Master Development Drainage Plan
Broadmoor Hotel Campus
Colorado Springs, Colorado

Prepared for:
Broadmoor Development Company
1 Lake Avenue
Colorado Springs, Colorado 80906

Prepared by:
Kiowa Engineering Corporation
1604 South 21st Street
Colorado Springs, Colorado 80904-4208

Kiowa Project No. 03068

October 29, 2003
Revised January 8, 2004
Revised January 27, 2004

Kiowa Engineering Corporation

January 27, 2004

Mr. Steve Kuehster
City of Colorado Springs
Engineering Division – Stormwater and Subdivision
30 South Nevada Avenue, Suite 702
Colorado Springs, Colorado 80903

RE: Broadmoor Hotel Campus (Kiowa Project No. 03068)

Dear Steve:

Following is the revised Master Development Drainage Plan (MDDP) for the Broadmoor Hotel Campus. The Broadmoor is roughly situated east of El Pomar Road, south of Mesa Avenue, west of Lake Circle, and north of the Broadmoor Golf Course. The study does not include the golf course areas. This report addresses the proposed renovations to the resort complex including demolition of some existing structures. This report was prepared according to City/County drainage criteria and is being submitted for approval.

If there are any questions or if we may be of further assistance, please feel free to call at any time.

Sincerely,
Kiowa Engineering Corporation

Andrew W. McCord, P.E.
Associate

\R03068DR.doc

1604 South 21st Street, Colorado Springs, CO 80904
(719) 630-7342 (719) 630-0406 FAX

ENGINEER'S STATEMENT:

The attached drainage plan and report were prepared under my direction and supervision and are correct to the best of my knowledge and belief. Said drainage report has been prepared according to the criteria established by the City/County for drainage reports and said report is in conformity with the master plan of the drainage basin. I accept responsibility for any liability caused by any negligent acts, errors or omissions on my part in preparing this report.

Kiowa Engineering Corporation, 1604 South 21st Street, Colorado Springs, Colorado 80904

________________________ 1/27/04
Registered Engineer #25057 Date
For and on Behalf of Kiowa Engineering Corporation

DEVELOPER'S STATEMENT:

I, the Developer, have read and will comply with all of the requirements specified in this drainage report and plan.

________________________ 1/26/04
Date

ADDRESS: Broadmoor Development Company
1 Lake Avenue
Colorado Springs, Colorado 80906

CITY OF COLORADO SPRINGS:

Filed in accordance with Section 15-3-906 of the code of the City of Colorado Springs, 1980, as amended.

________________________ 1/29/04
For the City Engineer Date

Conditions:

I. General Location and Description

The Broadmoor Hotel Campus is located in the southwestern part 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 north by Mesa Avenue, to the east by 1st Street and Pourtales Road, to the south by the Broadmoor Golf Course, and to the west by El Pomar Road. A vicinity map showing the location of the site is located on the following page, as Figure 1.

The site contains roughly 100 acres and resides within a fully developed residential area. The Broadmoor is an existing hotel resort complex containing hotels, resort facilities, tennis courts, parking areas, and a lake. The golf course to the south is part of the Broadmoor Resort. However, it is not included in this drainage study.

The property is being masterplanned. Demolition of some existing structures is proposed along with construction of new facilities. Townhomes are proposed to be developed where the Broadmoor Greenhouse, Broadmoor Garage, Human Resources building, Carriage Museum, and Parking Garage are currently located. Two condominium buildings are proposed. One building will be located where the existing tennis courts are situated. Another building is proposed to be located on the west end of existing Hole 1 of the West Golf Course. Hole 1 will be realigned. A new Events Center with an underground Parking Structure is proposed where the Gas Station currently exists. The Engineering building is proposed to be expanded to house the Human Resources department.

Road and parking improvements are included in the proposed layout of the Broadmoor Campus. Construction is proposed on Lake Circle, Lake Avenue, and El Pomar Road. Medians are proposed on both Lake Circle and Lake Avenue. A roundabout is proposed at the intersection of Mesa Avenue and Lake Circle. One block of Hazel Avenue will be vacated to allow for the construction of the proposed Events Center. Holly Avenue will no longer have access to Mesa Avenue with the development of the proposed townhomes. The parking lot and driveways associated with Broadmoor West hotel are to be redesigned. The entrance to Broadmoor West is proposed to be relocated further south on El Pomar Road. Parking on the west side of El Pomar Road is proposed to be improved.

Presently, the complex generally slopes from the west to the east at an average slope of approximately 3%. According to the *Soil Survey for El Paso County, Colorado,* the site's soil, as shown on Figure 2, consists of Bresser Sandy Loam (#12), which is classified within Hydrologic Soil Group B.

II. Previous Reports

The following reports and plans were reviewed in the process of preparing this preliminary/final drainage plan:

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

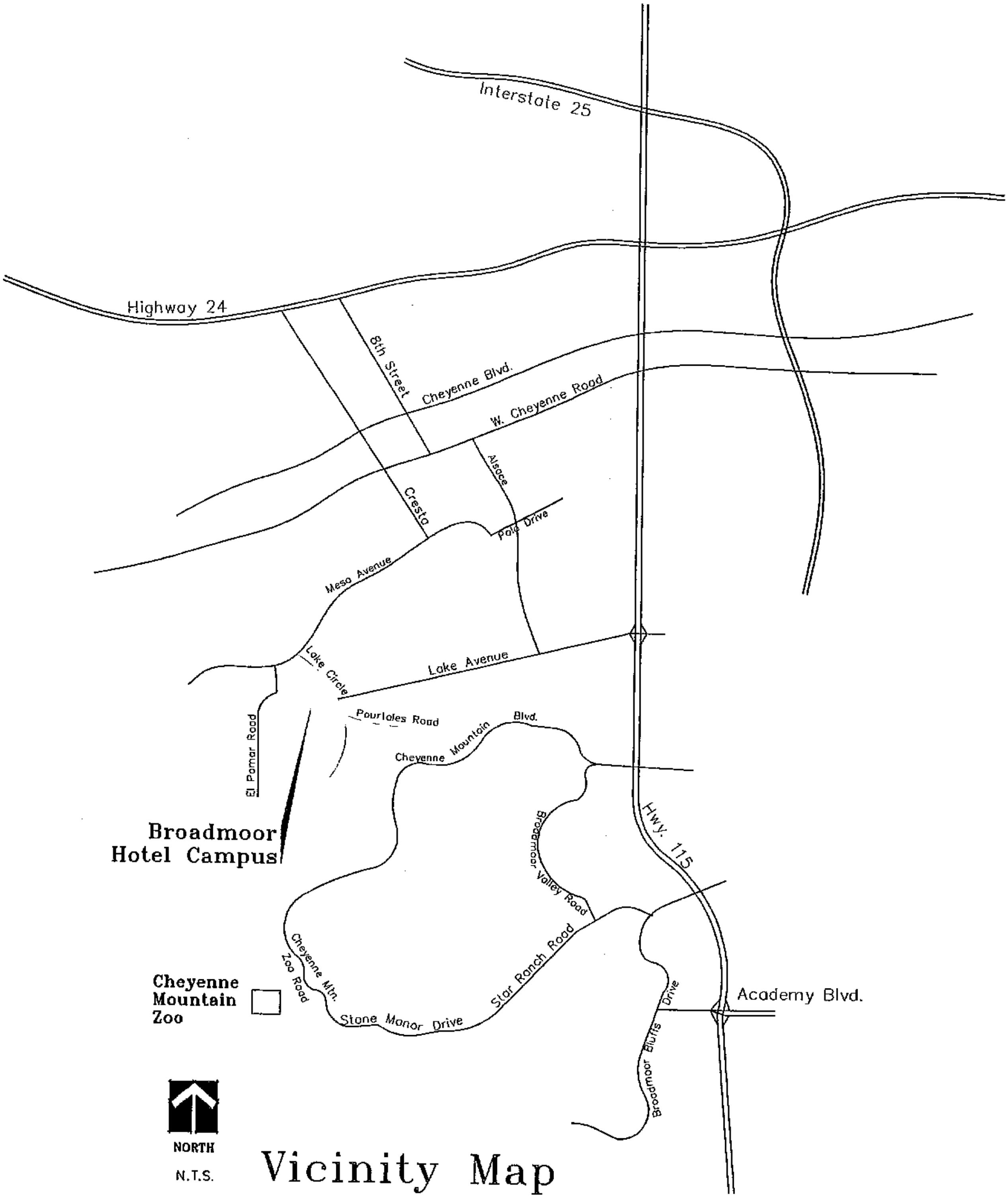
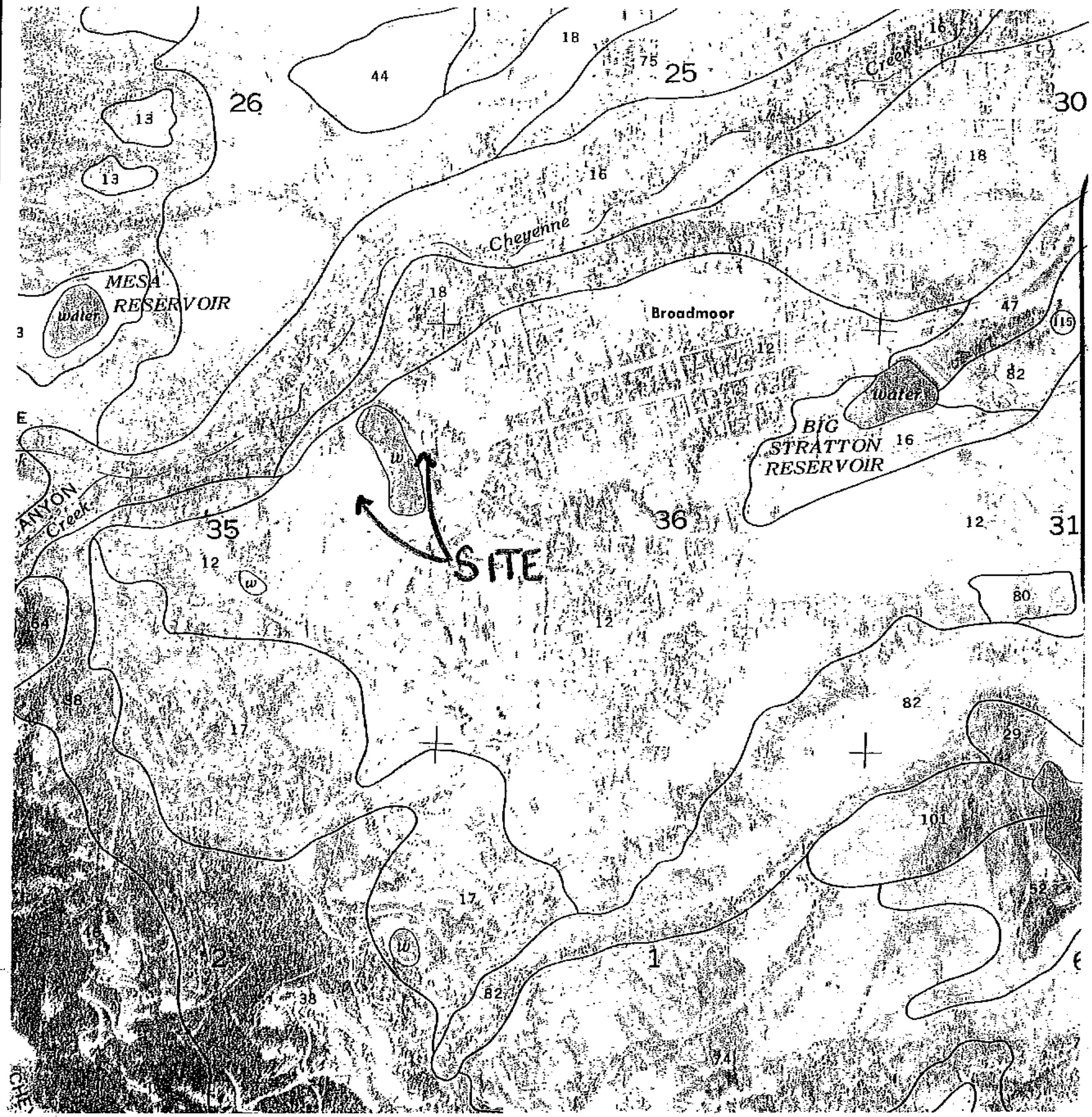


FIGURE 1
VICINITY MAP
BROADMOOR HOTEL CAMPUS



SHEET NO. 16
EL PASO COUNTY AREA, COLORADO
(COLORADO SPRINGS QUADRANGLE)

SCALE: N.T.S.

SOIL SERIES
12 BRESSER SANDY LOAM

FIGURE 2
SOIL SURVEY OF EL PASO COUNTY
BROADMOOR HOTEL CAMPUS

2. *Drainage Report for Fox Hollow Subdivision*, prepared by Berge-Brewer & Associates, Inc., filed July 12, 1982.

3. *Preliminary and Final Drainage Report for Beech Subdivision*, prepared by Jeffries Engineering, filed January 18, 1996.

4. *Broadmoor Heights Townhouses Drainage Report*, prepared by E.L.B. & Associates, Inc., dated March 31, 1978.

5. *El Pomar Subdivision No. 2 Drainage Plan and Report*, prepared by Oliver E. Watts, filed December 5, 1989.

6. *St. Paul's Parish Facility Final Drainage Report*, prepared by M.V.E., Inc., filed July 17, 2001.

7. *Drainage Report for Lloyd Subdivision*, prepared by Bradley B. Bean, P.E., filed August 12, 2002.

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

9. *Final Drainage Report for Broadmoor Campus Filing No. 1*, prepared by Rockwell-Minchow Consultants, Inc., dated September 2003.

10. City of Colorado Springs and El Paso County *Drainage Criteria Manual*, October 1987, revised November 1991.

11. City of Colorado Springs *Drainage Criteria Manual Volume 2*, November 2002.

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

III. Southwest Area Drainage Basin

The Broadmoor Hotel Campus lies within the Southwest Area Drainage Basin. According to the Southwest Area DBPS (*Engineering 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 a creek. Many culverts convey this runoff under roadways. In some instances, short 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 possible.

Specific facilities and improvements are recommended in the DBPS near the Broadmoor Hotel development. They include replacing an existing 36" CMP culvert located under Pourtales Road at the southeast corner of the property with a 4'x12' RCB culvert with wingwalls. Upgrading an existing 10" pipe to an 18" pipe is recommended at the intersection of Mesa Avenue and El Pomar Road. Both items are reimbursable costs per the DBPS.

IV. Drainage Design Criteria

The hydrology for this site was estimated using the methods outlined in the *City of Colorado Springs and El Paso County, Drainage Criteria Manual.* The topography for the site was compiled using a two-foot contour interval and is presented at a horizontal scale of 1-inch to 100-feet in Exhibits DP-1 and DP-2. The hydrologic calculations were made assuming both existing conditions and future conditions according to the proposed masterplan for the site. The existing drainage basins are shown on Exhibit DP-1. The future drainage basins are shown on Exhibit DP-2. The peak flow rates for the drainage basins were estimated by using the Rational Method. The peak flow rates for runoff draining to the existing 36" CMP culvert at Pourtales Road were estimated by using the U.S. Army Corps of Engineers HEC-1 Hydrograph Package. Runoff for the 5-year and 100-year recurrence intervals were determined for both methods used.

The runoff coefficients used for the Rational Method were determined using Table 5-1 of the *City of Colorado Springs and El Paso County, Drainage Criteria Manual* and the curve numbers used for the HEC-1 hydrologic modeling were obtained from Table 5-5 of the same manual. A copy of both tables is located in the Appendix of this report. The hydrological calculations were performed assuming Hydrologic Soil Group B for the Broadmoor Hotel Campus, Golf Course, and Residential area to the southwest of the subject property and Hydrologic Soil Group C for the National Forest area to the southwest of the development. Rainfall depths of 3.0 and 4.5 inches were used in the HEC-1 model for the 5-year and 100-year storm events, respectively. The hydrological calculations for both existing and future conditions are included in the Appendix.

V. Historic and Offsite Drainage Patterns

The Broadmoor Campus generally drains to the east while a small portion drains to the north of the property. A portion of runoff travels to the east side of the site to Maple Avenue, Elm Avenue, Lake Avenue, or Beech Avenue. Runoff travels in an easterly direction through the existing neighborhood either in gutters or roadside ditches until it reaches Spring Run. The southern portion of the Broadmoor Campus study area drains to the Spring Run channel located at the southeast corner of the study site. A small portion of the Broadmoor Campus drains to the north and travels generally along roadways to Cheyenne Creek. All runoff reaching Spring Run and Cheyenne Creek ultimately discharges into Fountain Creek.

Cheyenne Lake is situated in the central part of the Broadmoor Campus property, between the Main Broadmoor Hotel and Broadmoor West. The central and western portion of the site drains to the lake where the runoff is retained. An emergency overflow located at the southern end of the lake drains any overflow to a channel in the golf course, which would ultimately convey runoff to Spring Run. The emergency overflow consists of 2-24" CMPs that outfall in the golf course to the south. The overflow pipes can adequately carry the 5-year storm event. The 100-year storm will overflow the banks at the south end of the lake and travel in a southerly direction to the golf course.

The "A" sub-basins include the western and southern part of the property. Runoff generated from this area drains to an existing channel in the golf course. This channel is conveyed in an easterly direction to a series of three ponds. Over flow from these ponds discharge into Spring Run at the southeast corner of the study area. Sub-basin A-1 contains 5.65 acres and lies along the western side of El Pomar Road. The Engineering building is located within this sub-basin. The site sheet flows to a roadside swale to one of two grated inlets. Runoff is conveyed under the road to the channel in the golf course. Ponding currently exists at the existing 12" CMP along El Pomar Road. The outlet is covered and needs to be cleared of debris. Sub-basin A-2 contains 4.78 acres and includes a portion of Broadmoor West parking and driveway areas. This area sheet flows to numerous inlets and is carried by a storm sewer system to the channel in the golf course. Sub-basin A-3 contains 5.48 acres and includes Hole 1 of the golf course. This area drains to the channel in the golf course. Sub-basin A-4 contains 7.56 acres and lies along the southern side of Cheyenne Lake. This sub-basin includes a portion of the Golf Clubhouse and runoff generated from this area sheet flows to the channel that drains to a series of three ponds or drains directly into the ponds.

The "B" sub-basins include Cheyenne Lake and the areas that drain to the lake. Runoff collected in the lake is retained. An emergency overflow consisting of 2-24" CMPs is located at the southern end of the lake. These pipes drain to the golf course. Sub-basin B-1 contains 4.00 acres and lies to the west of Broadmoor West. This sub-basin consists of a portion of the parking area for Broadmoor West. Several grated inlets pick up runoff, which is then conveyed to the lake via a storm sewer system ending in a 24" RCP. The existing 24" RCP lies under the northern end of the Broadmoor West building before outfalling to the lake. Sub-basin B-2 contains 19.34 acres and includes the lake and its surrounding area. Roof drains from buildings adjacent to the lake contribute to the runoff draining to the lake. Some runoff generated from landscaped areas sheet flow directly into the lake. Many grated inlets can be found spread around the entire perimeter of the lake and many pipes can be seen outfalling into the lake. Many inlets and pipes drain the east half of Broadmoor West as well as the western portions of Broadmoor Main and Broadmoor South. A relatively new storm sewer system at the north end of the lake collects runoff generated from the area to the north and west of the pool area and outfalls into the lake as a 12" RCP.

