	0.19	0.22	0.24	0.25	0.26	0.27	0.29
Maximum Volume Stored (acre-ft) =	0.187	0.624	0.525	0.693	0.773	0.841	0.882	0.958	1.059

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)







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

Lot 1 Broadmoor Campus Filing No. 2
RipRap Design Calculation

Station	Description	Riprap or Boulder	Straight or Curved Section	Flow Velocity	Channel Slope	For Curved Sections			Velocity for Calc	Super-elevation dY	Rock Sizing Parameter	Calculated Riprap Type	Calculated Boulder Size
						rc	T	V_a					
EDB	Spillway	Riprap	Straight	3.6ft/sec	0.50%				3.6ft/sec		1.1	VL	---

Rock Sizing Parameter		Riprap Type	D50
0.00	3.29	VL	6 inches
3.30	3.99	L	9 inches
4.00	4.59	M	12 inches
4.60	5.59	H	18 inches
5.60	6.40	VH	24 inches

Equations:

Rock Sizing Parameter = $VS^{0.17}/(G_s-1)^{0.66}$

Straight	Boulder
Curve	Riprap

V = Mean channel flow velocity for Riprap Sizing

V = Critical Velocity for Grouted Boulder Sizing

S = Longitudinal channel slope

G_s = Specific Gravity of stone (minimum G_s = 2.50)

G_s = 2.55 (UDFCD Recommended) (2'x3' is about 1 ton, able to be moved by skid steer)

G_s = 2.55

Equations taken from UDFCD USDCM (Eqn MD-13 & HS-9) and City of Colorado Springs Drainage Criteria Manual (2014)

Rock Sizing Parameter		Grouted Boulder Classification	Grouted Boulder Min. Dimension
0.00	4.49	B18	18 inches
4.50	4.99	B18	18 inches
5.00	5.59	B24	24 inches
5.60	6.39	B30	30 inches
6.40	6.99	B36	36 inches
7.00	7.49	B42	42 inches
7.50	8.00	B48	48 inches

$v_a = (-0.147\ r_c/T + 2.176)V$ (Eqn UDFCD MD-10)

V_a = Adjusted channel velocity for riprap sizing along outside of channel bends

r_c = channel centerline radius

T = Top width of water during the major design flood

Superelevation (dY) = $V^2T/2gr_c$ (Eqn UDFCD MD-9)

V = Mean channel flow velocity

T = Top Width of the channel under design flow conditions

g = Gravitational constant = 32.2 ft/sec^2

r_c = channel centerline radius

NOTE: Type L Riprap is minimum recommended for bank lining/toe protection

Lot 1 Broadmoor Campus Filing No. 2
Emergency Overflow Channel Capacity Calculations

Description	Design Flow	Bottom Width	Channel Side Slope		Flow Depth	Channel Slope	Manning "n"	Top Width	Channel Area	Wetted Perimeter	Hydraulic Radius	Flow Velocity	Channel Flow Capacity
			Left	Right									
Emergency Overflow Channel	27.2 cfs	6.5 ft	1:1	1:1	1.00 ft	0.5%	0.025	8.5 ft	7.50 sf	9.3 ft	0.80 ft	3.6 ft/sec	**27.3 cfs**

Equations:

Area (A) = $b(d)+zd^2$
b = width
d = depth

Perimeter (P) = $b+2d*(1+z^2)^{0.5}$
z = side slope
Hydraulic Radius = A/P

Velocity = $(1.49/n)R_n^{2/3}\,S^{1/2}$
S = Slope of the channel
n = Manning's number
R_n = Hydraulic Radius (Reynold's Number)
Flow = $(1.49/n)AR_n^{2/3}\,S^{1/2}$