The "C" sub-basins include the northeast part of the Broadmoor Campus development that drains to Mesa Avenue. Runoff drains to a bubbler system located at Mesa Avenue and Heather Drive. From there, runoff travels down Heather Drive to Cheyenne Creek. Sub-basin C-1 contains 3.88 acres and includes part of the Broadmoor Greenhouse and Broadmoor Garage along with parking areas. Runoff from this area sheet flows in a northeasterly direction to Holly Avenue. Runoff collected in Holly Avenue travels in an easterly direction to Hazel Avenue. From there, runoff travels in northeasterly direction along Hazel and then westerly along Mesa Avenue to the bubbler at Heather Drive. Sub-basin C-2 contains 0.67 acres and contains a portion of the Broadmoor Greenhouse along Mesa Avenue. Runoff from this area drains to Mesa Avenue in a northwesterly direction. From there runoff travels in a gutter along Mesa Avenue in a northeasterly direction to the bubbler at Heather Drive. Sub-basin C-3 contains 2.11 acres and is located on the north side of Holly Avenue. This area includes the Human Resources building. Runoff generated from this sub-basin drains to the north across developed single-family lots before reaching Mesa Avenue. Sub-basin C-4 contains 1.17 acres and is located at the northwest corner of Holly Avenue and Hazel Avenue. This is a paved parking lot that drains to the residential area to the north. Runoff sheet flows to the north through developed residential lots to Mesa Avenue. Sub-basin C-5 contains 6.90 acres and contains single-family residences north of the Broadmoor Campus property. Runoff generated from this area sheet flows in a northerly direction to Mesa Avenue.

The "D" sub-basins are located on the easternmost side of the Broadmoor Campus development. This area drains to residential streets to the east. Runoff travels through the neighborhood via gutter flow or roadside ditches before reaching Spring Run. Sub-basin D-1 contains 7.25 acres and includes the gas station, a parking lot, and portions of the Broadmoor Garage, the International Center, and Colorado Hall. The northeastern side of Lake Circle is also included in this area. This part of Lake Circle drains either down Hazel Avenue or the driveway separating the gas station from the International Center. Several inlets and a roof drain along the north side of the International Center collect runoff and discharge it into the driveway. Runoff from this entire sub-basin drains to the roundabout located at the intersection of Holly Avenue, 1st Street, Maple Avenue, and Elm Avenue. At the roundabout, runoff drains to a concrete swale located in the center of the roundabout. Runoff is then collected in a bubbler system that carries the runoff to the northwestern side of Maple Avenue. Sub-basin D-2 contains 0.72 acres and includes a portion of Colorado Hall. Runoff from this sub-basin sheet flows to 1st Street where it drains to Elm Avenue via a crosspan.

The "E" sub-basins are located on the north end of the property and on the east half of the development. These sub-basins drain to the neighborhood streets to the east either via Lake Avenue or Beech Avenue. The runoff that drains to Lake Avenue is routed in an easterly direction along Lake Avenue via roadside ditches to Spring Run near Stratton Reservoir. The runoff that drains to Beech Avenue travels along residential streets to 2nd Street where it discharges into Spring Run.

Sub-basins E-1A, E-1, E-2, E-3, and E-4 drain to Lake Avenue. Sub-basins E-1A, E-1, and E-2 drain to the north side of Lake Avenue while sub-basins E-3 and E-4 drain to the south side of Lake Avenue. Two recently constructed bubbler systems located at the roundabout at Lake Avenue and Lake Circle drain the area and discharge runoff in both curb lines to Lake Avenue. Sub-basin E-1A contains 2.10 acres and contains a portion of the pool area and playground along Mesa Avenue. Runoff generated from this area sheet flows to Mesa Avenue. Sub-basin E-1 contains 8.61 acres and contains the Broadmoor Power Plant and Cleaners, Broadmoor Northeast, and a portion of Broadmoor Main. This area sheet flows in an easterly direction to Lake Circle. Runoff from this sub-basin then combines with runoff from Sub-basin E-1A and travels along the gutter in Lake Circle to a 10' curb inlet. This inlet is part of the bubbler system on the north side of the roundabout. Sub-basin E-2 contains 2.61 acres and contains part of the International Center and Colorado Hall. The majority of runoff generated from this area drains to Lake Avenue. A system of inlets and pipes collects runoff from the roof and landscaped areas around the International Center and discharges into Lake Avenue. A portion of runoff drains to a 4' curb inlet on Lake Circle. This inlet is connected to the previously mentioned bubbler system that discharges into Lake Avenue. The eastern portion of this sub-basin sheet flows to 1st Street where it travels in a southerly direction to Lake Avenue. Sub-basin E-3 contains 2.05 acres and consists of the northern half of the Carriage Museum and a single-family residence. Runoff generated from this area sheet flows to Lake Avenue or to 1st Street where it travels in a northerly direction to Lake Avenue. A small portion of runoff from Lake Circle drains to a 4' curb inlet that is connected to the southern bubbler system. Sub-basin E-4 contains 4.10 acres and contains Broadmoor Southeast, parking areas, and a portion of Broadmoor Main. Runoff sheet flows in an easterly direction to Lake Circle. Concrete chases and a pipe system drain areas around several buildings. A 15" pipe discharges runoff in the landscaped area south of Broadmoor Southeast. The majority of the runoff in this sub-basin is collected in a 5' curb inlet in Lake Circle that is connected to the southern bubbler system.

Sub-basins E-5, E-6, and E-7 drain to Beech Avenue. Sub-basin E-5 contains 1.59 acres and consists of the existing parking structure with a tennis court. The area sheet flows in an easterly direction to Beech Avenue. Sub-basin E-6 contains 1.68 acres and includes the southern half of the Carriage Museum and a vacant lot. This area sheet flows to Beech Avenue. Sub-basin E-7 contains 1.94 acres and consists of single-family residences. Runoff sheet flows in a northerly/northeasterly direction to Beech Avenue.

The "F" sub-basins are located in the southeastern portion of the Broadmoor Campus development. This area drains directly to Spring Run. Sub-basin F-1 contains 2.73 acres and consists of a parking area, Pourtales Road, and landscaped areas near the tennis courts. Runoff generated from this area sheet flows to Pourtales Road where it is directed to a 10' curb inlet. Runoff collected in this inlet is conveyed to Spring Run via a storm sewer. Sub-basin F-2 contains 8.77 acres and contains tennis courts, a portion of a parking lot, and a portion of the Golf Clubhouse. Runoff generated from the parking lot is collected in inlets and conveyed to Spring Run via a storm sewer system. Some additional inlets on the western side of the tennis courts are also connected to this storm sewer system. Several more inlets at the southernmost tennis courts collect runoff and discharge the runoff directly into Spring Run via 6" pipes. A 48" CMP culvert connects the outfall of the three ponds in the golf course to Spring Run.

Nearly 400 acres drains to the existing 36" CMP at the southeast corner of the property under Pourtales Road (Design Point 5). This culvert carries runoff to Spring Run. In addition to the sub-basins discussed previously, a large area including forest, residential areas, and portions of the golf course to the south and southwest of the Broadmoor Hotel Campus drains to this point. Presently, the existing culvert does not have the capacity to pass the 5-year storm event.

Other basins include sub-basins G-1, OS-1, and OS-2. These areas are located on the western side of the Broadmoor Hotel Campus. Runoff generated from Sub-basins G-1 and OS-2 drains to the western side of El Pomar Road and then travels in a northerly direction along El Pomar to the intersection of Mesa Avenue. From there, runoff travels down Mayhurst Avenue and discharges into Cheyenne Creek. Sub-basin G-1 contains 3.65 acres and includes a portion of St. Paul's Church, single-family residences, and parking areas. The parking area at the southern end of the sub-basin is part of the Broadmoor Hotel Campus. Runoff from this sub-basins sheet flows to El Pomar Road. Sub-basin OS-2 contains 8.80 acres and includes a portion of the Pauline Memorial Catholic School. Runoff generated from this sub-basin sheet flows across the southern end of Sub-basin G-1 to El Pomar Road. Sub-basin OS-1 contains 11.3 acres and contains the Broadmoor Heights Townhouses. Runoff drains to the northeast corner of the sub-basin to a roadside swale along El Pomar Road. Runoff from this sub-basin combines with runoff from the Engineering building (Sub-basin A-1) and is collected by grated inlets and conveyed under the road to the channel in the golf course.

VI. Stormwater Quality Facilities

According to current stormwater quality policies, water quality capture volume (WQCV) will be required for the proposed development at the Broadmoor Hotel Campus. However, certain areas will not require specific stormwater quality facilities. The areas ("A" sub-basins) draining to the golf course will not require any special stormwater quality facilities since the runoff will travel across a grassy area through the golf course before discharging into the 3 existing ponds located in the southeast portion of Sub-basin A-4. The grass acts as a filtering system by catching sediment and additional sediment settles out in the ponds before the runoff overflows from the ponds to Spring Run. Likewise, stormwater quality facilities will not be required for the "B" sub-basins that outfall into Cheyenne Lake which acts as a stormwater quality facility with sediment settling to the bottom. Water quality will not be required for the East Golf Course Residences B (Sub-basin F-2) since runoff will sheet flow across a large landscaped area before discharging into Spring Run. Water quality facilities will not be required for the South Brownstones in exchange for collecting the runoff generated from this area into a proposed storm sewer system that will discharge into Spring Run at 2nd Street. Since all of the runoff draining to Cheyenne Lake ("B" sub-basins) is being treated, water quality mitigation for the Events Center will be traded for these areas draining to the lake. Water quality facilities are not proposed for the Events Center.

To meet the requirements for stormwater quality, the runoff will be treated using one of the methods outlined by the City of Colorado Springs criteria. The primary method to be used for the proposed North Brownstones will be the Porous Landscape Detention Sedimentation Facility. These facilities will be located in landscaped areas or parking lot islands. If detention is necessary at the north end of the proposed North Brownstone Residences, the Extended Detention Basin will be used for both water quality and detention purposes. The proposed design of each stormwater quality facility will be included in each respective Final Drainage Report and will be subject to final design.

VII. Site Drainage Plan

The proposed drainage patterns will generally remain similar to existing drainage patterns. The layout of some of the proposed facilities will cause some minor drainage pattern variations in some areas.

Several changes are proposed on the west side of the Broadmoor Hotel Campus. The Engineering building will be expanded to the south. Most of the expansion will occur in a driveway/parking area that is already paved. A slight increase in imperviousness and runoff will result in the building expansion (Sub-basin A-1). Runoff will continue to sheet flow to the roadside swale and grated inlets. Stormwater quality will not be required for this site since all runoff discharges to the golf course.

Other changes on the west side include moving the west entrance to El Pomar Road across from Pauline Memorial Catholic School. The West Golf Course Residences A is planned for the west end of Hole 1 of the west golf course across the street from the Engineering building. A new layout for the west parking lot and drives will be designed to accommodate the new west entrance and the new condominiums. These changes affect drainage patterns and runoff quantities in Sub-basins A-2, A-3, and B-1. A smaller area and less runoff (Sub-basin B-2) will be draining to the storm sewer system in the parking lot that carries runoff to the lake via the 24" RCP. Some of the existing inlets will need to be replaced with new inlets and pipe to pick up runoff due to the new parking lot configuration. A portion of the existing parking lot will be replaced with the new west entrance and driveways, which will now be collected into the storm sewer system that drains to the south onto the golf course. A portion of the proposed West Golf Course Residences A will drain into this system as well. This results in additional runoff collected by the existing storm sewer system. To collect the additional runoff, existing inlets may need to be upsized and new inlets may need to be added. Some inlets will need to be removed and replaced to fit the new driveway layout. Sub-basin A-3 contains the remainder of the condominium building and will continue to sheet flow to the channel in the golf course. Since both Sub-basins A-2 and A-3 drain to the golf course, no stormwater quality facilities will be required.

In the northeast portion of the Broadmoor Hotel Campus, the North Brownstone Residences are proposed on Lake Circle. With this development Holly Avenue will no longer connect to Mesa Avenue. Sub-basin C-1 will continue to drain to Holly Avenue while Sub-basin C-2 will continue to drain to Mesa Avenue. Sub-basins C-3 and C-4 will continue to drain to the single-family residences located to the north of the proposed townhomes. Runoff reaching the bubbler at Mesa Avenue and Heather Drive remains essentially the same. Runoff collected in the bubbler actually decreases by 1.2 cfs (3.6%) and 1.3 cfs (1.9%) for the 5-year and 100-year storm events, respectively. Stormwater quality facilities will be required for this townhome development. Possible locations are shown on DP-2. A proposed detention facility at the northernmost point of Sub-basin C-3 will restrict runoff released onto the single-family residences at this point to historic conditions.

The proposed Events Center and Parking Structure is located between Lake Circle and Holly Avenue. With this structure, Hazel Avenue will be vacated in this block as well as the driveway entrance on Lake Circle that currently provides access to the north side of Colorado Hall and the International Center. Runoff from a portion of Lake Circle will no longer drain to Holly Avenue as part of Sub-basin D-1. With the development of the Events Center, less area and runoff will be generated from Sub-basin D-1. This area will continue to drain to Holly Avenue and discharge from a bubbler system on Maple Avenue. Runoff draining to the bubbler in Maple Avenue decreases by 4.9 cfs (20.0%) and 9.5 cfs (20.3%) for the 5-year and 100-year storm events, respectively. The existing inlets along the north side of the International Center may need to be removed to conform to the layout of the proposed Events Center.

Townhomes are proposed at the southeast corner of Lake Circle and Lake Avenue. Less runoff will drain to Beech Avenue since the townhomes are replacing the existing parking lot. Runoff draining to Beech Avenue will decrease by 3.3 cfs (23.1%) and 6.5 cfs (22.3%) for the 5-year and 100-year storm events, respectively. Sub-basin E-3 will continue to drain to Lake Avenue. Sub-basins E-5 and E-6 will continue to drain to Beech Avenue. In exchange for stormwater quality facilities runoff from the townhomes will be collected in several onsite inlets and conveyed to a proposed 24" storm drain in Beech Avenue.

With the construction of medians in both Lake Circle and Lake Avenue, a 17' lane will be provided in each direction for both roadways. The narrowing of the lanes will increase the water depth in the driving lanes. In order to reduce the water depth to 3" or less at 12' from the median for the 5-year storm event, two additional 10' combination inlets are proposed along the west side of Lake Circle and a storm sewer system is proposed to pick up runoff collected in the bubbler systems in Lake Avenue. The system is sized to pick up the 5-year storm event in both Lake Avenue and Lake Circle. With this storm sewer system, runoff traveling to Lake Avenue (DP-3) will decrease to 11.7 cfs and 39.0 cfs for the 5-year and 100-year storm events, respectively. Runoff for the 100-year storm event from the South Brownstones and groundwater that will be pumped from the Events Center will also be collected in the proposed storm sewer system. The runoff collected in the proposed storm sewer system will be tied into the existing concrete box culvert under 2nd Street and discharge into Spring Run.

In the southeast portion of the Broadmoor Hotel Campus, the tennis courts, some minor buildings, and a driveway are being removed. The East Golf Course Residences B is proposed for this area with an access driveway off of Pourtales Road. Single-family lots are also proposed for this area. Runoff generated from Sub-basin F-1 remains essentially the same and continues to drain to Pourtales Road. Runoff generated from Sub-basin F-2 decreases due to the decrease in impervious areas. Sub-basin F-2 will continue to drain to Spring Run. Several inlets that currently pick up runoff from the tennis courts may no longer be needed. No stormwater quality facilities will be required for the East Golf Course Residences B since runoff from this structure will sheet flow across a large grass area before outfalling into Spring Run.

With the proposed development at the Broadmoor Hotel Campus, the runoff reaching the existing 36" CMP culvert at the southeast corner of the site at Pourtales Road remains essentially the same. Runoff collected in the culvert will increase by only 1 cfs (0.9%) and 2 cfs (0.6%) for the 5-year and 100-year storm events, respectively. However, the culvert is currently undersized and needs to be replaced with 2-36" RCP culverts with a headwall in order to convey the 5-year storm event.

VIII. Floodplain 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 08041C0736F, dated March 17, 1997, was reviewed to determine any potential floodplain delineation. A copy of the relevant portion of the FIRM panel is shown on Figure 3.

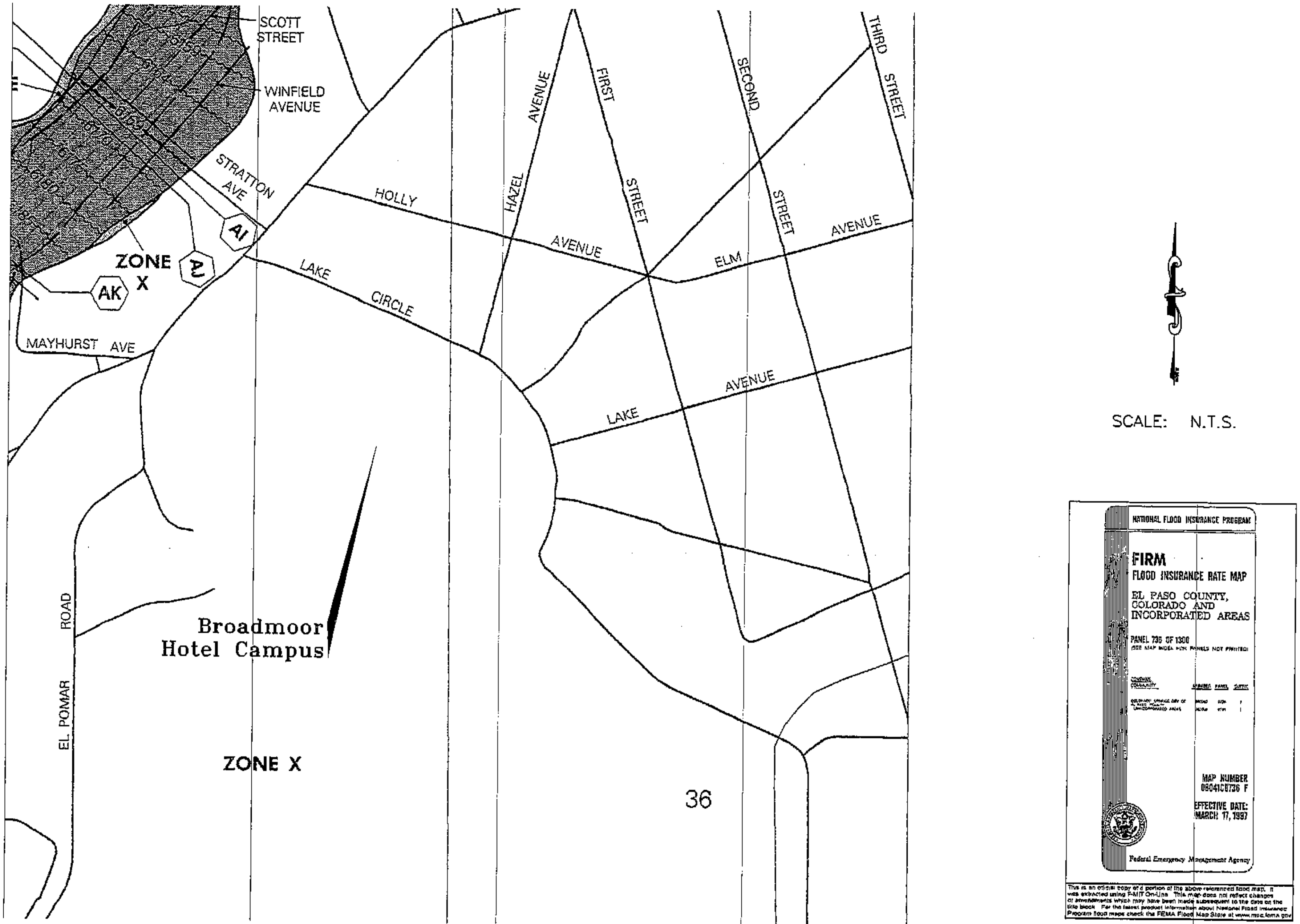


FIGURE 3 FLOOD INSURANCE RATE MAP BROADMOOR HOTEL CAMPUS

FIGURE 3.dwg/Oct 21, 2003/9:13am

IX. Cost Estimate/Fees

The Broadmoor Hotel Campus lies within the Southwest Area Drainage Basin. Drainage Fees will be due in accordance with the City of Colorado Springs Drainage fee policy for the area of each individual platting. The drainage fees will be calculated for each plat and listed in the respective Final Drainage Reports. No fees will be required for sites that have been previously platted.

A cost estimate for proposed drainage facilities, if necessary, will be calculated for each individual filing and presented in the respective Final Drainage Reports.

As discussed in the Southwest Area DBPS, the existing 36" CMP culvert under Pourtales Road is to be replaced. The estimated cost for the culvert replacement is $66,700. The cost of replacing the culvert can be applied towards required drainage fees for the Broadmoor Hotel Campus platting. Reimbursable costs will be based upon bid documents supplied by the developer.

X. Summary and Conclusions

The Broadmoor Hotel Campus is an existing hotel resort complex consisting of hotel facilities, parking areas, a lake, and other buildings. The resort encompasses roughly 100 acres excluding the golf course. The property is being masterplanned and demolition of existing structures is proposed along with construction of new facilities. The proposed facilities include an events center with underground parking, townhomes, single-family lots, condominiums, and roadway and parking lot improvements.

Drainage facilities are minimal and runoff is conveyed mostly by gutter flow or roadside ditches. The majority of the site drains either to the neighborhood to the east of the property or to Spring Run, a creek located at the southeast corner of the development. Runoff draining to the neighborhood to the east travels along the residential streets before reaching Spring Run. A small portion of the development on the north and northeast drains to neighborhood streets that carry the runoff to Cheyenne Creek. Both Spring Run and Cheyenne Creek ultimately discharge into Fountain Creek.

With the proposed facilities, drainage patterns will vary slightly. Additional area on the west side will drain to a channel in the golf course. This channel discharges into three ponds in the golf course. The golf course ponds outfall into Spring Run. Runoff from a portion of Lake Circle will be rerouted to drain to Lake Avenue rather than to Holly Avenue. With the proposed storm sewer system on the east side of the site, a portion of runoff draining to Lake Circle and Lake Avenue will be rerouted to 2nd Street. Runoff draining to Lake Avenue at 1st Street (DP-3) will decrease to 11.2 cfs and 32.3 cfs for the 5-year and 100-year storm events, respectively.

The existing onsite drainage facilities will be used as much as possible with the new Masterplan. With the new layout for the proposed buildings, parking lots, and driveways, some existing inlets may need to be moved or upgraded. Some additional inlets may be needed. Two additional 10' combination inlets along the western side of Lake Circle along with a proposed storm sewer system will collect runoff from: Lake Circle, the existing bubbler systems in Lake Avenue, the proposed South Brownstones, and groundwater from the Events Center to the existing concrete box culvert under 2nd Street.

Stormwater quality facilities will be required for some of the new development at the Broadmoor Hotel Campus. Some areas of new development, such as the West Golf Course Residences A, will not require stormwater quality facilities since runoff generated from these areas drain to a grass-lined channel and a series of ponds where sediment will settle out. The stormwater quality facility to be used for the proposed North Brownstones will likely be the Porous Landscape Detention Sedimentation Facility. These facilities will be determined, sized and designed with each respective Final Drainage Report.

Appendix
Hydrologic Calculations
Runoff Coefficient Calculations
Time of Concentration
Runoff Calculations

TABLE 5-1

RECOMMENDED AVERAGE RUNOFF COEFFICIENTS AND PERCENT IMPERVIOUS

LAND USE OR SURFACE CHARACTERISTICS	PERCENT IMPERVIOUS	"C" FREQUENCY 10		100	
		A&B*	C&D*	A&B*	C&D*
Business					
Commercial Areas	95	0.90	0.90	0.90	0.90
Neighborhood Areas	70	0.75	0.75	0.80	0.80
Residential					
1/8 Acre or less	65	0.60	0.70	0.70	0.80
1/4 Acre	40	0.50	0.60	0.60	0.70
1/3 Acre	30	0.40	0.50	0.55	0.60
1/2 Acre	25	0.35	0.45	0.45	0.55
1 Acre	20	0.30	0.40	0.40	0.50
Industrial					
Light Areas	80	0.70	0.70	0.80	0.80
Heavy Areas	90	0.80	0.80	0.90	0.90
Parks and Cemeteries	7	0.30	0.35	0.55	0.60
Playgrounds	13	0.30	0.35	0.60	0.65
Railroad Yard Areas	40	0.50	0.55	0.60	0.65
Undeveloped Areas					
Historic Flow Analysis- Greenbelts, Agricultural	2	0.15	0.25	0.20	0.30
Pasture/Meadow	0	0.25	0.30	0.35	0.45
Forest	0	0.10	0.15	0.15	0.20
Exposed Rock	100	0.90	0.90	0.95	0.95
Offsite Flow Analysis (when land use not defined)	45	0.55	0.60	0.65	0.70
Streets					
Paved	100	0.90	0.90	0.95	0.95
Gravel	80	0.80	0.80	0.85	0.85
Drive and Walks	100	0.90	0.90	0.95	0.95
Roofs	90	0.90	0.90	0.95	0.95
Lawns	0	0.25	0.30	0.35	0.45

* Hydrologic Soil Group

Broadmoor Hotel Campus
Existing Runoff Coefficient Calculations

Basin / Design Point	Total Area (acres)	% Pavement & Roof Area	% Lawn Area	Coefficients C_5	C_{100}
Existing Condition					
A-1	5.65 ac	60.0%	40.0%	**0.64**	**0.71**
A-2	4.78 ac	60.0%	40.0%	**0.64**	**0.71**
A-3	5.48 ac	5.0%	95.0%	**0.28**	**0.38**
A-4	7.56 ac	10.0%	90.0%	**0.32**	**0.41**
B-1	4.00 ac	75.0%	25.0%	**0.74**	**0.80**
B-2	19.34 ac	25.0%	75.0%	**0.41**	**0.50**
C-1	3.88 ac	90.0%	10.0%	**0.84**	**0.89**
C-2	0.67 ac	63.0%	37.0%	**0.66**	**0.73**
C-3	2.11 ac	38.0%	62.0%	**0.50**	**0.58**
C-4	1.17 ac	78.0%	22.0%	**0.76**	**0.82**
C-5	6.90 ac	25.0%	75.0%	**0.41**	**0.50**
D-1	7.25 ac	85.0%	15.0%	**0.80**	**0.86**
D-2	0.72 ac	82.0%	18.0%	**0.78**	**0.84**
E-1A	2.10 ac	50.0%	50.0%	**0.58**	**0.65**
E-1	8.61 ac	60.0%	40.0%	**0.64**	**0.71**
E-2	2.61 ac	75.0%	25.0%	**0.74**	**0.80**
E-3	2.05 ac	40.0%	60.0%	**0.51**	**0.59**
E-4	4.10 ac	60.0%	40.0%	**0.64**	**0.71**
E-5	1.59 ac	95.0%	5.0%	**0.87**	**0.92**
E-6	1.68 ac	18.0%	82.0%	**0.37**	**0.46**
E-7	1.94 ac	25.0%	75.0%	**0.41**	**0.50**
F-1	2.73 ac	55.0%	45.0%	**0.61**	**0.68**
F-2	8.77 ac	51.0%	49.0%	**0.58**	**0.66**
F-3	1.39 ac	25.0%	75.0%	**0.41**	**0.50**
G-1	3.65 ac	70.0%	30.0%	**0.71**	**0.77**
OS-1	11.30 ac	50.0%	50.0%	**0.58**	**0.65**
OS-2	8.80 ac	50.0%	50.0%	**0.58**	**0.65**
DP-1	12.45 ac	55.9%	44.1%	**0.61**	**0.69**
DP-2	14.73 ac	49.9%	50.1%	**0.57**	**0.65**
DP-3	19.47 ac	58.8%	41.2%	**0.63**	**0.70**
DP-4	5.21 ac	44.1%	55.9%	**0.54**	**0.61**

Runoff Coefficients		5-Year	100-Year
	Road/Roof	0.90	0.95
	Lawn	0.25	0.35

Broadmoor Hotel Campus

Existing Time of Concentration Calculation

Basin	Slope			Length			Run Coef.	Velocity			T_c			T_c	Basin
	O'land 1	Chan. 1	Chan. 2	O'land 1	Chan. 1	Chan. 2	(5-year)	O'land 1	Chan. 1	Chan. 2	O'land 1	Chan. 1	Chan. 2		
Existing Condition															
A-1	6.0 %	3.5 %	2.3 %	200 lf	240 lf	260 lf	0.64		2.9 ft/sec	2.3 ft/sec	6.7 min.	1.4 min.	1.9 min.	**10.0 min.**	A-1
A-2	2.7 %			75 lf	565 lf		0.64		4.8 ft/sec		5.4 min.	2.0 min.		**7.3 min.**	A-2
A-3	3.3 %	3.4 %		300 lf	530 lf		0.28		2.0 ft/sec		17.8 min.	4.4 min.		**22.2 min.**	A-3
A-4	4.7 %	3.2 %		380 lf	310 lf		0.32		2.9 ft/sec		17.1 min.	1.8 min.		**18.9 min.**	A-4
B-1	3.3 %	3.2 %		60 lf	110 lf	670 lf	0.74		3.5 ft/sec	5.7 ft/sec	3.5 min.	0.5 min.	2.0 min.	**6.0 min.**	B-1
B-2	2.7 %			75 lf	260 lf		0.41		3.7 ft/sec		8.0 min.	1.2 min.		**9.2 min.**	B-2
C-1		3.7 %	0.8 %		215 lf	500 lf	0.84		3.5 ft/sec	1.4 ft/sec		1.0 min.	6.0 min.	**7.0 min.**	C-1
C-2	2.9 %	2.7 %		70 lf	130 lf		0.66		3.3 ft/sec		4.8 min.	0.7 min.		**5.5 min.**	C-2
C-3		1.4 %	3.0 %		430 lf	320 lf	0.50		1.8 ft/sec	3.5 ft/sec		4.0 min.	1.5 min.	**5.5 min.**	C-3
C-4		1.5 %			160 lf		0.76		2.4 ft/sec			1.1 min.		**5.0 min.**	C-4
C-5	3.3 %	3.0 %	1.6 %	300 lf	260 lf	185 lf	0.41		2.7 ft/sec	2.5 ft/sec	15.0 min.	1.6 min.	1.2 min.	**17.8 min.**	C-5
D-1		1.4 %	2.8 %		1,200 lf	325 lf	0.80		2.4 ft/sec	5.6 ft/sec		8.3 min.	1.0 min.	**9.3 min.**	D-1
D-2	5.6 %	1.3 %		90 lf	160 lf		0.78		2.2 ft/sec		3.2 min.	1.2 min.		**5.0 min.**	D-2
E-1A	5.0 %	2.5 %		60 lf	650 lf		0.58		3.2 ft/sec		4.4 min.	3.4 min.		**7.8 min.**	E-1A
E-1	25.0 %	1.5 %		40 lf	1,230 lf		0.64		2.4 ft/sec		1.9 min.	8.5 min.		**10.4 min.**	E-1
E-2	12.0 %	2.7 %		40 lf	470 lf		0.74		3.3 ft/sec		1.9 min.	2.4 min.		**5.0 min.**	E-2
E-3		2.0 %	2.4 %		30 lf	550 lf	0.51		2.8 ft/sec	3.0 ft/sec		0.2 min.	3.1 min.	**5.0 min.**	E-3
E-4	2.5 %	1.9 %		60 lf	655 lf		0.64		2.8 ft/sec		4.9 min.	3.9 min.		**8.8 min.**	E-4
E-5		3.0 %	1.5 %		230 lf	80 lf	0.87		3.5 ft/sec	2.4 ft/sec		1.1 min.	0.6 min.	**5.0 min.**	E-5
E-6	4.7 %	2.0 %		80 lf	450 lf		0.37		2.2 ft/sec		7.3 min.	3.4 min.		**10.7 min.**	E-6
E-7	1.5 %	1.7 %		280 lf	230 lf		0.41		2.5 ft/sec		18.8 min.	1.5 min.		**20.3 min.**	
F-1	2.5 %	1.6 %		20 lf	1,100 lf		0.61		2.5 ft/sec		3.0 min.	7.3 min.		**10.4 min.**	F-1
F-2	2.0 %		1.5 %	200 lf	870 lf	535 lf	0.58	2.8 ft/sec	4.8 ft/sec	4.3 ft/sec	1.2 min.	3.0 min.	2.1 min.	**6.3 min.**	F-2
F-3	3.0 %	3.0 %		210 lf	560 lf		0.41		2.7 ft/sec		12.9 min.	3.5 min.		**16.4 min.**	F-3
G-1		2.6 %	2.0 %		115 lf	950 lf	0.71		2.5 ft/sec	2.8 ft/sec		0.8 min.	5.7 min.	**6.4 min.**	G-1
OS-1	7.3 %	3.5 %		900 lf	400 lf		0.58		2.8 ft/sec		15.2 min.	2.4 min.		**17.6 min.**	OS-1
OS-2	8.8 %	4.0 %	2.1 %	300 lf	600 lf	480 lf	0.58		3.0 ft/sec	2.9 ft/sec	8.2 min.	3.3 min.	2.8 min.	**14.3 min.**	OS-2
DP-1							0.61							**20.0 min.**	DP-1
DP-2							0.57							**10.7 min.**	DP-2
DP-3							0.63							**18.8 min.**	DP-3
DP-4							0.54							**5.0 min.**	DP-4

Equations:

Time of Concentration (Overland) = $1.87(1.1-C_5)L^{0.5}\,S^{-0.333}$

C_5 = Runoff coefficient for five-year flow

L = Length of overland flow in feet

S = Slope of flow path in percent

Velocity (Road) = $10(10^{(0.5\log S+0.3)})$

S = Slope of flow path in percent

Velocity (Channel) = $(1.49/n)R_n^{2/3}\,S^{1/2}$

Slope (S) = Slope of the channel

n = Manning's number

R_n = Hydraulic Radius (Reynold's Number)

Broadmoor Hotel Campus
Existing Basin Runoff Calculation

Basin / Design Point	Contributing Basins	Area	C_5	C_{100}	Time of Concentration	Rainfall Intensity i_5	Rainfall Intensity i_{100}	Runoff Q_5	Runoff Q_{100}	Basin / Design Point
Existing Condition										
A-1		5.65 ac	0.64	0.71	10.0 min.	4.1 in/hr	7.3 in/hr	**14.9 cfs**	**29.4 cfs**	A-1
A-2		4.78 ac	0.64	0.71	7.3 min.	4.6 in/hr	8.2 in/hr	**14.0 cfs**	**27.7 cfs**	A-2
A-3		5.48 ac	0.28	0.38	22.2 min.	2.9 in/hr	5.1 in/hr	**4.4 cfs**	**10.6 cfs**	A-3
A-4		7.56 ac	0.32	0.41	18.9 min.	3.1 in/hr	5.5 in/hr	**7.4 cfs**	**17.1 cfs**	A-4
B-1		4.00 ac	0.74	0.80	6.0 min.	4.9 in/hr	8.7 in/hr	**14.3 cfs**	**27.7 cfs**	B-1
B-2		19.34 ac	0.41	0.50	9.2 min.	4.2 in/hr	7.5 in/hr	**33.8 cfs**	**73.0 cfs**	B-2
C-1		3.88 ac	0.84	0.89	7.0 min.	4.6 in/hr	8.3 in/hr	**15.1 cfs**	**28.6 cfs**	C-1
C-2		0.67 ac	0.66	0.73	5.5 min.	5.0 in/hr	8.9 in/hr	**2.2 cfs**	**4.3 cfs**	C-2
C-3		2.11 ac	0.50	0.58	5.5 min.	5.0 in/hr	8.9 in/hr	**5.2 cfs**	**10.8 cfs**	C-3
C-4		1.17 ac	0.76	0.82	5.0 min.	5.1 in/hr	9.1 in/hr	**4.5 cfs**	**8.7 cfs**	C-4
C-5		6.90 ac	0.41	0.50	17.8 min.	3.2 in/hr	5.7 in/hr	**9.1 cfs**	**19.6 cfs**	C-5
D-1		7.25 ac	0.80	0.86	9.3 min.	4.2 in/hr	7.5 in/hr	**24.5 cfs**	**46.8 cfs**	D-1
D-2		0.72 ac	0.78	0.84	5.0 min.	5.1 in/hr	9.1 in/hr	**2.9 cfs**	**5.5 cfs**	D-2
E-1A		2.10 ac	0.58	0.65	7.8 min.	4.5 in/hr	8.0 in/hr	**5.4 cfs**	**10.9 cfs**	E-1A
E-1		8.61 ac	0.64	0.71	10.4 min.	4.0 in/hr	7.2 in/hr	**22.3 cfs**	**44.0 cfs**	E-1
E-2		2.61 ac	0.74	0.80	5.0 min.	5.1 in/hr	9.1 in/hr	**9.8 cfs**	**19.0 cfs**	E-2
E-3		2.05 ac	0.51	0.59	5.0 min.	5.1 in/hr	9.1 in/hr	**5.3 cfs**	**11.0 cfs**	E-3
E-4		4.10 ac	0.64	0.71	8.8 min.	4.3 in/hr	7.7 in/hr	**11.3 cfs**	**22.3 cfs**	E-4
E-5		1.59 ac	0.87	0.92	5.0 min.	5.1 in/hr	9.1 in/hr	**7.0 cfs**	**13.3 cfs**	E-5
E-6		1.68 ac	0.37	0.46	10.7 min.	4.0 in/hr	7.1 in/hr	**2.5 cfs**	**5.5 cfs**	E-6
E-7		1.94 ac	0.41	0.50	20.3 min.	3.0 in/hr	5.3 in/hr	**2.4 cfs**	**5.2 cfs**	E-7
F-1		2.73 ac	0.61	0.68	10.4 min.	4.0 in/hr	7.2 in/hr	**6.7 cfs**	**13.4 cfs**	F-1
F-2		8.77 ac	0.58	0.66	6.3 min.	4.8 in/hr	8.5 in/hr	**24.5 cfs**	**49.1 cfs**	F-2
F-3		1.39 ac	0.41	0.50	16.4 min.	3.3 in/hr	5.9 in/hr	**1.9 cfs**	**4.1 cfs**	F-3
G-1		3.65 ac	0.71	0.77	6.4 min.	4.8 in/hr	8.5 in/hr	**12.3 cfs**	**23.9 cfs**	G-1
OS-1		11.30 ac	0.58	0.65	17.6 min.	3.2 in/hr	5.7 in/hr	**20.9 cfs**	**42.0 cfs**	OS-1
OS-2		8.80 ac	0.58	0.65	14.3 min.	3.5 in/hr	6.3 in/hr	**17.9 cfs**	**36.0 cfs**	OS-2
DP-1	OS-2, G-1	12.45 ac	0.61	0.69	20.0 min.	3.0 in/hr	5.4 in/hr	**23.0 cfs**	**45.8 cfs**	DP-1
DP-2	All C Basins	14.73 ac	0.57	0.65	10.7 min.	4.0 in/hr	7.1 in/hr	**33.8 cfs**	**68.0 cfs**	DP-2
DP-3	E-1A, E-1, E-2, E-3, E-4	19.47 ac	0.63	0.70	18.8 min.	3.1 in/hr	5.5 in/hr	**38.4 cfs**	**75.9 cfs**	DP-3
DP-4	E-5, E-6, E-7	5.21 ac	0.54	0.61	5.0 min.	5.1 in/hr	9.1 in/hr	**14.3 cfs**	**29.1 cfs**	DP-4

Equations:

$i_5=40/((10+T_c)^{0.76})$

$i_{100}=71.2/((10+T_c)^{0.76})$

i_5=Average 5-year Rainafall Intensity in inches per hou

i_{100}=Average 100-year Rainfall Intensity in inches per hou

T_c=Time of Concentration

Q = CiA

Q = Peak Runoff Rate, in cubic feet per second (cfs)