Appendix D

Custom Soil Resource Report

FEMA National Flood Hazard Layer FIRMette

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for

El Paso County Area, Colorado

Lot 1 Broadmoor Campus Filing No. 2, Broadmoor Event Center Exhibit Hall

January 12, 2019

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

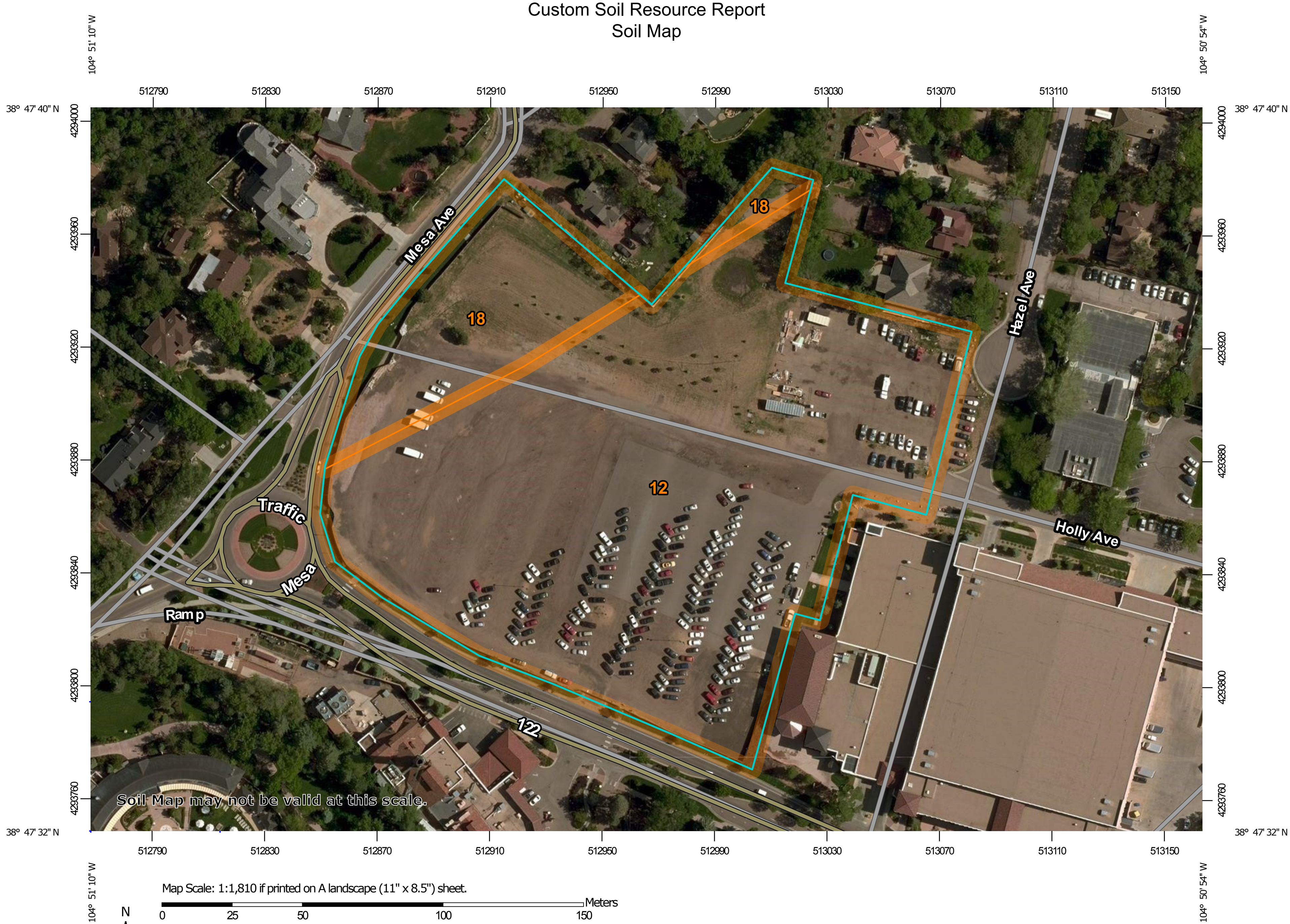
Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Soil Map



Map Scale: 1:1,810 if printed on A landscape (11" x 8.5") sheet.

Meters: 0, 25, 50, 100, 150

Feet: 0, 50, 100, 200, 300

N

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

MAP LEGEND

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

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

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

Background
- Aerial Photography

MAP INFORMATION

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

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: El Paso County Area, Colorado
Survey Area Data: Version 16, Sep 10, 2018

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

Date(s) aerial images were photographed: Jun 3, 2014—Jun 17, 2014

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.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
12	Bresser sandy loam, cool, 3 to 5 percent slopes	6.0	82.7%
18	Chaseville-Midway complex	1.3	17.3%
Totals for Area of Interest		**7.3**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

El Paso County Area, Colorado

12—Bresser sandy loam, cool, 3 to 5 percent slopes

Map Unit Setting

National map unit symbol: 2tlpd
Elevation: 6,300 to 6,800 feet
Mean annual precipitation: 13 to 19 inches
Mean annual air temperature: 46 to 50 degrees F
Frost-free period: 125 to 140 days
Farmland classification: Prime farmland if irrigated and the product of I (soil erodibility) x C (climate factor) does not exceed 60

Map Unit Composition

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

Description of Bresser, Cool

Setting

Landform: Interfluves
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Tertiary aged alluvium derived from arkose

Typical profile

Ap - 0 to 5 inches: sandy loam
Bt1 - 5 to 8 inches: sandy loam
Bt2 - 8 to 27 inches: sandy clay loam
Bt3 - 27 to 36 inches: sandy loam
C - 36 to 80 inches: loamy coarse sand

Properties and qualities

Slope: 3 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 5 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.1 to 2.0 mmhos/cm)
Available water storage in profile: Low (about 5.4 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 4s
Hydrologic Soil Group: B
Ecological site: Sandy Foothill (R049BY210CO)

Hydric soil rating: No

Minor Components

Truckton

Percent of map unit: 10 percent
Landform: Interfluves
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: Sandy Foothill (R049BY210CO)
Hydric soil rating: No

Yoder

Percent of map unit: 5 percent
Landform: Alluvial fans
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: Gravelly Foothill (R049BY214CO)
Hydric soil rating: No

18—Chaseville-Midway complex

Map Unit Setting

National map unit symbol: 367n
Elevation: 6,100 to 7,000 feet
Mean annual precipitation: 16 to 18 inches
Mean annual air temperature: 46 to 48 degrees F
Frost-free period: 125 to 145 days
Farmland classification: Not prime farmland

Map Unit Composition

Chaseville and similar soils: 70 percent
Midway and similar soils: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Chaseville