C = Runoff coefficient representing a ration of peak runoff rate to average rainfal intensity for a duration equal to the runoff time of concentration

i = average rainfall intensity in inches per hour

A = Drainage area in acres

Broadmoor Hotel Campus
Future Runoff Coefficient Calculations

Basin / Design Point	Total Area (acres)	% Pavement & Roof Area	% Lawn Area	Coefficients C_5	C_{100}
Future Condition					
A-1	5.65 ac	66.0%	34.0%	**0.68**	**0.75**
A-2	7.29 ac	52.0%	48.0%	**0.59**	**0.66**
A-3	4.53 ac	15.0%	85.0%	**0.35**	**0.44**
A-4	7.56 ac	10.0%	90.0%	**0.32**	**0.41**
B-1	2.32 ac	57.0%	43.0%	**0.62**	**0.69**
B-2	19.34 ac	25.0%	75.0%	**0.41**	**0.50**
C-1	3.63 ac	65.0%	35.0%	**0.67**	**0.74**
C-2	0.88 ac	61.0%	39.0%	**0.65**	**0.72**
C-3	1.99 ac	50.0%	50.0%	**0.58**	**0.65**
C-4	1.17 ac	53.0%	47.0%	**0.59**	**0.67**
C-5	6.90 ac	25.0%	75.0%	**0.41**	**0.50**
D-1	5.01 ac	90.0%	10.0%	**0.84**	**0.89**
D-2	0.72 ac	82.0%	18.0%	**0.78**	**0.84**
E-1A	2.42 ac	57.0%	43.0%	**0.62**	**0.69**
E-1	8.81 ac	60.0%	40.0%	**0.64**	**0.71**
E-2	4.36 ac	70.0%	30.0%	**0.71**	**0.77**
E-3	0.87 ac	64.0%	36.0%	**0.67**	**0.73**
E-3A	1.20 ac	41.0%	59.0%	**0.52**	**0.60**
E-4	4.10 ac	60.0%	40.0%	**0.64**	**0.71**
E-5	1.93 ac	60.0%	40.0%	**0.64**	**0.71**
E-6	0.50 ac	58.0%	42.0%	**0.63**	**0.70**
E-6A	1.46 ac	20.0%	80.0%	**0.38**	**0.47**
E-7	1.30 ac	28.0%	72.0%	**0.43**	**0.52**
F-1	2.48 ac	60.0%	40.0%	**0.64**	**0.71**
F-2	9.01 ac	29.0%	71.0%	**0.44**	**0.52**
F-3	1.39 ac	25.0%	75.0%	**0.41**	**0.50**
G-1	3.65 ac	70.0%	30.0%	**0.71**	**0.77**
OS-1	11.30 ac	50.0%	50.0%	**0.58**	**0.65**
OS-2	8.80 ac	50.0%	50.0%	**0.58**	**0.65**
DP-1	12.45 ac	55.9%	44.1%	**0.61**	**0.69**
DP-2	14.57 ac	42.8%	57.2%	**0.53**	**0.61**
DP-3	21.76 ac	60.8%	39.2%	**0.65**	**0.71**
DP-4	5.19 ac	40.5%	59.5%	**0.51**	**0.59**

		5-Year	100-Year
Runoff Coefficients	Road/Roof	0.90	0.95
	Lawn	0.25	0.35

Broadmoor Hotel Campus
Future Time of Concentration Calculation

Basin	Slope O'land 1	Slope Chan. 1	Slope Chan. 2	Length O'land 1	Length Chan. 1	Length Chan. 2	Run Coef. (5-year)	Velocity O'land 1	Velocity Chan. 1	Velocity Chan. 2	T_c O'land 1	T_c Chan. 1	T_c Chan. 2	T_c	Basin
Future Condition															
A-1	5.5 %	3.5 %		200 lf	240 lf		0.68		2.9 ft/sec		6.3 min.	1.4 min.		**7.7 min.**	A-1
A-2	2.7 %			75 lf	565 lf		0.59		4.8 ft/sec		6.0 min.	2.0 min.		**7.9 min.**	A-2
A-3	2.0 %	3.0 %		200 lf	625 lf		0.35		2.7 ft/sec		15.8 min.	3.9 min.		**19.7 min.**	A-3
A-4	4.7 %	3.2 %		380 lf	310 lf		0.32		2.9 ft/sec		17.1 min.	1.8 min.		**18.9 min.**	A-4
B-1	5.0 %	2.0 %		40 lf	110 lf	450 lf	0.62		2.8 ft/sec	5.7 ft/sec	3.3 min.	0.7 min.	1.3 min.	**5.3 min.**	B-1
B-2	2.7 %			75 lf	260 lf		0.41		3.7 ft/sec		8.0 min.	1.2 min.		**9.2 min.**	B-2
C-1		3.3 %	1.5 %		60 lf	780 lf	0.67		3.7 ft/sec	2.4 ft/sec		0.3 min.	5.4 min.	**5.7 min.**	C-1
C-2	4.0 %	3.0 %		50 lf	280 lf		0.65		3.5 ft/sec		3.8 min.	1.3 min.		**5.1 min.**	C-2
C-3	5.0 %	3.3 %	1.0 %	20 lf	120 lf	335 lf	0.58		2.7 ft/sec	2.0 ft/sec	2.6 min.	0.7 min.	2.8 min.	**6.1 min.**	C-3
C-4	3.0 %	1.0 %		30 lf	300 lf		0.59		1.5 ft/sec		3.6 min.	3.3 min.		**6.9 min.**	C-4
C-5	3.3 %	3.0 %	1.6 %	300 lf	260 lf	185 lf	0.41		2.7 ft/sec	2.5 ft/sec	15.0 min.	1.6 min.	1.2 min.	**17.8 min.**	C-5
D-1		1.5 %	2.2 %		320 lf	500 lf	0.84		1.8 ft/sec	2.2 ft/sec		3.0 min.	3.8 min.	**6.8 min.**	D-1
D-2	5.6 %	1.3 %		90 lf	160 lf		0.78		2.2 ft/sec		3.2 min.	1.2 min.		**5.0 min.**	D-2
E-1A		2.5 %			1,270 lf		0.62		3.2 ft/sec			6.6 min.		**6.6 min.**	E-1A
E-1	25.0 %	1.5 %		40 lf	1,230 lf		0.64		2.4 ft/sec		1.9 min.	8.5 min.		**10.4 min.**	E-1
E-2		1.7 %			1,570 lf		0.71		2.6 ft/sec			10.1 min.		**10.1 min.**	E-2
E-3	2.0 %	2.3 %		10 lf	350 lf		0.67		3.0 ft/sec		2.0 min.	1.9 min.		**5.0 min.**	E-3
E-3A	5.0 %	2.0 %	1.0 %	20 lf	240 lf	170 lf	0.52		2.2 ft/sec	2.0 ft/sec	2.9 min.	1.8 min.	1.4 min.	**6.1 min.**	E-3A
E-4	2.5 %	1.9 %		60 lf	655 lf		0.64		2.8 ft/sec		4.9 min.	3.9 min.		**8.8 min.**	E-4
E-5	2.0 %	2.0 %	1.5 %	40 lf	420 lf	100 lf	0.64		2.2 ft/sec	2.7 ft/sec	4.3 min.	3.2 min.	0.6 min.	**8.1 min.**	E-5
E-6	2.0 %	3.3 %		20 lf	180 lf		0.63		2.7 ft/sec		3.1 min.	1.1 min.		**5.0 min.**	E-6
E-6A	2.7 %	2.0 %	1.0 %	150 lf	120 lf	175 lf	0.38		2.2 ft/sec	2.0 ft/sec	11.8 min.	0.9 min.	1.5 min.	**14.2 min.**	E-6A
E-7	4.0 %	2.0 %	2.0 %	50 lf	200 lf	120 lf	0.43		2.2 ft/sec	2.8 ft/sec	5.6 min.	1.5 min.	0.7 min.	**7.8 min.**	E-7
F-1	2.5 %	1.6 %		20 lf	1,100 lf		0.64		2.5 ft/sec		2.8 min.	7.3 min.		**10.2 min.**	F-1
F-2	2.0 %		1.5 %	200 lf	870 lf	535 lf	0.44	2.8 ft/sec	4.8 ft/sec	4.3 ft/sec	1.2 min.	3.0 min.	2.1 min.	**6.3 min.**	F-2
F-3	3.0 %	3.0 %		210 lf	560 lf		0.41		2.7 ft/sec		12.9 min.	3.5 min.		**16.4 min.**	F-3
G-1		2.6 %	2.0 %		115 lf	950 lf	0.71		2.5 ft/sec	2.8 ft/sec		0.8 min.	5.7 min.	**6.4 min.**	G-1
OS-1	7.3 %	3.5 %		900 lf	400 lf		0.58		2.8 ft/sec		15.2 min.	2.4 min.		**17.6 min.**	OS-1
OS-2	8.8 %	4.0 %	2.1 %	300 lf	600 lf	480 lf	0.58		3.0 ft/sec	2.9 ft/sec	8.2 min.	3.3 min.	2.8 min.	**14.3 min.**	OS-2
DP-1							0.61							**20.0 min.**	DP-1
DP-2							0.53							**9.2 min.**	DP-2
DP-3							0.65							**18.3 min.**	DP-3
DP-4							0.51							**9.9 min.**	DP-4

Equations:

Time of Concentration (Overland) = $1.87(1.1-C_5)L^{0.5}S^{-0.333}$

C_5 = Runoff coefficient for five-year flow

L = Length of overland flow in feet

S = Slope of flow path in percent

Velocity (Road) = $10(10^{(0.5\log S - 0.3)})$

S = Slope of flow path in percent

Velocity (Channel) = $(1.49/n)R_n^{2/3}S^{1/2}$

Slope (S) = Slope of the channel

n = Manning's number

R_n = Hydraulic Radius (Reynold's Number)

Broadmoor Hotel Campus
Future Basin Runoff Calculation

Basin / Design Point	Contributing Basins	Area	C_5	C_{100}	Time of Concentration	Rainfall Intensity i_5	Rainfall Intensity i_{100}	Runoff Q_5	Runoff Q_{100}	Basin / Design Point
Future Condition										
A-1		5.65 ac	0.68	0.75	7.7 min.	4.5 in/hr	8.0 in/hr	**17.3 cfs**	**33.8 cfs**	A-1
A-2		7.29 ac	0.59	0.66	7.9 min.	4.5 in/hr	7.9 in/hr	**19.1 cfs**	**38.3 cfs**	A-2
A-3		4.53 ac	0.35	0.44	19.7 min.	3.0 in/hr	5.4 in/hr	**4.8 cfs**	**10.8 cfs**	A-3
A-4		7.56 ac	0.32	0.41	18.9 min.	3.1 in/hr	5.5 in/hr	**7.4 cfs**	**17.1 cfs**	A-4
B-1		2.32 ac	0.62	0.69	5.3 min.	5.0 in/hr	9.0 in/hr	**7.2 cfs**	**14.4 cfs**	B-1
B-2		19.34 ac	0.41	0.50	9.2 min.	4.2 in/hr	7.5 in/hr	**33.8 cfs**	**73.0 cfs**	B-2
C-1		3.63 ac	0.67	0.74	5.7 min.	4.9 in/hr	8.8 in/hr	**12.1 cfs**	**23.6 cfs**	C-1
C-2		0.88 ac	0.65	0.72	5.1 min.	5.1 in/hr	9.0 in/hr	**2.9 cfs**	**5.7 cfs**	C-2
C-3		1.99 ac	0.58	0.65	6.1 min.	4.8 in/hr	8.6 in/hr	**5.5 cfs**	**11.1 cfs**	C-3
C-4		1.17 ac	0.59	0.67	6.9 min.	4.7 in/hr	8.3 in/hr	**3.2 cfs**	**6.5 cfs**	C-4
C-5		6.90 ac	0.41	0.50	17.8 min.	3.2 in/hr	5.7 in/hr	**9.1 cfs**	**19.6 cfs**	C-5
D-1		5.01 ac	0.84	0.89	6.8 min.	4.7 in/hr	8.4 in/hr	**19.6 cfs**	**37.3 cfs**	D-1
D-2		0.72 ac	0.78	0.84	5.0 min.	5.1 in/hr	9.1 in/hr	**2.9 cfs**	**5.5 cfs**	D-2
E-1A		2.42 ac	0.62	0.69	6.6 min.	4.7 in/hr	8.4 in/hr	**7.1 cfs**	**14.1 cfs**	E-1A
E-1		8.81 ac	0.64	0.71	10.4 min.	4.0 in/hr	7.2 in/hr	**22.8 cfs**	**45.0 cfs**	E-1
E-2		4.36 ac	0.71	0.77	10.1 min.	4.1 in/hr	7.3 in/hr	**12.6 cfs**	**24.5 cfs**	E-2
E-3		0.87 ac	0.67	0.73	5.0 min.	5.1 in/hr	9.1 in/hr	**3.0 cfs**	**5.8 cfs**	E-3
E-3A		1.20 ac	0.52	0.60	6.1 min.	4.8 in/hr	8.6 in/hr	**3.0 cfs**	**6.2 cfs**	E-3A
E-4		4.10 ac	0.64	0.71	8.8 min.	4.3 in/hr	7.7 in/hr	**11.3 cfs**	**22.3 cfs**	E-4
E-5		1.93 ac	0.64	0.71	8.1 min.	4.4 in/hr	7.9 in/hr	**5.5 cfs**	**10.8 cfs**	E-5
E-6		0.50 ac	0.63	0.70	5.0 min.	5.1 in/hr	9.1 in/hr	**1.6 cfs**	**3.2 cfs**	E-6
E-6A		1.46 ac	0.38	0.47	14.2 min.	3.5 in/hr	6.3 in/hr	**2.0 cfs**	**4.3 cfs**	E-6A
E-7		1.30 ac	0.43	0.52	7.8 min.	4.5 in/hr	8.0 in/hr	**2.5 cfs**	**5.4 cfs**	E-7
F-1		2.48 ac	0.64	0.71	10.2 min.	4.1 in/hr	7.3 in/hr	**6.5 cfs**	**12.8 cfs**	F-1
F-2		9.01 ac	0.44	0.52	6.3 min.	4.8 in/hr	8.5 in/hr	**19.0 cfs**	**40.3 cfs**	F-2
F-3		1.39 ac	0.41	0.50	16.4 min.	3.3 in/hr	5.9 in/hr	**1.9 cfs**	**4.1 cfs**	F-3
G-1		3.65 ac	0.71	0.77	6.4 min.	4.8 in/hr	8.5 in/hr	**12.3 cfs**	**23.9 cfs**	G-1
OS-1		11.30 ac	0.58	0.65	17.6 min.	3.2 in/hr	5.7 in/hr	**20.9 cfs**	**42.0 cfs**	OS-1
OS-2		8.80 ac	0.58	0.65	14.3 min.	3.5 in/hr	6.3 in/hr	**17.9 cfs**	**36.0 cfs**	OS-2
DP-1	OS-2, G-1	12.45 ac	0.61	0.69	20.0 min.	3.0 in/hr	5.4 in/hr	**23.0 cfs**	**45.8 cfs**	DP-1
DP-2	C-1, C-2, C-3, C-4, C-5	14.57 ac	0.53	0.61	9.2 min.	4.2 in/hr	7.5 in/hr	**32.6 cfs**	**66.7 cfs**	DP-2
DP-3	E-1A, E-1, E-2, E-3, E-3A, E-4	21.76 ac	0.65	0.71	18.3 min.	3.2 in/hr	5.6 in/hr	**44.3 cfs**	**87.4 cfs**	DP-3
DP-4	E-5, E-6, E-6A, E-7	5.19 ac	0.51	0.59	9.9 min.	4.1 in/hr	7.3 in/hr	**11.0 cfs**	**22.6 cfs**	DP-4

Equations:

$i_5 = 40/((10+T_c)^{0.76})$

$i_{100} = 71.2/((10+T_c)^{0.76})$

i_5=Average 5-year Rainfall Intensity in inches per hour

i_{100}=Average 100-year Rainfall Intensity in inches per hour

T_c=Time of Concentration

Q = CiA

Q = Peak Runoff Rate, in cubic feet per second (cfs)

C = Runoff coefficient representing a ration of peak runoff rate to average 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

TABLE 5-4
RUNOFF CURVE NUMBERS FOR HYDROLOGIC SOIL COVER COMPLEXES - RURAL CONDITIONS
(Antecedent Moisture Condition II, and Ia = 0.2 S)
(From: U.S. Dept. of Agriculture, Soil Conservation Service, 1977)

Land Use	Cover Treatment or Practice	Hydrologic Condition	Runoff Curve Number by Hydrologic Soil Group A	B	C	D
Fallow	Straight Row	----	77	86	91	94
Row Crops	Straight Row	Poor	72	81	88	91
	Straight Row	Good	67	78	85	89
	Contoured	Poor	70	79	84	88
	Contoured	Good	65	75	82	86
	Cont. & Terraced	Poor	66	74	80	82
	Cont. & Terraced	Good	62	71	78	81
Small Grain	Straight Row	Poor	65	76	84	88
	Straight Row	Good	63	75	83	87
	Contoured	Poor	63	74	82	85
	Contoured	Good	61	73	81	84
	Cont. & Terraced	Poor	61	72	79	82
	Cont. & Terraced	Good	59	70	78	81
Close-seeded legumes 1/ or rotation meadow	Straight Row	Poor	66	77	85	89
	Straight Row	Good	58	72	81	85
	Contoured	Poor	64	75	83	85
	Contoured	Good	55	69	78	83
	Cont. & Terraced	Poor	63	73	80	83
	Cont. & Terraced	Good	51	67	76	80
Pasture or range		Poor	68	79	86	89
		Fair	49	69	79	84
		Good	39	61	74	80
	Contoured	Poor	47	67	81	88
	Contoured	Fair	25	59	75	83
	Contoured	Good	6	35	70	79
Meadow		Good	30	58	71	78
Woods		Poor	45	66	77	83
		Fair	36	60	73	79
		Good	25	55	70	77
Farmsteads		----	59	74	82	86
Roads (dirt) 2/		----	72	82	87	89
(hard surface) 2/		----	74	84	90	92

1/ Close-drilled or broadcast
2/ Including right-of-way

TABLE 5-5
RUNOFF CURVE NUMBERS FOR HYDROLOGIC SOIL COVER COMPLEXES - URBAN AND SUBURBAN CONDITIONS 1/
(Antecedent Moisture Condition II)
(From: U.S. Dept. of Agriculture, Soil Conservation Service, 1977)

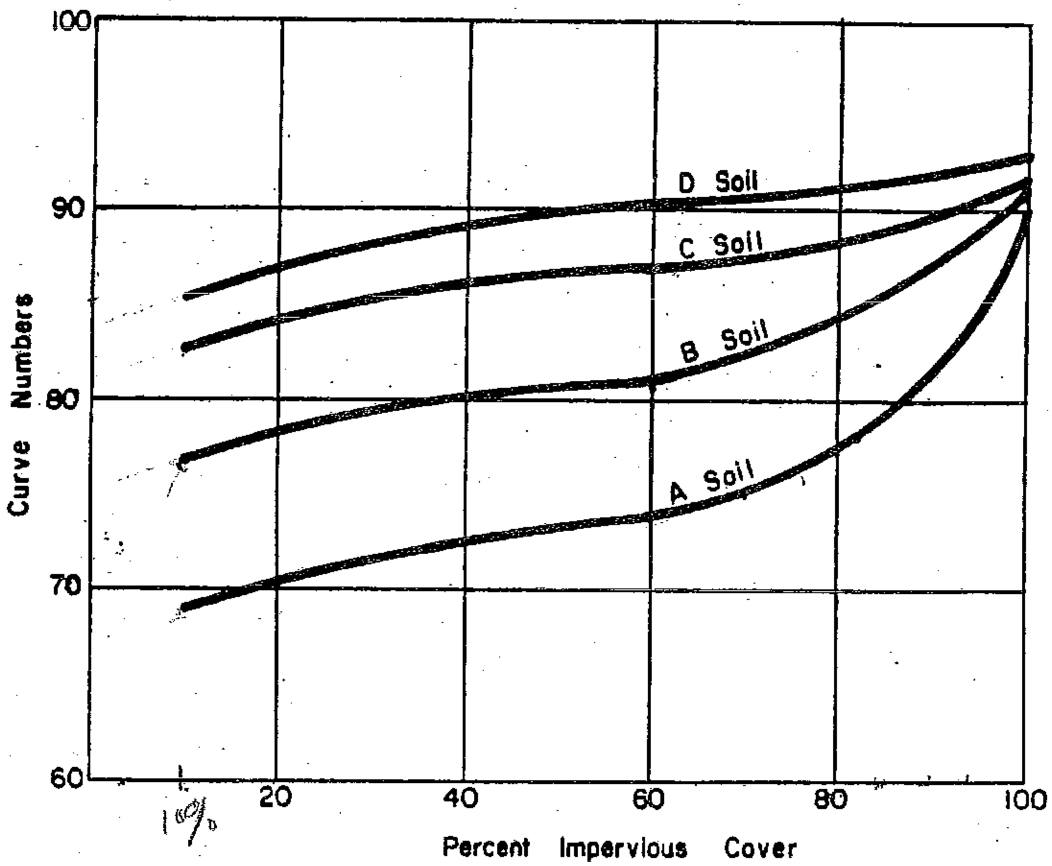
Land Use		Hydrologic Soil Group A	B	C	D
Open spaces, lawns, parks, golf courses, cemeteries, etc.					
Good condition: grass cover on 75% or more of the area		39*	61	74	80
Fair condition: grass cover on 50% to 75% of the area		49*	69	79	84
Commercial and Business areas (85% Impervious)		89*	92	94	95
Industrial Districts 72% Impervious)		81*	88	91	93
Residential: 2/					
Acres per Dwelling Unit	Average % Impervious 3/				
1/8 acre or less	65	77*	85	90	92
1/4 acre	38	61*	75	83	87
1/3 acre	30	57*	72	81	86
1/2 acre	25	54*	70	80	85
1 acre	20	51*	68	79	84
Paved parking lots, roofs, driveways, etc.		98	98	98	98
Streets and Roads:					
paved with curbs and storm sewers		98	98	98	98
gravel		76*	85	89	91
dirt		72*	82	87	89

1/ For a more detailed description of agricultural land use curve numbers, refer to the National Engineering Handbook (U.S. Dept. of Agriculture, Soil Conservation Service, 1972).

2/ Curve numbers are computed assuming the runoff from the house and driveway is directed towards the street with a minimum of roof water directed to lawns where additional infiltration could occur.

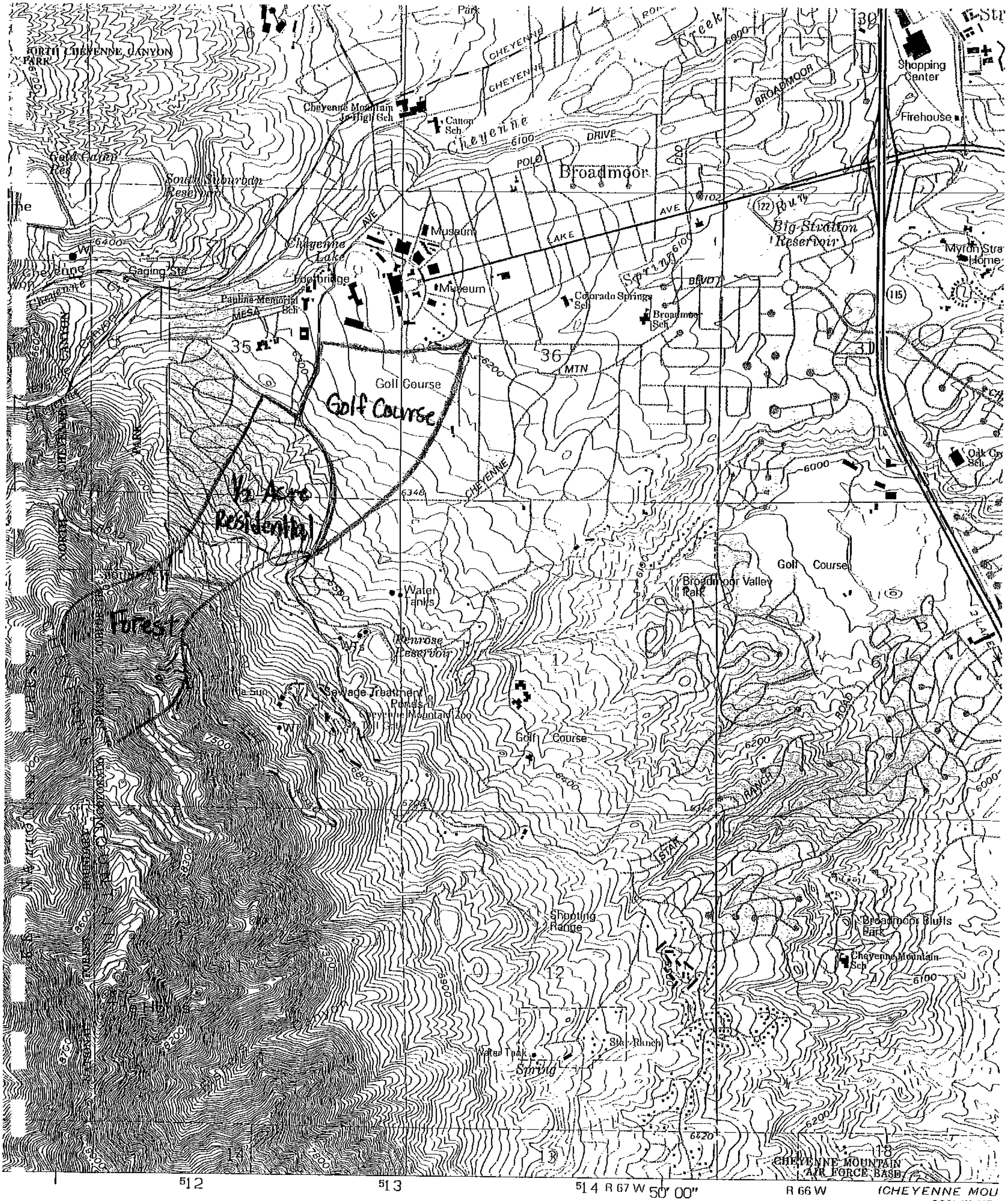
3/ The remaining pervious areas (lawn) are considered to be in good pasture condition for these curve numbers.

* Not to be used wherever overlot grading or filling is to occur.

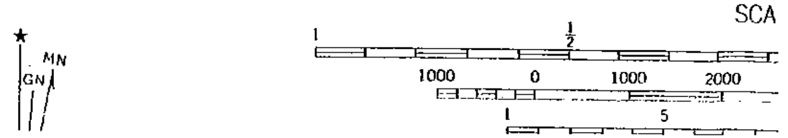


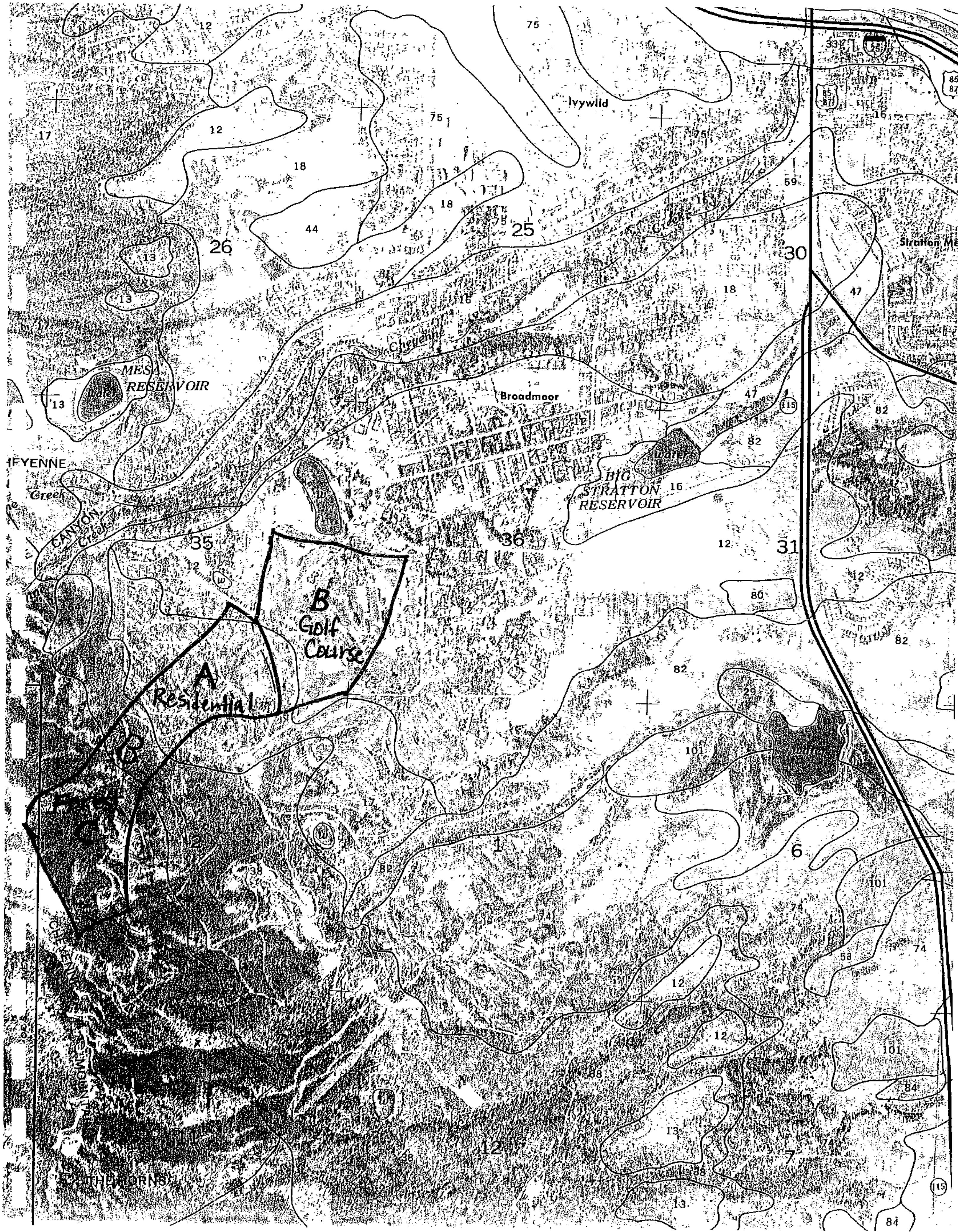
URBAN HYDROLOGIC SOIL COVER COMPLEX
& ASSOCIATED CURVE NUMBERS

REFERENCE : Pikes Peak Area Council of Governments Areawide Urban Runoff Control Manual



ed by the United States Geological Survey
y USGS and NOS/NOAA
I I m aerial photographs taken 1947. Field checked 1993
rc .. aerial photographs taken 1988 and other sources
ed 1994. Contours and land elevations have not been





Ivywild
Broadmoor
Stratton Me
MESA RESERVOIR
CHEYENNE
Creek
CANYON
Cheyenne Creek
BIG STRATTON RESERVOIR
water
A Residential
B Golf Course
B
Forest C
THE HORNS
26
25
30
35
36
31

Broadmoor Hotel Campus
HEC Calculations
Time of Concentration Calculation

Basin	Description	Runoff Curve Number	Area		Slope			Length			Run Coef.	Velocity			T_c			T_c		Lag ($0.6*T_c$)	Basin
					O'land 1	Chan. 1	Chan. 2	O'land 1	Chan. 1	Chan. 2	(5-year)	O'land 1	Chan. 1	Chan. 2	O'land 1	Chan. 1	Chan. 2				
Existing Conditions																					
1	Forest	70	110	0.1719 sq. mi.	50.0 %			3,000 lf			0.15	1.8 ft/sec			27.8 min.			**27.8 min.**	**0.46 hours**	**0.278 hours**	1
2	Residential	70	117	0.1828 sq. mi.	17.0 %	13.0 %		1,200 lf	2,000 lf		0.35	6.2 ft/sec	6.0 ft/sec		3.2 min.	5.6 min.		**8.8 min.**	**0.15 hours**	**0.088 hours**	2
3	Golf Course	61	116	0.1813 sq. mi.	7.0 %			3,200 lf			0.25	1.9 ft/sec			28.1 min.			**28.1 min.**	**0.47 hours**	**0.281 hours**	3
4	Sub-basins A-1, OS-1	81	17	0.0266 sq. mi.	7.3 %	3.5 %	3.0 %	900 lf	400 lf	1,500 lf	0.60		2.8 ft/sec	2.7 ft/sec	14.5 min.	2.4 min.		**17.6 min.**	**0.29 hours**	**0.176 hours**	4
5	Sub-basins A-2, A-3, A-4, F-2	80.5	26.6	0.0416 sq. mi.	2.7 %		3.0 %	75 lf	565 lf	600 lf	0.46		4.8 ft/sec	2.7 ft/sec	7.4 min.	2.0 min.	3.7 min.	**13.1 min.**	**0.22 hours**	**0.131 hours**	5
A	1, 2, 3	67	343.0	0.5359 sq. mi.																**0.646 hours**	A
B	4, 5	80.7	43.6	0.0681 sq. mi.																**0.307 hours**	B
Proposed Conditions																					
4		81	17	0.0266 sq. mi.	7.3 %	3.5 %		900 lf	400 lf		0.61		2.8 ft/sec		14.2 min.	2.4 min.		**17.6 min.**	**0.29 hours**	**0.176 hours**	4
5		80	28.4	0.0444 sq. mi.	2.7 %		3.0 %	75 lf	565 lf	600 lf	0.43		4.8 ft/sec	2.7 ft/sec	7.8 min.	2.0 min.	3.7 min.	**13.5 min.**	**0.22 hours**	**0.135 hours**	5
B	4,5	80.4	45.4	0.0709 sq. mi.																**0.311 hours**	B

Equations:

Time of Concentration (Overland) = $1.87(1.1-C_5)L^{0.5}S^{-0.333}$

C_5 = Runoff coefficient for five-year flow

L = Length of overland flow in feet

S = Slope of flow path in percent

```
1*****************************************                    ****************************************
 *                                       *                    *                                      *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                    *   U.S. ARMY CORPS OF ENGINEERS       *
 *             JUN   1998                *                    *   HYDROLOGIC ENGINEERING CENTER      *
 *           VERSION 4.1                 *                    *         609 SECOND STREET            *
 *                                       *                    *      DAVIS, CALIFORNIA 95616         *
 *  RUN DATE    17OCT03  TIME  16:36:02  *                    *          (916) 756-1104              *
 *                                       *                    *                                      *
*****************************************                    ****************************************
```

```
X     X  XXXXXXX   XXXXX          X
X     X  X        X     X        XX
X     X  X        X               X
XXXXXXX  XXXX     X        XXXXX  X
X     X  X        X               X
X     X  X        X     X         X
X     X  XXXXXXX   XXXXX         XXX
```

```
THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM
```

```
1                                      HEC-1 INPUT                                          PAGE  1

         LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

            1          ID        BROADMOOR RESORT COMPLEX MDDP
            2          ID        RUNOFF REACHING 36" CMP CULVERT AT POURTALES ROAD
            3          ID        OCTOMBER 17, 2003
            4          ID        5-YEAR AND 100-YEAR 24-HOUR STORMS
            5          ID        EXISTING CONDITION
            6          ID        FILENAME: BRDEXIST.DAT
                       *DIAGRAM
            7          IT       5               800     300
            8          IO       5
            9          JR    PREC      .67   1.0

           10          KK       A
           11          KM           Basin A (forest, residential, golf course)
```

```
          12          BA   .5359
          13          PB     4.5
          14          IN      15
          15          PC   .0005    .0015    .0030    .0045    .0060    .0080    .0100    .0120    .0143    .0165
          16          PC   .0188    .0210    .0233    .0255    .0278    .0320    .0390    .0460    .0530    .0600
          17          PC   .0750    .1000    .4000    .7000    .7250    .7500    .7650    .7800    .7900    .8000
          18          PC   .8100    .8200    .8250    .8300    .8350    .8400    .8450    .8500    .8550    .8600
          19          PC   .8638    .8675    .8713    .8750    .8788    .8825    .8863    .8900    .8938    .8975
          20          PC   .9013    .9050    .9083    .9115    .9148    .9180    .9210    .9240    .9270    .9300
          21          PC   .9325    .9350    .9375    .9400    .9425    .9450    .9475    .9500    .9525    .9550
          22          PC   .9575    .9600    .9625    .9650    .9675    .9700    .9725    .9750    .9775    .9800
          23          PC   .9813    .9825    .9838    .9850    .9863    .9875    .9888    .9900    .9913    .9925
          24          PC   .9938    .9950    .9963    .9975    .9988    1.000
          25          LS              67
          26          UD    .646

          27          KK       B
          28          KM            Basin B (sub-basins A-1, OS-1, A-2, A-3, A-4, F-2)
          29          BA   .0681
          30          LS             80.7
          31          UD    .307

          32          KK      DP
          33          KM            Combine Basins A and B
          34          HC       2
          35          ZZ
1
              SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

   NO.      (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

   10           A
                .
                .
   27           .           B
                .           .
                .           .
   32         DP ...........

 (***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1****************************************
 *                                      *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *
 *              JUN   1998              *
 *           VERSION 4.1                *
 *                                      *
 *  RUN DATE   17OCT03  TIME  16:36:02  *
 *                                      *
 ****************************************

 ****************************************
 *                                      *
 *    U.S. ARMY CORPS OF ENGINEERS      *
 *   HYDROLOGIC ENGINEERING CENTER      *
 *         609 SECOND STREET            *
 *      DAVIS, CALIFORNIA 95616         *
 *          (916) 756-1104              *
 *                                      *
 ****************************************
```

```
                              BROADMOOR RESORT COMPLEX MDDP
                              RUNOFF REACHING 36" CMP CULVERT AT POURTALES ROAD
                              OCTOMBER 17, 2003
                              5-YEAR AND 100-YEAR 24-HOUR STORMS
                              EXISTING CONDITION
                              FILENAME: BRDEXIST.DAT

 8 IO          OUTPUT CONTROL VARIABLES
                     IPRNT           5  PRINT CONTROL
                     IPLOT           0  PLOT CONTROL
                     QSCAL          0.  HYDROGRAPH PLOT SCALE

   IT          HYDROGRAPH TIME DATA
                      NMIN           5  MINUTES IN COMPUTATION INTERVAL
                     IDATE      1    0  STARTING DATE
                     ITIME        0800  STARTING TIME
                        NQ         300  NUMBER OF HYDROGRAPH ORDINATES
                    NDDATE      2    0  ENDING DATE
                    NDTIME        0855  ENDING TIME
                     ICENT          19  CENTURY MARK

                COMPUTATION INTERVAL     .08 HOURS
                     TOTAL TIME BASE   24.92 HOURS

       ENGLISH UNITS
            DRAINAGE AREA          SQUARE MILES
            PRECIPITATION DEPTH    INCHES
            LENGTH, ELEVATION      FEET
            FLOW                   CUBIC FEET PER SECOND
            STORAGE VOLUME         ACRE-FEET
            SURFACE AREA           ACRES
            TEMPERATURE            DEGREES FAHRENHEIT

   JP          MULTI-PLAN OPTION
                     NPLAN           1  NUMBER OF PLANS

   JR          MULTI-RATIO OPTION
                  RATIOS OF PRECIPITATION
                   .67      1.00
1

          PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
                         FLOWS IN CUBIC FEET PER SECOND,  AREA IN SQUARE MILES
                                         TIME TO PEAK IN HOURS
```

OPERATION	STATION	AREA	PLAN		RATIOS APPLIED TO PRECIPITATION RATIO 1	RATIO 2
					.67	1.00
HYDROGRAPH AT						
+	A	.54	1	FLOW	88.	261.
				TIME	6.33	6.33
HYDROGRAPH AT						
+	B	.07	1	FLOW	54.	110.
				TIME	5.92	5.92
2 COMBINED AT						
+	DP	.60	1	FLOW	111.	309.
				TIME	6.17	6.17