Setting

Landform: Hills, hills, breaks
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from arkose

Typical profile

A1 - 0 to 6 inches: gravelly sandy loam
A2 - 6 to 19 inches: very gravelly sandy loam
C1 - 19 to 40 inches: extremely gravelly loamy coarse sand
C2 - 40 to 60 inches: very gravelly loamy sand

Properties and qualities

Slope: 8 to 50 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat excessively drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very low (about 2.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: A
Ecological site: Gravelly Foothill (R049BY214CO)
Hydric soil rating: No

Description of Midway

Setting

Landform: Hills
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Slope alluvium over residuum weathered from shale

Typical profile

A - 0 to 4 inches: clay loam
C - 4 to 13 inches: clay
Cr - 13 to 17 inches: weathered bedrock

Properties and qualities

Slope: 5 to 25 percent
Depth to restrictive feature: 6 to 20 inches to paralithic bedrock
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 15 percent
Gypsum, maximum in profile: 15 percent
Salinity, maximum in profile: Very slightly saline to moderately saline (2.0 to 8.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 15.0
Available water storage in profile: Very low (about 2.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: D
Ecological site: Shaly Foothill (R049BY212CO)
Hydric soil rating: No

Minor Components

Other soils

Percent of map unit:
Hydric soil rating: No

Pleasant

Percent of map unit:
Landform: Depressions
Hydric soil rating: Yes

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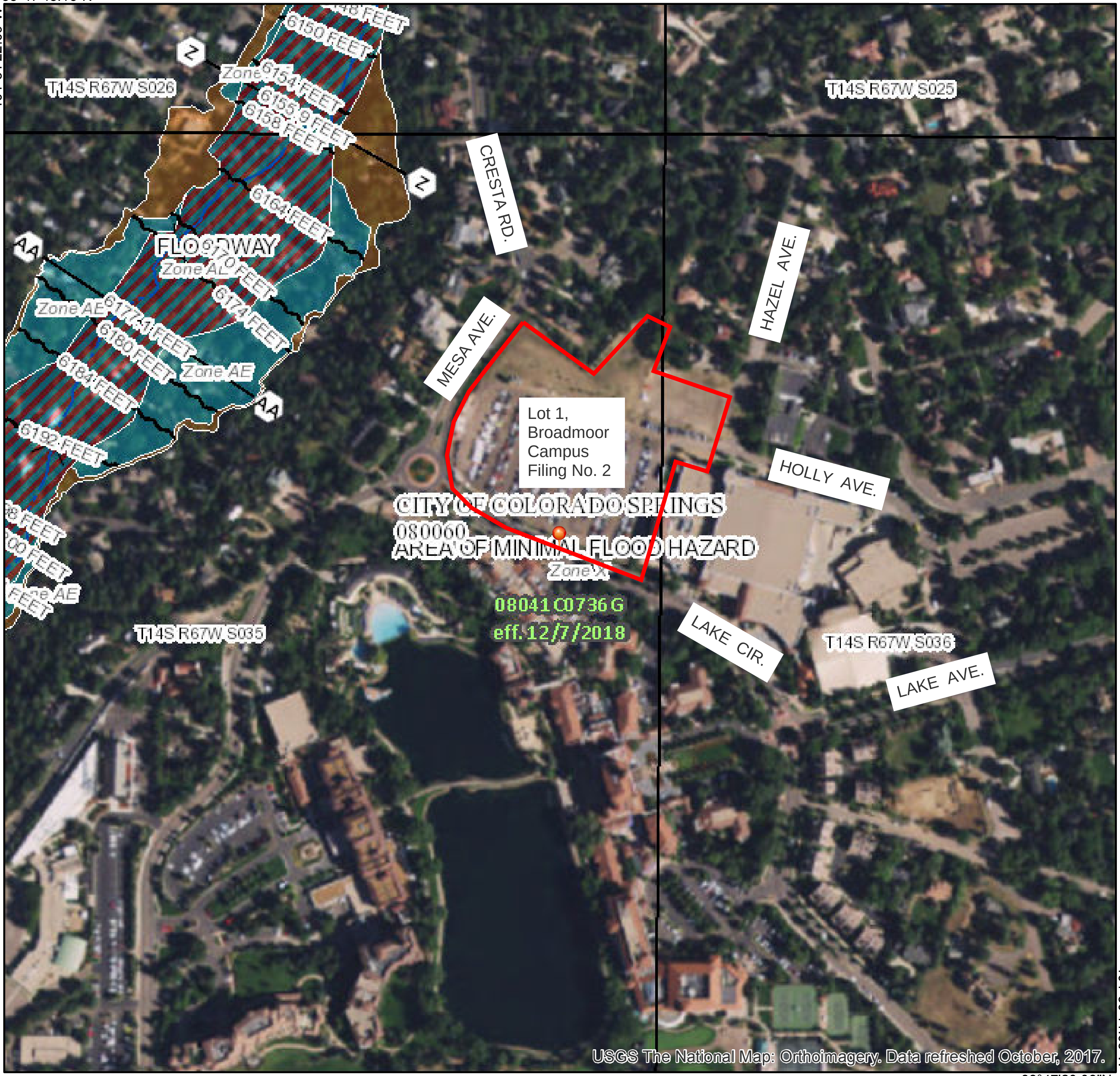
National Flood Hazard Layer FIRMette