*** NORMAL END OF HEC-1 ***

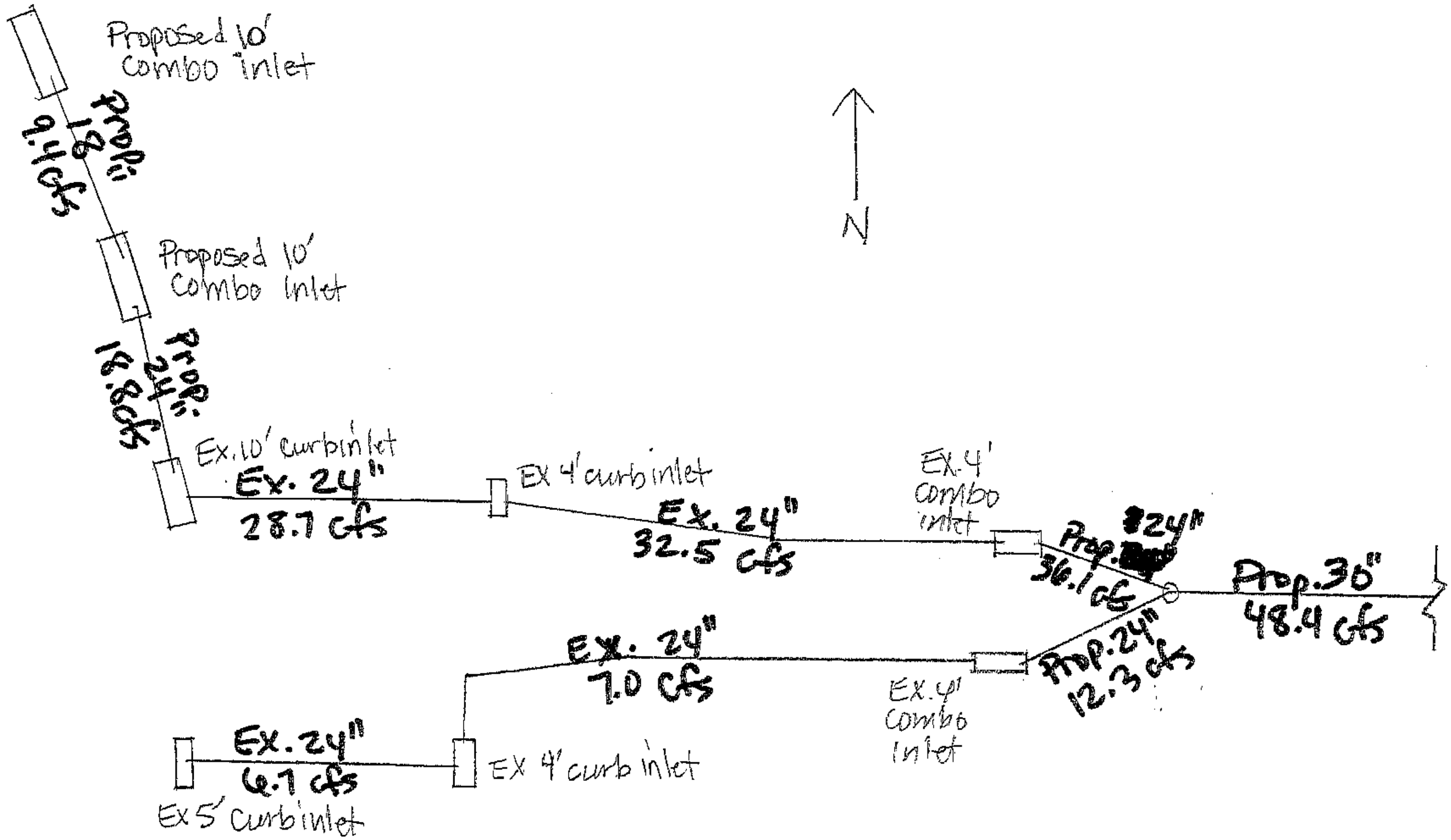
```
1*****************************************                                                        ***************************************
 *                                       *                                                        *                                     *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                                                        *   U.S. ARMY CORPS OF ENGINEERS      *
 *             JUN   1998                *                                                        *   HYDROLOGIC ENGINEERING CENTER     *
 *           VERSION 4.1                 *                                                        *         609 SECOND STREET           *
 *                                       *                                                        *     DAVIS, CALIFORNIA 95616         *
 *  RUN DATE   17OCT03  TIME  11:27:32   *                                                        *         (916) 756-1104              *
 *                                       *                                                        *                                     *
*****************************************                                                         ***************************************


                                        X     X  XXXXXXX   XXXXX          X
                                        X     X  X        X     X        XX
                                        X     X  X        X               X
                                        XXXXXXX  XXXX     X        XXXXX  X
                                        X     X  X        X               X
                                        X     X  X        X     X         X
                                        X     X  XXXXXXX   XXXXX         XXX


                  THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

                  THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
                  THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
                  NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
                  DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
                  KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM


1                                            HEC-1 INPUT                                                      PAGE  1

         LINE       ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

           1        ID       BROADMOOR RESORT COMPLEX MDDP
           2        ID       RUNOFF REACHING 36" CMP CULVERT AT POURTALES ROAD
           3        ID       OCTOMBER 17, 2003
           4        ID       5-YEAR AND 100-YEAR 24-HOUR STORMS
           5        ID       PROPOSED CONDITION
           6        ID       FILENAME: BRDFUTUR.DAT
                    *DIAGRAM
           7        IT       5             800     300
           8        IO       5
           9        JR    PREC      .67    1.0

          10        KK       A
          11        KM          Basin A (forest, residential, golf course)
          12        BA   .5359
          13        PB     4.5
          14        IN      15
          15        PC   .0005   .0015   .0030   .0045   .0060   .0080   .0100   .0120   .0143   .0165
          16        PC   .0188   .0210   .0233   .0255   .0278   .0320   .0390   .0460   .0530   .0600
          17        PC   .0750   .1000   .4000   .7000   .7250   .7500   .7650   .7800   .7900   .8000
          18        PC   .8100   .8200   .8250   .8300   .8350   .8400   .8450   .8500   .8550   .8600
```

```
            19             PC  .8638   .8675   .8713   .8750   .8788   .8825   .8863   .8900   .8938   .8975
            20             PC  .9013   .9050   .9083   .9115   .9148   .9180   .9210   .9240   .9270   .9300
            21             PC  .9325   .9350   .9375   .9400   .9425   .9450   .9475   .9500   .9525   .9550
            22             PC  .9575   .9600   .9625   .9650   .9675   .9700   .9725   .9750   .9775   .9800
            23             PC  .9813   .9825   .9838   .9850   .9863   .9875   .9888   .9900   .9913   .9925
            24             PC  .9938   .9950   .9963   .9975   .9988   1.000
            25             LS             67
            26             UD   .646

            27             KK      B
            28             KM           Basin B (sub-basins A-1, OS-1, A-2, A-3, A-4, F-2)
            29             BA  .0709
            30             LS            80.4
            31             UD   .311

            32             KK     DP
            33             KM           Combine Basins A and B
            34             HC      2
            35             ZZ
1
                SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE      (V) ROUTING         (--->) DIVERSION OR PUMP FLOW

   NO.      (.) CONNECTOR       (<---) RETURN OF DIVERTED OR PUMPED FLOW

    10          A
                .
                .
    27          .           B
                .           .
                .           .
    32        DP ............

 (***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1*****************************************                                   ***************************************
 *                                       *                                   *                                     *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                                   *     U.S. ARMY CORPS OF ENGINEERS    *
 *              JUN   1998               *                                   *     HYDROLOGIC ENGINEERING CENTER   *
 *           VERSION 4.1                 *                                   *           609 SECOND STREET         *
 *                                       *                                   *        DAVIS, CALIFORNIA 95616      *
 *  RUN DATE   17OCT03  TIME  11:27:32   *                                   *            (916) 756-1104           *
 *                                       *                                   *                                     *
 *****************************************                                   ***************************************


                               BROADMOOR RESORT COMPLEX MDDP
                               RUNOFF REACHING 36" CMP CULVERT AT POURTALES ROAD
                               OCTOMBER 17, 2003
                               5-YEAR AND 100-YEAR 24-HOUR STORMS
                               PROPOSED CONDITION
                               FILENAME: BRDFUTUR.DAT

    8 IO          OUTPUT CONTROL VARIABLES
                        IPRNT           5  PRINT CONTROL
```

```
                    IPLOT           0  PLOT CONTROL
                    QSCAL           0.  HYDROGRAPH PLOT SCALE

     IT          HYDROGRAPH TIME DATA
                      NMIN           5  MINUTES IN COMPUTATION INTERVAL
                     IDATE      1    0  STARTING DATE
                     ITIME        0800  STARTING TIME
                        NQ         300  NUMBER OF HYDROGRAPH ORDINATES
                    NDDATE      2    0  ENDING DATE
                    NDTIME        0855  ENDING TIME
                    ICENT           19  CENTURY MARK

               COMPUTATION INTERVAL    .08 HOURS
                    TOTAL TIME BASE  24.92 HOURS

          ENGLISH UNITS
               DRAINAGE AREA           SQUARE MILES
               PRECIPITATION DEPTH     INCHES
               LENGTH, ELEVATION       FEET
               FLOW                    CUBIC FEET PER SECOND
               STORAGE VOLUME          ACRE-FEET
               SURFACE AREA            ACRES
               TEMPERATURE             DEGREES FAHRENHEIT

     JP           MULTI-PLAN OPTION
                       NPLAN           1  NUMBER OF PLANS

     JR           MULTI-RATIO OPTION
                      RATIOS OF PRECIPITATION
                       .67      1.00
1

          PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
                             FLOWS IN CUBIC FEET PER SECOND,  AREA IN SQUARE MILES
                                             TIME TO PEAK IN HOURS


                                                                  RATIOS APPLIED TO PRECIPITATION
 OPERATION        STATION      AREA    PLAN                    RATIO 1  RATIO 2
                                                                   .67     1.00

 HYDROGRAPH AT
+                       A       .54      1    FLOW              88.     261.
                                                TIME            6.33     6.33

 HYDROGRAPH AT
+                       B       .07      1    FLOW              55.     112.
                                                TIME            5.92     5.92

  2 COMBINED AT
+                      DP       .61      1    FLOW             112.     311.
                                                TIME            6.17     6.17


 *** NORMAL END OF HEC-1 ***
```

Hydraulic Calculations

Gutter Calculations
Roadside Ditch Calculations
HY8 Calculations

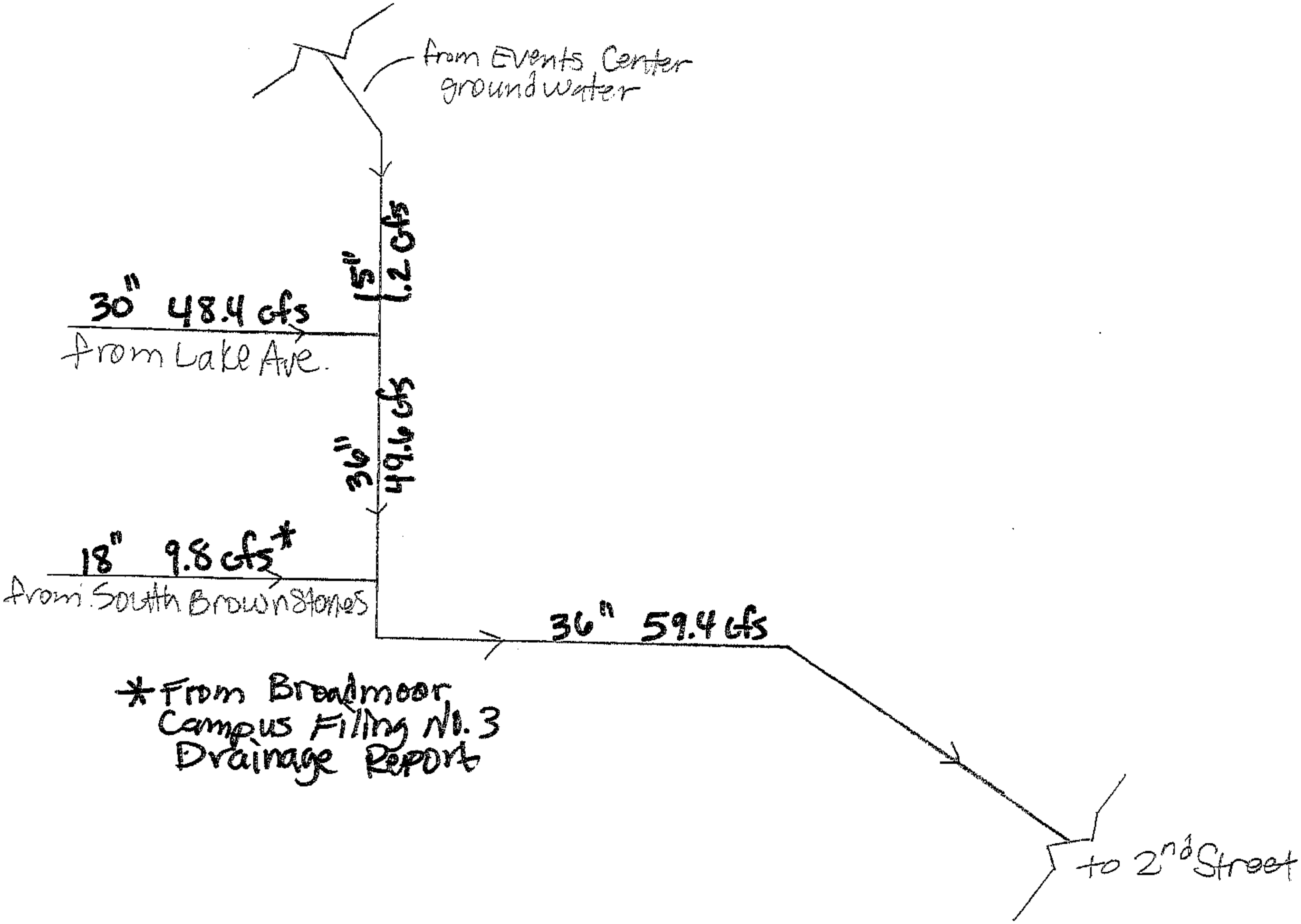


Storm Sewer System

Lake Circle & Lake Avenue (5-year Storm event)

Kiowa Engineering Corporation

CLIENT
PROJECT BT moor MDDP
DETAIL
JOB NO. D3068
DATE CHECKED
CHECKED BY
PAGE
DATE 1/7/04
COMPUTED BY JGD



Proposed Storm Sewer System

Future Runoff in Lake Circle on West side

Midway between Mesa Ave & Lake Avenue (@ proposed grated inlet #1)

Sub-basins E-1A & 3.8 Acres of E-1

	Area	C_5
E-1	2.81	0.64
E-1A	2.42	0.62
Total	5.23	0.63

T_c = T_c for Sub E-1A plus 560' of C&g flow at 2.4 fps

$T_c = 6.6 + \frac{560'}{60(2.4)} = 10.5$ min

$i_5 = 4.0$ in/hr

$Q_5 = 0.63(5.23)(4.0) = 13.2$ cfs

Across from Hazel Avenue (@ prop. grated inlet #2)

- 41% (3.6 Ac.) of Sub-basin E-1
- plus carry over from prop inlet #1

$Q_5 = 0.41(22.8) + 3.8 = 13.1$ cfs

Kiowa Engineering Corporation

CLIENT PROJECT B'moor MDDP DETAIL JOB No. 03068 DATE CHECKED CHECKED BY PAGE DATE 1/2/04 COMPUTED BY JGD

Future Runoff in Lake Circle @ Lake Avenue

West Side North of Roundabout:

- 27% (2.4 Ac) of Sub-basin E-1
- carry over from prop. inlet #2

$Q_5 = 0.27(22.8) + 3.7 = 9.9$ cfs

East Side North of Roundabout

40% of Sub. E-2 drains to Lake Circle

$Q_5 = 0.40(12.6) = 5.0$ cfs

Future Runoff in Lake Circle

South of Roundabout @ Lake Avenue

West Side

Sub-basin E-4 → drains to C&g in Lake Circle

Q_5 = 11.3 cfs

East Side

10% of Sub E-3 drains to Lake Circle

$Q_5 = (0.10)(3.0) = 0.3$ cfs

Future Runoff Draining to Existing Combination Inlets on Lake Avenue

North Side

- 9% of Sub. E-1
- 12% of Sub. E-2
- carryover from 4' inlet = 1.2 cfs

$Q_5 = 0.09(22.8) + (0.12)(12.6) + 1.2 = 4.8$ cfs

South Side

- 24% of Sub. E-4
- 30% of Sub E-3
- carryover from 5' inlet = 4.6 cfs

$Q_5 = 0.24(11.3) + (0.30)(3.0) + 4.6 = 8.2$ cfs

Future Runoff in Lake Avenue @ 1st Street

North Side

- 40% of E-2
- carry over flow from 4' inlet on Lake Avenue

$Q_5 = 12.6(0.40) + 1.2 = 6.2$ cfs

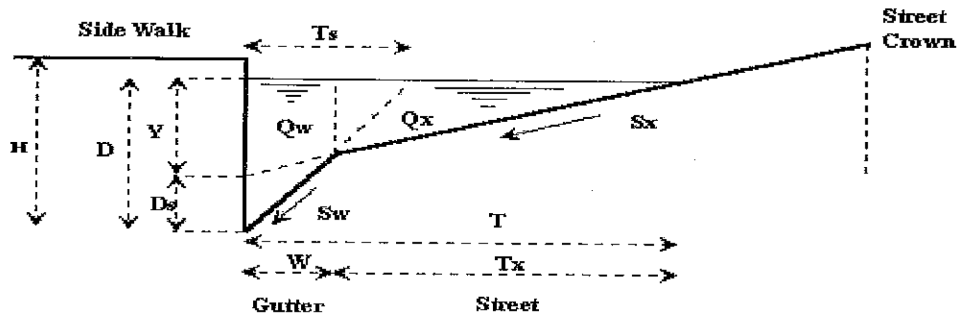
South Side

- 60% of Sub. E-3
- 25% of Sub E-3A
- carryover flow from 4' inlet on Lake Avenue

$Q_5 = 3.0(0.6) + 3.0(0.25) + 2.9 = 5.5$ cfs

GUTTER CONVEYANCE CAPACITY

Project = Project #03068 Broadmoor MDDP
Street ID = Gutter Flow in South Side of Pourtales Road (Sub-basin F-1 - 5-year)

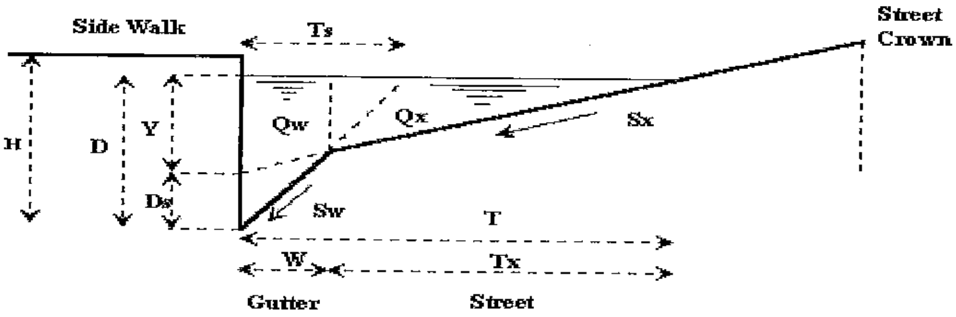


Street Geometry (Input)		
Design Discharge in the Gutter	**Qo =**	**6.5 cfs**
Curb Height	H =	8.00 inches
Gutter Width	W =	2.00 ft
Gutter Depression	Ds =	1.50 inches
Street Transverse Slope	Sx =	0.0200 ft/ft
Street Longitudinal Slope	So =	0.0400 ft/ft
Manning's Roughness	N =	0.015

Gutter Conveyance Capacity		
Gutter Cross Slope	Sw =	0.08 ft/ft
Water Spread Width	T =	9.92 ft
Water Depth without Gutter Depression	Y =	0.20 ft
Water Depth with a Gutter Depression	D =	0.32 ft
Spread for Side Flow on the Street	Tx =	7.92 ft
Spread for Gutter Flow along Gutter Slope	Ts =	3.92 ft
Flowrate Carried by Width Ts	Qws =	4.4 cfs
Flowrate Carried by Width (Ts - W)	Qww =	0.7 cfs
Gutter Flow	Qw =	3.8 cfs
Side Flow	Qx =	2.7 cfs
Total Flow (Check against Qo)	**Qs =**	**6.5 cfs**
Gutter Flow to Design Flow Ratio	Eo =	0.58
Equivalent Slope for the Street	Se =	0.06 ft/ft
Flow Area	As =	1.11 sq ft
Flow Velocity	Vs =	5.87 fps
VsD product	**VsD =**	**1.90 ft^2/s**