FEMA

38°47'48.13"N

104°51'22.09"W



104°50'44.63"W

38°47'20.09"N

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

1:6,000

Legend

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

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

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

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

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

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

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

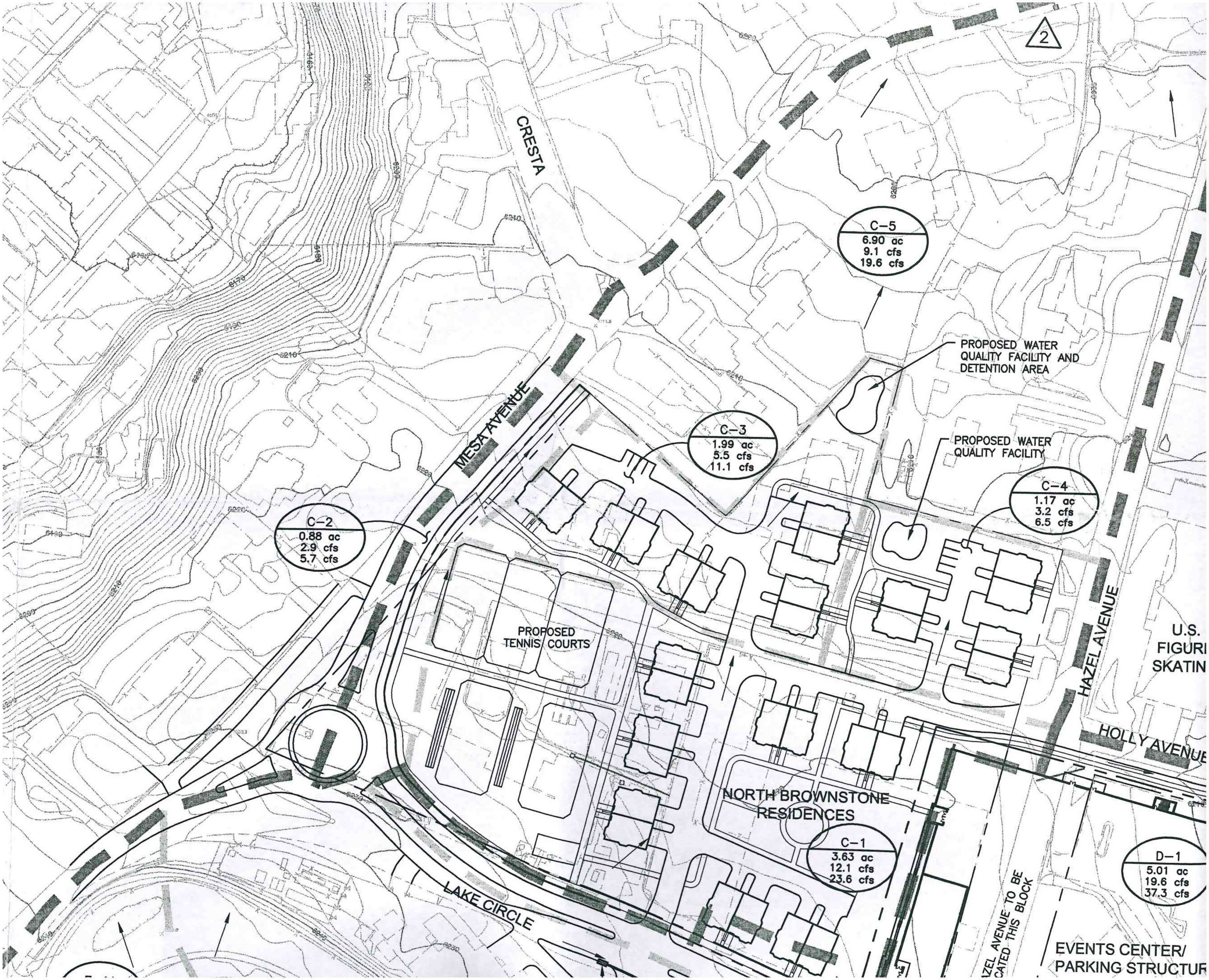
N

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

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

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 1/12/2019 at 11:01:01 AM 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.