GUTTER CONVEYANCE CAPACITY

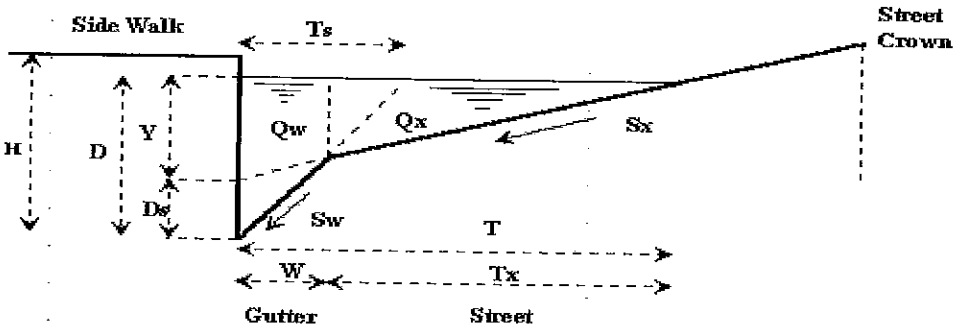
Project = Project #03068 Broadmoor MDDP
Street ID = Gutter Flow in South Side of Pourtales Road (Sub-basin F-1 - 100yr)



Street Geometry (Input)		
Design Discharge in the Gutter	**Qo =**	**12.8 cfs**
Curb Height	H =	8.00 inches
Gutter Width	W =	2.00 ft
Gutter Depression	Ds =	1.50 inches
Street Transverse Slope	Sx =	0.0200 ft/ft
Street Longitudinal Slope	So =	0.0400 ft/ft
Manning's Roughness	N =	0.015
Gutter Conveyance Capacity		
Gutter Cross Slope	Sw =	0.08 ft/ft
Water Spread Width	T =	13.35 ft
Water Depth without Gutter Depression	Y =	0.27 ft
Water Depth with a Gutter Depression	D =	0.39 ft
Spread for Side Flow on the Street	Tx =	11.35 ft
Spread for Gutter Flow along Gutter Slope	Ts =	4.75 ft
Flowrate Carried by Width Ts	Qws =	7.4 cfs
Flowrate Carried by Width (Ts - W)	Qww =	1.7 cfs
Gutter Flow	Qw =	5.7 cfs
Side Flow	Qx =	7.1 cfs
Total Flow (Check against Qo)	**Qs =**	**12.8 cfs**
Gutter Flow to Design Flow Ratio	Eo =	0.44
Equivalent Slope for the Street	Se =	0.05 ft/ft
Flow Area	As =	1.91 sq ft
Flow Velocity	Vs =	6.72 fps
VsD product	**VsD =**	**2.64 ft^2/s**

GUTTER CONVEYANCE CAPACITY

Project = 03068 Broadmoor MDDP
Street ID = Proposed 10' Grated Inlet #1 on West Side of Lake Circle (5-year)

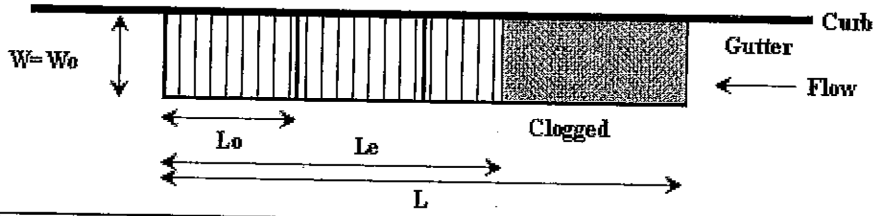


	Street Geometry (Input)		
	Design Discharge in the Gutter	**Qo =**	**13.2 cfs**
	Curb Height	H =	8.00 inches
	Gutter Width	W =	2.00 ft
	Gutter Depression	Ds =	1.50 inches
	Street Transverse Slope	Sx =	0.0200 ft/ft
	Street Longitudinal Slope	So =	0.0130 ft/ft
Warning 01	Manning's Roughness	N =	0.013
	Gutter Conveyance Capacity		
	Gutter Cross Slope	Sw =	0.08 ft/ft
	Water Spread Width	T =	16.07 ft
	Water Depth without Gutter Depression	Y =	0.32 ft
	Water Depth with a Gutter Depression	D =	0.45 ft
	Spread for Side Flow on the Street	Tx =	14.07 ft
	Spread for Gutter Flow along Gutter Slope	Ts =	5.41 ft
	Flowrate Carried by Width Ts	Qws =	6.9 cfs
	Flowrate Carried by Width (Ts - W)	Qww =	2.0 cfs
	Gutter Flow	Qw =	4.9 cfs
	Side Flow	Qx =	8.3 cfs
	Total Flow (Check against Qo)	**Qs =**	**13.2 cfs**
	Gutter Flow to Design Flow Ratio	Eo =	0.37
	Equivalent Slope for the Street	Se =	0.04 ft/ft
	Flow Area	As =	2.71 sq ft
	Flow Velocity	Vs =	4.88 fps
	VsD product	**VsD =**	**2.18 ft^2/s**

Warning 01: Manning's n-value does not meet the USDCM recommended criteria.

GRATE INLET ON A GRADE

Project: 03068 Broadmoor MDDP
Inlet ID: Proposed 10' Grated Inlet #1 on West Side of Lake Circle (5-year)

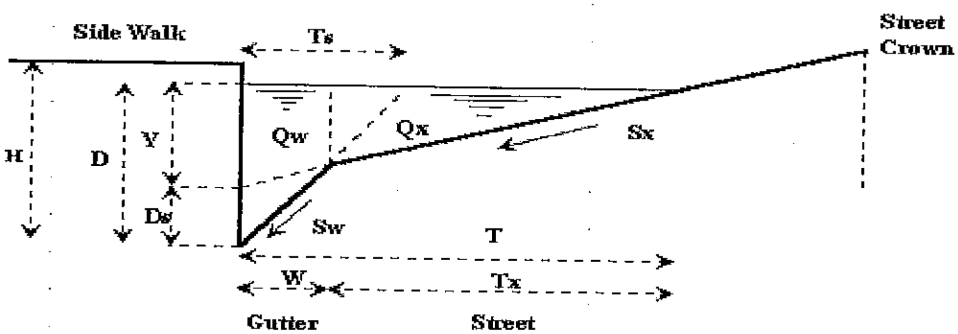


Design Information (Input)		
Design Discharge on the Street (from *Street Hy*)	Qo =	13.2 cfs
Type of Grate	Type =	Reticuline
Length of a Unit Grate	Lo =	10.00 ft
Width of a Unit Grate	Wo =	2.00 ft
Clogging Factor for a Unit Grate	Co =	0.60
Water Depth for Design Condition	Yd =	8.00 inches
Number of Grates	No =	1

Analysis (Calculated)		
Total Length of Grate Inlet	L =	10.00 ft
Ratio of Gutter Flow to Design Flow Eo (from *Street Hy*)	Eo =	0.37
Equivalent Slope Se (from *Street Hy*)	Se =	0.0400 ft/ft
Flow Velocity Vs (from *Street Hy*)	Vs =	4.88 fps
Spash-over Velocity	Vo =	13.52 fps
Under No-Clogging Condition		
Interception Rate of Gutter Flow	Rf =	1.00
Effective Length of Grate Inlet	L =	10.00 ft
Interception Rate of Side Flow Rx (from *Street Hy*)	Rx =	0.61
Interception Capacity	Qi =	9.9 cfs
Under Clogging Condition		
Interception Rate of Gutter Flow	Rf =	1.00
Clogging Coefficient for Multiple-unit Grate Inlet	Coef =	1.99
Clogging Factor for Multiple-unit Grate Inlet	Clog =	0.10
Effective (unclogged) Length of Multiple-unit Grate Inlet	Le =	9.01 ft
Interception Rate of Side Flow Rx (from *Street Hy*)	Rx =	0.55
Actual Interception Capacity	**Qa =**	**9.4 cfs**
Carry-Over Flow = Qo-Qa =	**Q-co =**	**3.8 cfs**
Capture Percentage = Qa/Qo =	**C% =**	**71.43 %**

GUTTER CONVEYANCE CAPACITY

Project = 03068 Broadmoor MDDP
Street ID = Proposed 10' Grated Inlet #2 on West Side of Lake Circle (5-year)

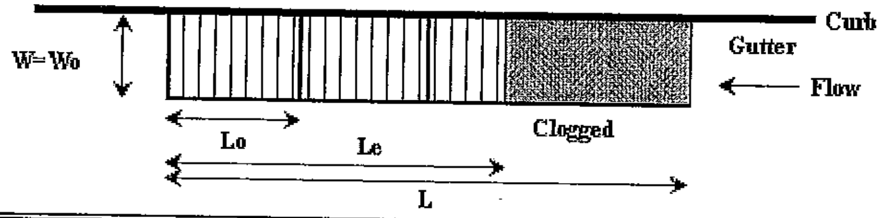


Street Geometry (Input)		
Design Discharge in the Gutter	**Qo =**	**13.1 cfs**
Curb Height	H =	8.00 inches
Gutter Width	W =	2.00 ft
Gutter Depression	Ds =	1.50 inches
Street Transverse Slope	Sx =	0.0200 ft/ft
Street Longitudinal Slope	So =	0.0130 ft/ft
Warning 01 Manning's Roughness	N =	0.013
Gutter Conveyance Capacity		
Gutter Cross Slope	Sw =	0.08 ft/ft
Water Spread Width	T =	16.02 ft
Water Depth without Gutter Depression	Y =	0.32 ft
Water Depth with a Gutter Depression	D =	0.45 ft
Spread for Side Flow on the Street	Tx =	14.02 ft
Spread for Gutter Flow along Gutter Slope	Ts =	5.40 ft
Flowrate Carried by Width Ts	Qws =	6.9 cfs
Flowrate Carried by Width (Ts - W)	Qww =	2.0 cfs
Gutter Flow	Qw =	4.9 cfs
Side Flow	Qx =	8.2 cfs
Total Flow (Check against Qo)	**Qs =**	**13.1 cfs**
Gutter Flow to Design Flow Ratio	Eo =	0.37
Equivalent Slope for the Street	Se =	0.04 ft/ft
Flow Area	As =	2.69 sq ft
Flow Velocity	Vs =	4.87 fps
VsD product	**VsD =**	**2.17 ft^2/s**

Warning 01: Manning's n-value does not meet the USDCM recommended criteria.

GRATE INLET ON A GRADE

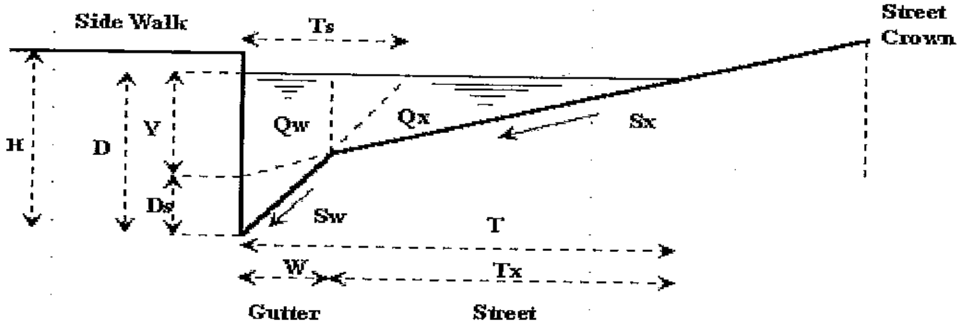
Project: 03068 Broadmoor MDDP
Inlet ID: Proposed 10' Grated Inlet #2 on West Side of Lake Circle (5-year)



Design Information (Input)		
Design Discharge on the Street (from *Street Hy*)	**Qo =**	**13.1 cfs**
Type of Grate	Type =	Reticuline
Length of a Unit Grate	Lo =	10.00 ft
Width of a Unit Grate	Wo =	2.00 ft
Clogging Factor for a Unit Grate	Co =	0.60
Water Depth for Design Condition	Yd =	8.00 inches
Number of Grates	No =	1
Analysis (Calculated)		
Total Length of Grate Inlet	L =	10.00 ft
Ratio of Gutter Flow to Design Flow Eo (from *Street Hy*)	Eo =	0.37
Equivalent Slope Se (from *Street Hy*)	Se =	0.0400 ft/ft
Flow Velocity Vs (from *Street Hy*)	Vs =	4.87 fps
Spash-over Velocity	Vo =	13.52 fps
Under No-Clogging Condition		
Interception Rate of Gutter Flow	Rf =	1.00
Effective Length of Grate Inlet	L =	10.00 ft
Interception Rate of Side Flow Rx (from *Street Hy*)	Rx =	0.61
Interception Capacity	Qi =	9.9 cfs
Under Clogging Condition		
Interception Rate of Gutter Flow	Rf =	1.00
Clogging Coefficient for Multiple-unit Grate Inlet	Coef =	1.99
Clogging Factor for Multiple-unit Grate Inlet	Clog =	0.10
Effective (unclogged) Length of Multiple-unit Grate Inlet	Le =	9.01 ft
Interception Rate of Side Flow Rx (from *Street Hy*)	Rx =	0.55
Actual Interception Capacity	**Qa =**	**9.4 cfs**
Carry-Over Flow = Qo-Qa =	**Q-co =**	**3.7 cfs**
Capture Percentage = Qa/Qo =	**C% =**	**71.49 %**

GUTTER CONVEYANCE CAPACITY

Project = 03068 Broadmoor MDDP
Street ID = Ex. 10' Curb Inlet at Lake Circle and Lake Avenue (5-year)



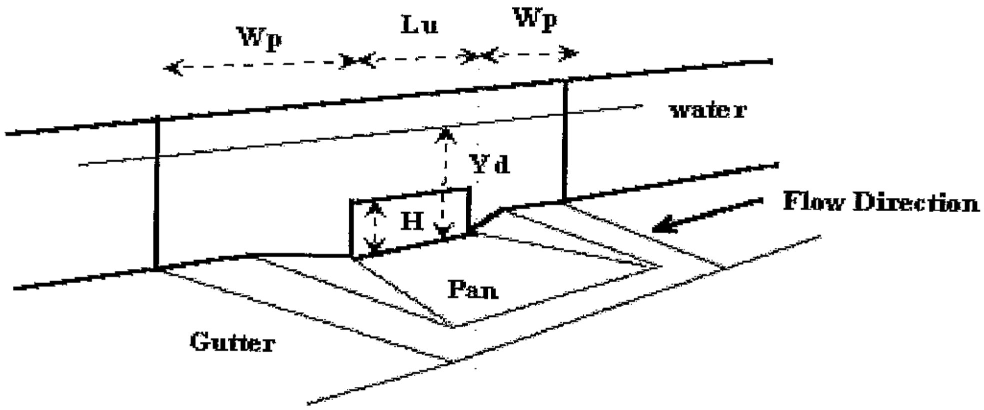
Street Geometry (Input)			
Design Discharge in the Gutter	**Qo =**	**9.9**	**cfs**
Curb Height	H =	8.00	inches
Gutter Width	W =	2.00	ft
Gutter Depression	Ds =	1.50	inches
Street Transverse Slope	Sx =	0.0200	ft/ft
Street Longitudinal Slope	So =	0.0100	ft/ft
Warning 01 Manning's Roughness	N =	0.013	

Gutter Conveyance Capacity			
Gutter Cross Slope	Sw =	0.08	ft/ft
Water Spread Width	T =	15.07	ft
Water Depth without Gutter Depression	Y =	0.30	ft
Water Depth with a Gutter Depression	D =	0.43	ft
Spread for Side Flow on the Street	Tx =	13.07	ft
Spread for Gutter Flow along Gutter Slope	Ts =	5.17	ft
Flowrate Carried by Width Ts	Qws =	5.4	cfs
Flowrate Carried by Width (Ts - W)	Qww =	1.5	cfs
Gutter Flow	Qw =	3.9	cfs
Side Flow	Qx =	6.0	cfs
Total Flow (Check against Qo)	**Qs =**	**9.9**	**cfs**
Gutter Flow to Design Flow Ratio	Eo =	0.40	
Equivalent Slope for the Street	Se =	0.04	ft/ft
Flow Area	As =	2.40	sq ft
Flow Velocity	Vs =	4.13	fps
VsD product	**VsD =**	**1.76**	**ft^2/s**

Warning 01: Manning's n-value does not meet the USDCM recommended criteria.

CURB OPENING INLET IN A SUMP

Project = **03068 Broadmoor MDDP**
Inlet ID = **Existing 10' Curb Inlet at Lake Ave. & Lake Circle (100-year)**



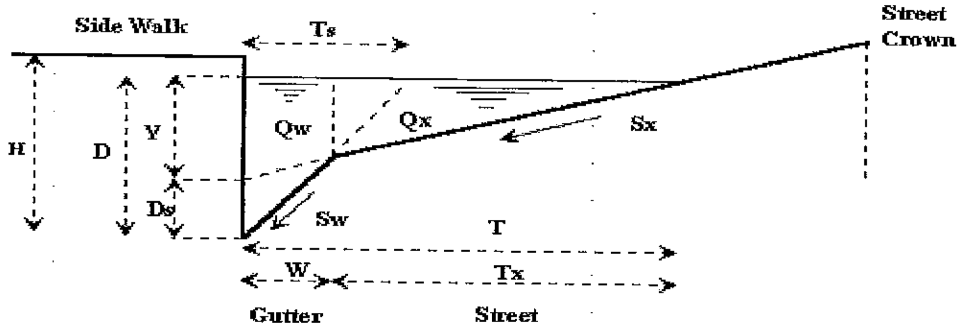
Design Information (Input)			
Design Discharge on the Street (from *Street Hy*)	**Qo =**	**9.9**	**cfs**
Length of a Unit Inlet	Lu =	10.00	ft
Side Width for Depression Pan	Wp =	3.00	ft
Clogging Factor for a Single Unit	Co =	0.50	
Height of Curb Opening in Inches	H =	8.00	inches
Orifice Coefficient	Cd =	0.60	
Weir Coefficient	Cw =	3.10	
Water Depth for the Design Condition	Yd =	1.00	ft
Angle of Throat (see USDCM Chapter 6, Figure ST-5)	Theta =	63.0	degrees
Number of Curb Opening Inlets	No =	1	

Curb Opening Inlet Capacity in a Sump			
As a Weir			
Total Length of Curb Opening Inlet	L =	10.00	ft
Capacity as a Weir without Clogging	Qwi =	47.7	cfs
Clogging Coefficient for Multiple Units	Clog-Coeff =	1.00	
Clogging Factor for Multiple Units	Clog =	0.50	
Capacity as a Weir with Clogging	Qwa =	32.2	cfs
As an Orifice			
Capacity as an Orifice without Clogging	Qoi =	26.9	cfs
Capacity as an Orifice with Clogging	Qoa =	13.5	cfs
Capacity for Design with Clogging	**Qa =**	**13.5**	**cfs**
Capture Percentage for this Inlet = Qa / Qo =	**C% =**	**100.00**	**%**

Note: Unless additional ponding depth or spilling over the curb is acceptable, a capture percentage of less than 100% in a sump may indicate the need for additional inlet units.