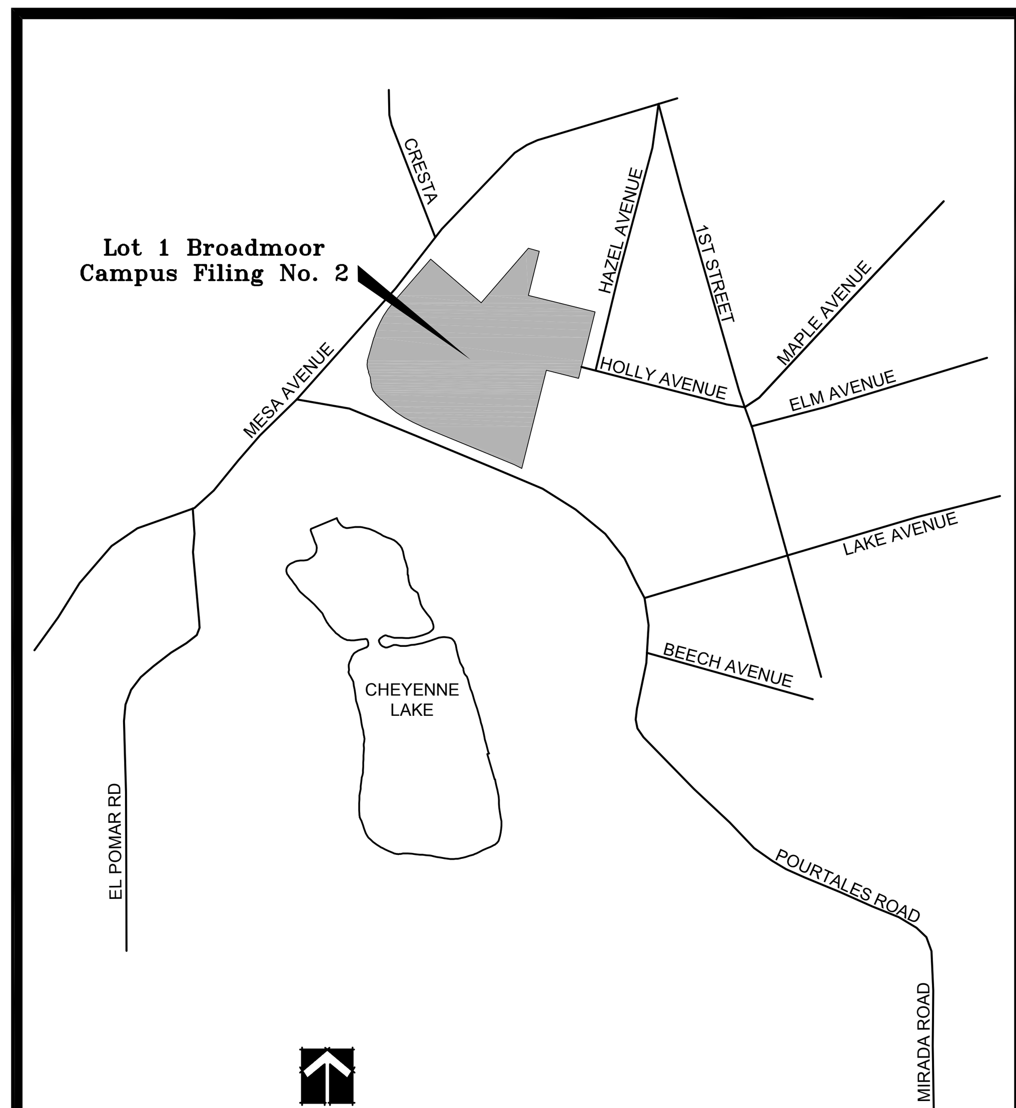
This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory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



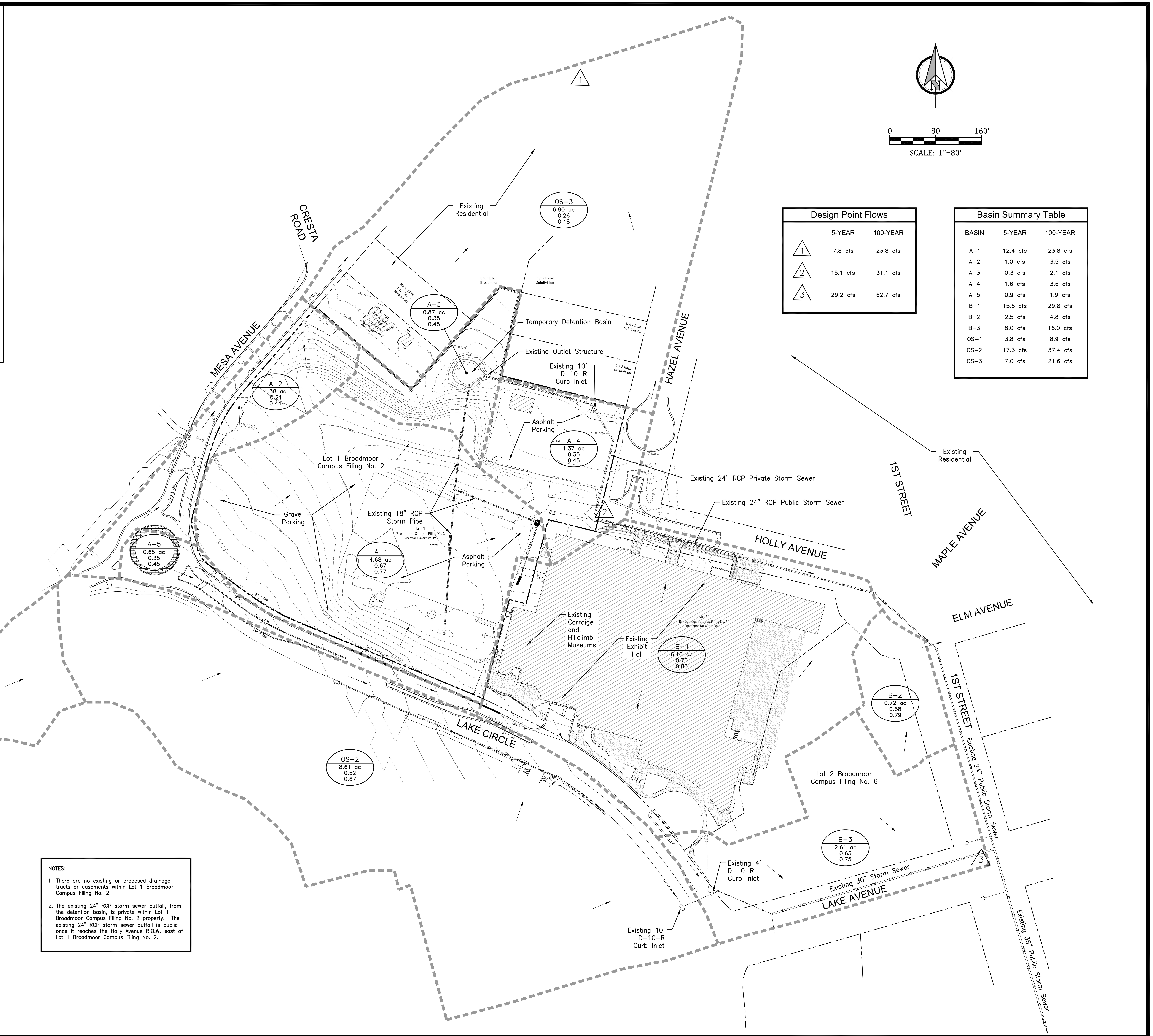
A Portion of Sheet DP-2, from the MDDP Broadmoor Hotel Complex

Appendix E

Figures 2 & 3



Vicinity Map



DRAINAGE LEGEND

A-1 / 10.24 ac / 0.67 / 0.77	Basin Designation; Basin Area; 5-Year Runoff Coefficient; 100-Year Runoff Coefficient
△2	Design Point
	Existing Drainage Basin Boundary
	Project Property Boundary
	Existing Flow Direction
(6748)	Existing Index Contour
	Existing Intermediate Contour

Design Point Flows

	5-YEAR	100-YEAR
1	7.8 cfs	23.8 cfs
2	15.1 cfs	31.1 cfs
3	29.2 cfs	62.7 cfs

Basin Summary Table

BASIN	5-YEAR	100-YEAR
A-1	12.4 cfs	23.8 cfs
A-2	1.0 cfs	3.5 cfs
A-3	0.3 cfs	2.1 cfs
A-4	1.6 cfs	3.6 cfs
A-5	0.9 cfs	1.9 cfs
B-1	15.5 cfs	29.8 cfs
B-2	2.5 cfs	4.8 cfs
B-3	8.0 cfs	16.0 cfs
OS-1	3.8 cfs	8.9 cfs
OS-2	17.3 cfs	37.4 cfs
OS-3	7.0 cfs	21.6 cfs

NOTES:

1. There are no existing or proposed drainage tracts or easements within Lot 1 Broadmoor Campus Filing No. 2.
2. The existing 24" RCP storm sewer outfall, from the detention basin, is private within Lot 1 Broadmoor Campus Filing No. 2 property. The existing 24" RCP storm sewer outfall is public once it reaches the Holly Avenue R.O.W. east of Lot 1 Broadmoor Campus Filing No. 2.

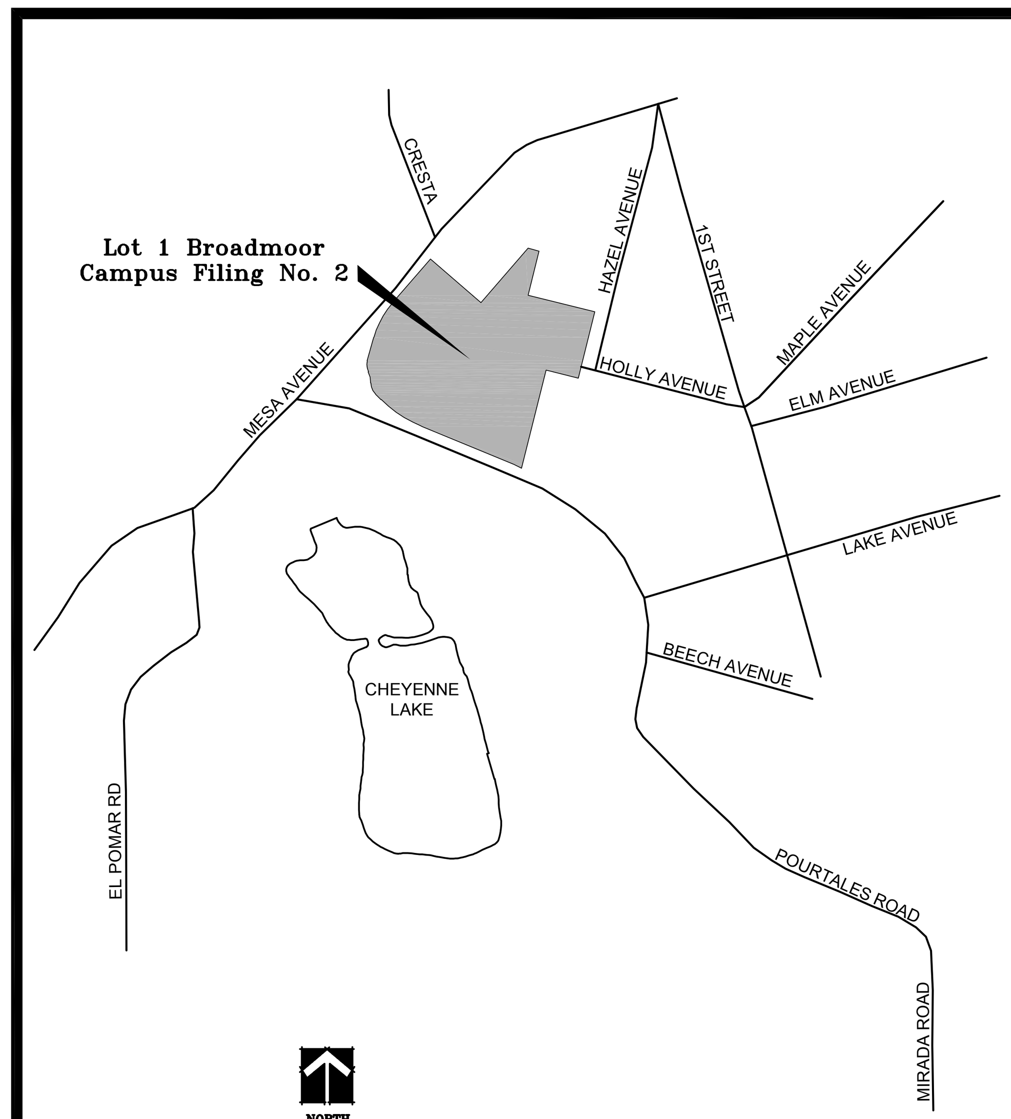
Kiowa Engineering Corporation
Celebrating 30 years
1604 South 21st Street
Colorado Springs, Colorado 80904
(719)630-7342

Lot 1 Broadmoor Campus Filing No. 2
Broadmoor Exhibit Hall
Final Drainage Plan - Existing Conditions
3 Lake Circle, Colorado Springs, Colorado 80906

Project No.:	18062
Date:	April 5, 2019
Design:	JAK
Drawn:	JAK
Check:	AWMc
Revisions:	

SHEET
Figure 2
OF 2 SHEETS

Figures 2-3.dwg/Apr 04, 2019



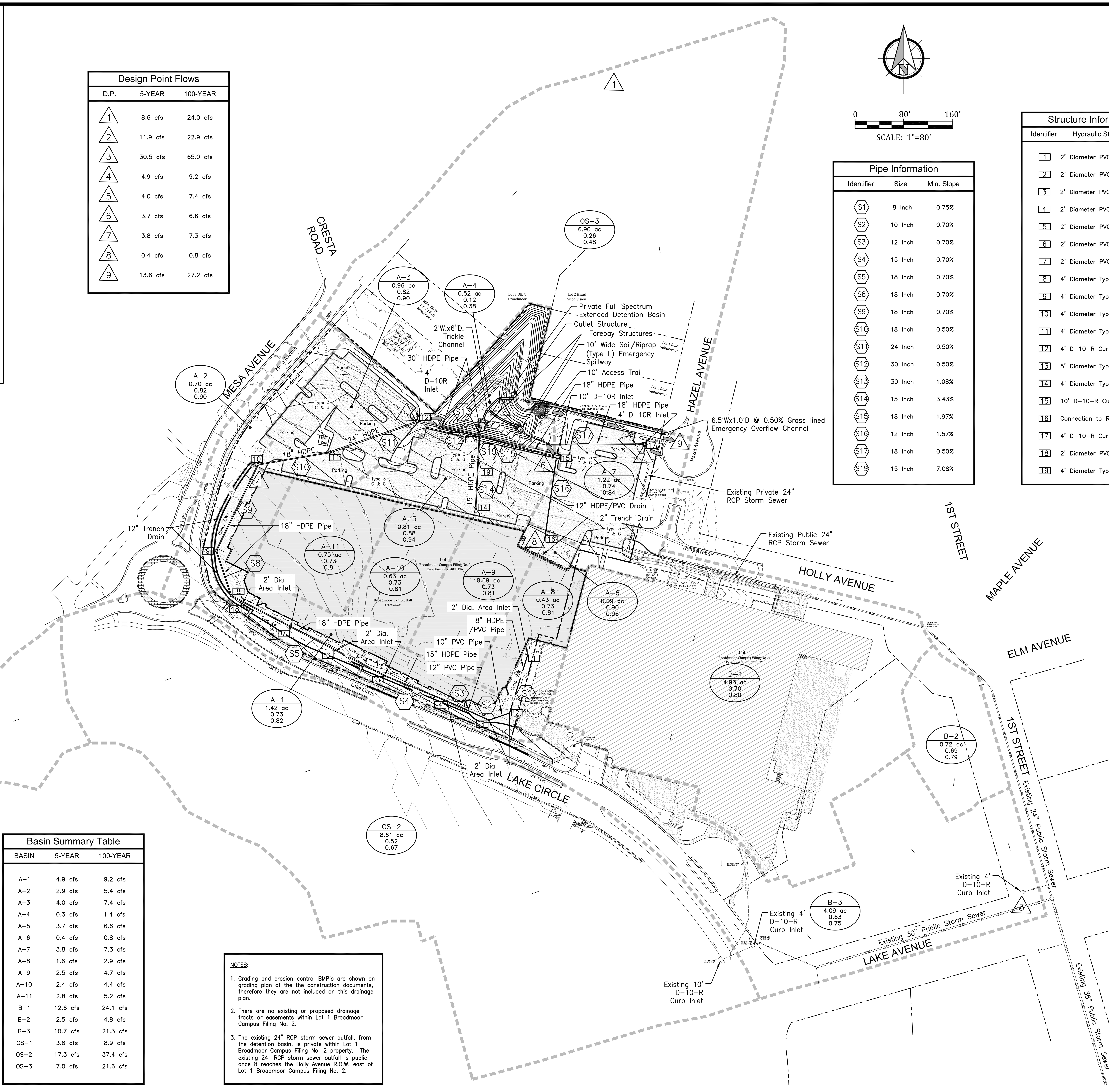
Vicinity Map

DRAINAGE LEGEND

A-1 / 1.42 ac / 0.73 / 0.82	Basin Designation; Basin Area; 5-Year Runoff Coefficient; 100-Year Runoff Coefficient
2	Design Point
	Developed Drainage Basin Boundary
	Emergency Overflow Path
	Flow Direction
	Project Property Boundary
	Adjacent Property Boundary
6220	Developed Index Contour
	Developed Intermediate Contour
(6220)	Existing Index Contour
	Existing Intermediate Contour
	Proposed Curb and Gutter
	Proposed Building
	Proposed Paved Surface

Design Point Flows

D.P.	5-YEAR	100-YEAR
1	8.6 cfs	24.0 cfs
2	11.9 cfs	22.9 cfs
3	30.5 cfs	65.0 cfs
4	4.9 cfs	9.2 cfs
5	4.0 cfs	7.4 cfs
6	3.7 cfs	6.6 cfs
7	3.8 cfs	7.3 cfs
8	0.4 cfs	0.8 cfs
9	13.6 cfs	27.2 cfs



Pipe Information

Identifier	Size	Min. Slope
S1	8 Inch	0.75%
S2	10 Inch	0.70%
S3	12 Inch	0.70%
S4	15 Inch	0.70%
S5	18 Inch	0.70%
S8	18 Inch	0.70%
S9	18 Inch	0.70%
S10	18 Inch	0.50%
S11	24 Inch	0.50%
S12	30 Inch	0.50%
S13	30 Inch	1.08%
S14	15 Inch	3.43%
S15	18 Inch	1.97%
S16	12 Inch	1.57%
S17	18 Inch	0.50%
S19	15 Inch	7.08%

Structure Information

Identifier	Hydraulic Structure
1	2' Diameter PVC Drain Basin
2	2' Diameter PVC Drain Basin
3	2' Diameter PVC Drain Basin
4	2' Diameter PVC Drain Basin
5	2' Diameter PVC Drain Basin
6	2' Diameter PVC Drain Basin
7	2' Diameter PVC Drain Basin
8	4' Diameter Type II Manhole
9	4' Diameter Type II Manhole
10	4' Diameter Type II Manhole
11	4' Diameter Type II Manhole
12	4' D-10-R Curb Inlet
13	5' Diameter Type II Manhole
14	4' Diameter Type II Manhole
15	10' D-10-R Curb Inlet
16	Connection to Roof Drain Pipe
17	4' D-10-R Curb Inlet
18	2' Diameter PVC Drain Basin
19	4' Diameter Type II Manhole

Basin Summary Table

BASIN	5-YEAR	100-YEAR
A-1	4.9 cfs	9.2 cfs
A-2	2.9 cfs	5.4 cfs
A-3	4.0 cfs	7.4 cfs
A-4	0.3 cfs	1.4 cfs
A-5	3.7 cfs	6.6 cfs
A-6	0.4 cfs	0.8 cfs
A-7	3.8 cfs	7.3 cfs
A-8	1.6 cfs	2.9 cfs
A-9	2.5 cfs	4.7 cfs
A-10	2.4 cfs	4.4 cfs
A-11	2.8 cfs	5.2 cfs
B-1	12.6 cfs	24.1 cfs
B-2	2.5 cfs	4.8 cfs
B-3	10.7 cfs	21.3 cfs
OS-1	3.8 cfs	8.9 cfs
OS-2	17.3 cfs	37.4 cfs
OS-3	7.0 cfs	21.6 cfs

NOTES:

1. Grading and erosion control BMP's are shown on grading plan of the the construction documents, therefore they are not included on this drainage plan.
2. There are no existing or proposed drainage tracts or easements within Lot 1 Broadmoor Campus Filing No. 2.
3. The existing 24" RCP storm sewer outfall, from the detention basin, is private within Lot 1 Broadmoor Campus Filing No. 2 property. The existing 24" RCP storm sewer outfall is public once it reaches the Holly Avenue R.O.W. east of Lot 1 Broadmoor Campus Filing No. 2.

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Project No.:	18062
Date:	April 5, 2019
Design:	JAK
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Revisions:	

Figure 3