GUTTER CONVEYANCE CAPACITY

Project = 03068 Broadmoor MDDP
Street ID = Ex. 4' Curb Inlet East side of Lake Circle north of Roundabout (5-year)



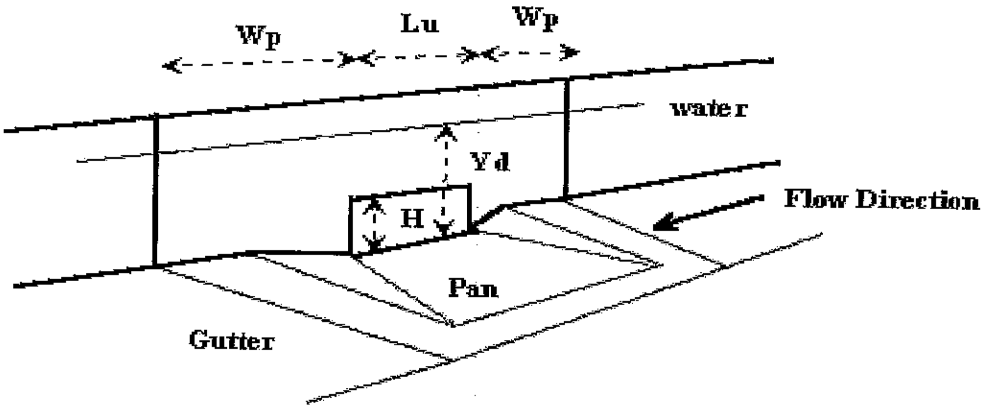
Street Geometry (Input)		
Design Discharge in the Gutter	**Qo =**	**5.0 cfs**
Curb Height	H =	8.00 inches
Gutter Width	W =	2.00 ft
Gutter Depression	Ds =	1.50 inches
Street Transverse Slope	Sx =	0.0200 ft/ft
Street Longitudinal Slope	So =	0.0100 ft/ft
Warning 01 Manning's Roughness	N =	0.013

Gutter Conveyance Capacity		
Gutter Cross Slope	Sw =	0.08 ft/ft
Water Spread Width	T =	11.29 ft
Water Depth without Gutter Depression	Y =	0.23 ft
Water Depth with a Gutter Depression	D =	0.35 ft
Spread for Side Flow on the Street	Tx =	9.29 ft
Spread for Gutter Flow along Gutter Slope	Ts =	4.25 ft
Flowrate Carried by Width Ts	Qws =	3.2 cfs
Flowrate Carried by Width (Ts - W)	Qww =	0.6 cfs
Gutter Flow	Qw =	2.6 cfs
Side Flow	Qx =	2.4 cfs
Total Flow (Check against Qo)	**Qs =**	**5.0 cfs**
Gutter Flow to Design Flow Ratio	Eo =	0.52
Equivalent Slope for the Street	Se =	0.05 ft/ft
Flow Area	As =	1.40 sq ft
Flow Velocity	Vs =	3.58 fps
VsD product	**VsD =**	**1.26 ft^2/s**

Warning 01: Manning's n-value does not meet the USDCM recommended criteria.

CURB OPENING INLET IN A SUMP

Project = 03068 Broadmoor MDDP
Inlet ID = Ex. 4' Curb Inlet East Side of Lake Circle north of Roundabout (5-year)



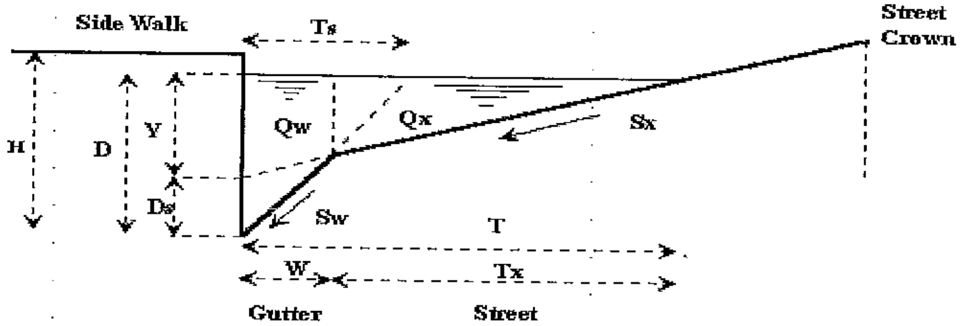
Design Information (Input)		
Design Discharge on the Street (from *Street Hy*)	**Qo =**	**5.0 cfs**
Length of a Unit Inlet	Lu =	4.00 ft
Side Width for Depression Pan	Wp =	3.00 ft
Clogging Factor for a Single Unit	Co =	0.50
Height of Curb Opening in Inches	H =	6.00 inches
Orifice Coefficient	Cd =	0.60
Weir Coefficient	Cw =	3.10
Water Depth for the Design Condition	Yd =	0.83 ft
Angle of Throat (see USDCM Chapter 6, Figure ST-5)	Theta =	63.0 degrees
Number of Curb Opening Inlets	No =	1

Curb Opening Inlet Capacity in a Sump		
As a Weir		
Total Length of Curb Opening Inlet	L =	4.00 ft
Capacity as a Weir without Clogging	Qwi =	22.2 cfs
Clogging Coefficient for Multiple Units	Clog-Coeff =	1.00
Clogging Factor for Multiple Units	Clog =	0.50
Capacity as a Weir with Clogging	Qwa =	17.4 cfs
As an Orifice		
Capacity as an Orifice without Clogging	Qoi =	7.5 cfs
Capacity as an Orifice with Clogging	Qoa =	3.8 cfs
Capacity for Design with Clogging	**Qa =**	**3.8 cfs**
Capture Percentage for this Inlet = Qa / Qo =	**C% =**	**75.23 %**

Note: Unless additional ponding depth or spilling over the curb is acceptable, a capture percentage of less than 100% in a sump may indicate the need for additional inlet units.

GUTTER CONVEYANCE CAPACITY

Project = 03068 Broadmoor MDDP
Street ID = Ex. 4' combo inlet on north side of Lake Avenue (5-year)



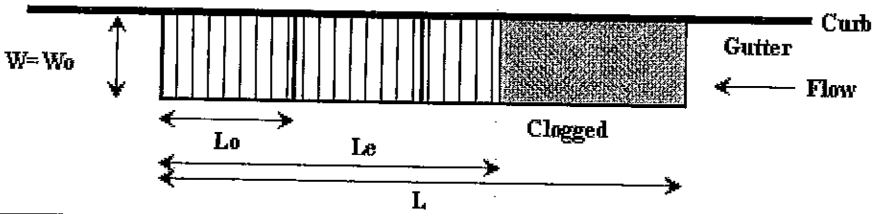
	Street Geometry (Input)		
	Design Discharge in the Gutter	**Qo =**	**4.8 cfs**
	Curb Height	H =	8.00 inches
	Gutter Width	W =	2.00 ft
	Gutter Depression	Ds =	1.50 inches
	Street Transverse Slope	Sx =	0.0300 ft/ft
	Street Longitudinal Slope	So =	0.0260 ft/ft
Warning 01	Manning's Roughness	N =	0.013

Gutter Conveyance Capacity		
Gutter Cross Slope	Sw =	0.09 ft/ft
Water Spread Width	T =	6.84 ft
Water Depth without Gutter Depression	Y =	0.21 ft
Water Depth with a Gutter Depression	D =	0.33 ft
Spread for Side Flow on the Street	Tx =	4.84 ft
Spread for Gutter Flow along Gutter Slope	Ts =	3.57 ft
Flowrate Carried by Width Ts	Qws =	3.9 cfs
Flowrate Carried by Width (Ts - W)	Qww =	0.4 cfs
Gutter Flow	Qw =	3.5 cfs
Side Flow	Qx =	1.3 cfs
Total Flow (Check against Qo)	**Qs =**	**4.8 cfs**
Gutter Flow to Design Flow Ratio	Eo =	0.72
Equivalent Slope for the Street	Se =	0.08 ft/ft
Flow Area	As =	0.83 sq ft
Flow Velocity	Vs =	5.81 fps
VsD product	**VsD =**	**1.92 ft^2/s**

Warning 01: Manning's n-value does not meet the USDCM recommended criteria.

GRATE INLET ON A GRADE

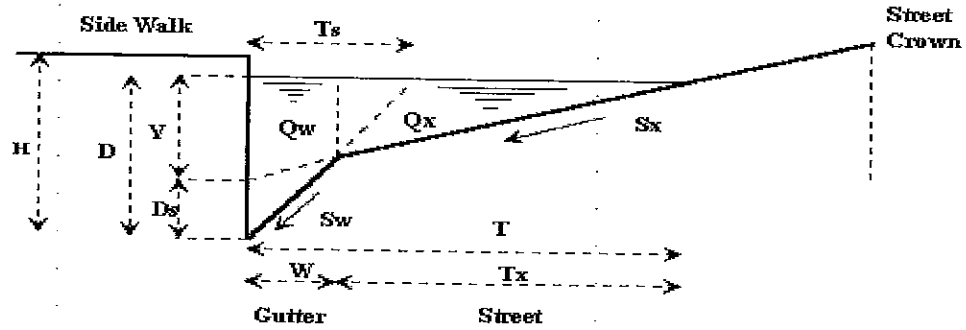
Project: 03068 Broadmoor MDDP
Inlet ID: Ex. 4' combo inlet on north side of Lake Avenue (5-year)



Design Information (Input)	
Design Discharge on the Street (from *Street Hy*)	Qo = 4.8 cfs
Type of Grate	Type = Reticuline
Length of a Unit Grate	Lo = 4.00 ft
Width of a Unit Grate	Wo = 2.00 ft
Clogging Factor for a Unit Grate	Co = 0.60
Water Depth for Design Condition	Yd = 8.00 inches
Number of Grates	No = 1
Analysis (Calculated)	
Total Length of Grate Inlet	L = 4.00 ft
Ratio of Gutter Flow to Design Flow Eo (from *Street Hy*)	Eo = 0.72
Equivalent Slope Se (from *Street Hy*)	Se = 0.0800 ft/ft
Flow Velocity Vs (from *Street Hy*)	Vs = 5.81 fps
Spash-over Velocity	Vo = 6.62 fps
Under No-Clogging Condition	
Interception Rate of Gutter Flow	Rf = 1.00
Effective Length of Grate Inlet	L = 4.00 ft
Interception Rate of Side Flow Rx (from *Street Hy*)	Rx = 0.17
Interception Capacity	Qi = 3.7 cfs
Under Clogging Condition	
Interception Rate of Gutter Flow	Rf = 1.00
Clogging Coefficient for Multiple-unit Grate Inlet	Coef = 1.99
Clogging Factor for Multiple-unit Grate Inlet	Clog = 0.10
Effective (unclogged) Length of Multiple-unit Grate Inlet	Le = 3.60 ft
Interception Rate of Side Flow Rx (from *Street Hy*)	Rx = 0.14
Actual Interception Capacity	**Qa =** 3.6 cfs
Carry-Over Flow = Qo-Qa =	**Q-co =** 1.2 cfs
Capture Percentage = Qa/Qo =	**C% =** 75.87 %

GUTTER CONVEYANCE CAPACITY

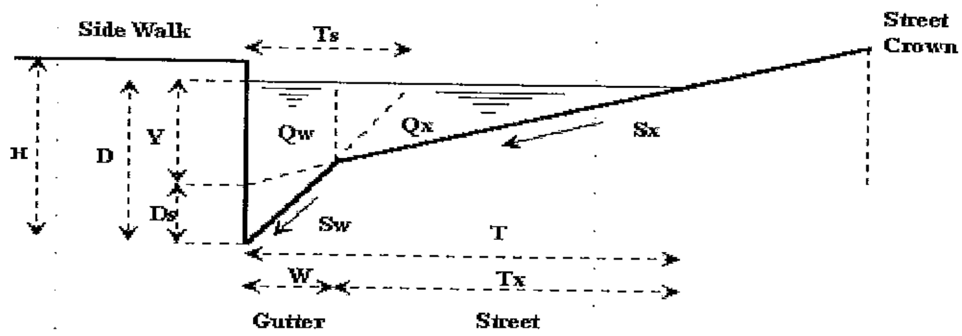
Project = Project #03068 Broadmoor MDDP
Street ID = Gutter Flow on north side of Lake Avenue @ 1st Street (5-year)



Street Geometry (Input)			
Design Discharge in the Gutter	**Qo =**	**6.2**	**cfs**
Curb Height	H =	8.00	inches
Gutter Width	W =	2.00	ft
Gutter Depression	Ds =	1.50	inches
Street Transverse Slope	Sx =	0.0300	ft/ft
Street Longitudinal Slope	So =	0.0260	ft/ft
Manning's Roughness	N =	0.015	
Gutter Conveyance Capacity			
Gutter Cross Slope	Sw =	0.09	ft/ft
Water Spread Width	T =	8.25	ft
Water Depth without Gutter Depression	Y =	0.25	ft
Water Depth with a Gutter Depression	D =	0.37	ft
Spread for Side Flow on the Street	Tx =	6.25	ft
Spread for Gutter Flow along Gutter Slope	Ts =	4.03	ft
Flowrate Carried by Width Ts	Qws =	4.7	cfs
Flowrate Carried by Width (Ts - W)	Qww =	0.8	cfs
Gutter Flow	Qw =	3.9	cfs
Side Flow	Qx =	2.3	cfs
Total Flow (Check against Qo)	**Qs =**	**6.2**	**cfs**
Gutter Flow to Design Flow Ratio	Eo =	0.63	
Equivalent Slope for the Street	Se =	0.07	ft/ft
Flow Area	As =	1.15	sq ft
Flow Velocity	Vs =	5.42	fps
VsD product	**VsD =**	**2.02**	**ft^2/s**

GUTTER CONVEYANCE CAPACITY

Project = 03068 Broadmoor MDDP
Street ID = Ex. 5' curb inlet on west side of Lake Circle south of Roundabout (5-year)

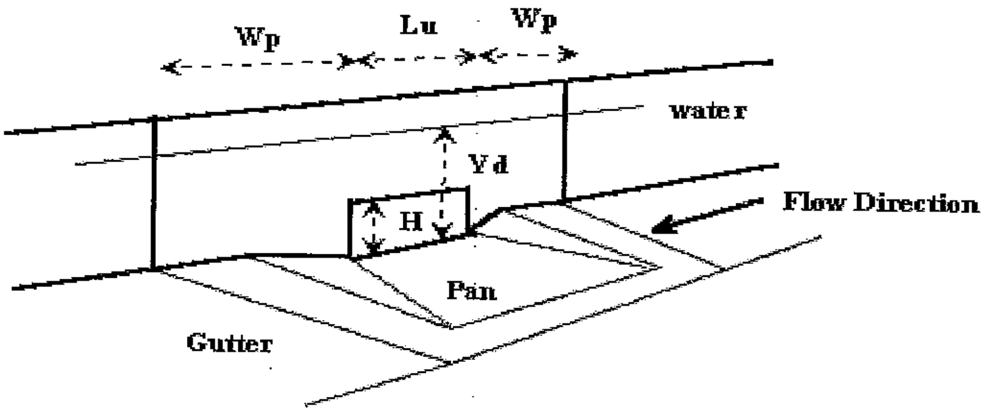


	Street Geometry (Input)			
	Design Discharge in the Gutter	**Qo =**	**11.3**	**cfs**
	Curb Height	H =	8.00	inches
	Gutter Width	W =	2.00	ft
	Gutter Depression	Ds =	1.50	inches
	Street Transverse Slope	Sx =	0.0200	ft/ft
	Street Longitudinal Slope	So =	0.0280	ft/ft
Warning 01	Manning's Roughness	N =	0.013	
	Gutter Conveyance Capacity			
	Gutter Cross Slope	Sw =	0.08	ft/ft
	Water Spread Width	T =	12.85	ft
	Water Depth without Gutter Depression	Y =	0.26	ft
	Water Depth with a Gutter Depression	D =	0.38	ft
	Spread for Side Flow on the Street	Tx =	10.85	ft
	Spread for Gutter Flow along Gutter Slope	Ts =	4.63	ft
	Flowrate Carried by Width Ts	Qws =	6.7	cfs
	Flowrate Carried by Width (Ts - W)	Qww =	1.5	cfs
	Gutter Flow	Qw =	5.2	cfs
	Side Flow	Qx =	6.1	cfs
	Total Flow (Check against Qo)	**Qs =**	**11.3**	**cfs**
	Gutter Flow to Design Flow Ratio	Eo =	0.46	
	Equivalent Slope for the Street	Se =	0.05	ft/ft
	Flow Area	As =	1.78	sq ft
	Flow Velocity	Vs =	6.37	fps
	VsD product	**VsD =**	**2.43**	**ft^2/s**

Warning 01: Manning's n-value does not meet the USDCM recommended criteria.

CURB OPENING INLET IN A SUMP

Project = 03068 Broadmoor MDDP
Inlet ID = Ex. 5' Curb Inlet on West Side of Lake Circle South of Roundabout (5-year)



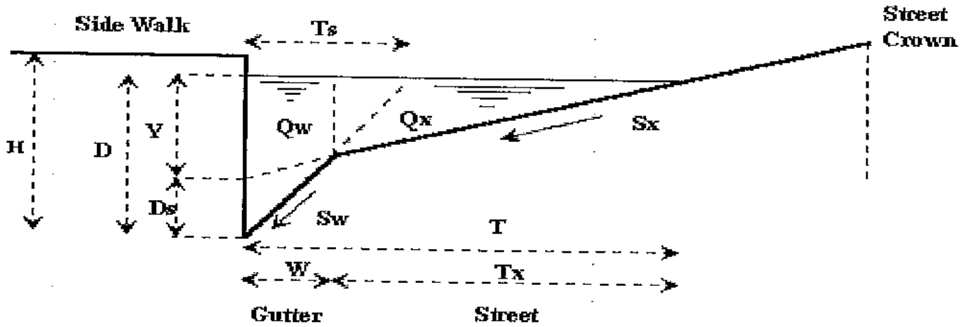
Design Information (Input)		
Design Discharge on the Street (from *Street Hy*)	**Qo =**	**11.3 cfs**
Length of a Unit Inlet	Lu =	5.00 ft
Side Width for Depression Pan	Wp =	3.00 ft
Clogging Factor for a Single Unit	Co =	0.50
Height of Curb Opening in Inches	H =	8.00 inches
Orifice Coefficient	Cd =	0.60
Weir Coefficient	Cw =	3.10
Water Depth for the Design Condition	Yd =	1.00 ft
Angle of Throat (see USDCM Chapter 6, Figure ST-5)	Theta =	63.0 degrees
Number of Curb Opening Inlets	No =	1

Curb Opening Inlet Capacity in a Sump		
As a Weir		
Total Length of Curb Opening Inlet	L =	5.00 ft
Capacity as a Weir without Clogging	Qwi =	32.2 cfs
Clogging Coefficient for Multiple Units	Clog-Coeff =	1.00
Clogging Factor for Multiple Units	Clog =	0.50
Capacity as a Weir with Clogging	Qwa =	24.5 cfs
As an Orifice		
Capacity as an Orifice without Clogging	Qoi =	13.5 cfs
Capacity as an Orifice with Clogging	Qoa =	6.7 cfs
Capacity for Design with Clogging	**Qa =**	**6.7 cfs**
Capture Percentage for this Inlet = Qa / Qo =	**C% =**	**59.54 %**

Note: Unless additional ponding depth or spilling over the curb is acceptable, a capture percentage of less than 100% in a sump may indicate the need for additional inlet units.

GUTTER CONVEYANCE CAPACITY

Project = 03068 Broadmoor MDDP
Street ID = Ex. 4' Curb Inlet on east side of Lake Circle south of Roundabout (5-year)

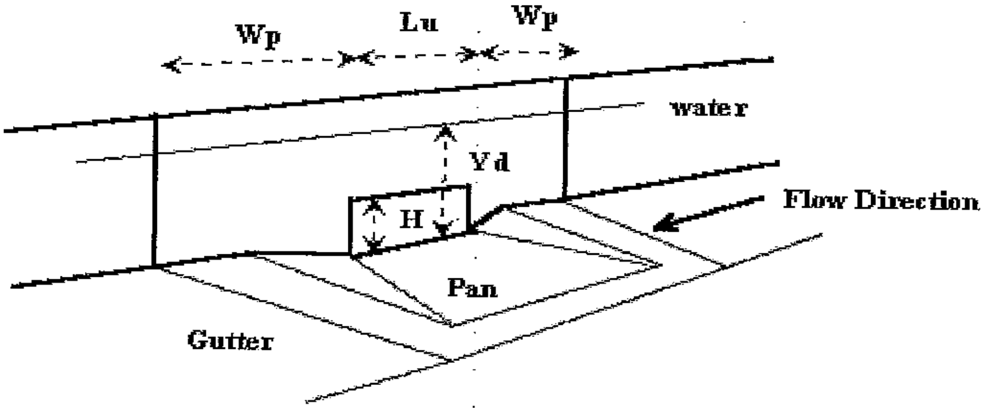


	Street Geometry (Input)		
	Design Discharge in the Gutter	**Qo =**	**0.3 cfs**
	Curb Height	H =	8.00 inches
	Gutter Width	W =	2.00 ft
	Gutter Depression	Ds =	1.50 inches
	Street Transverse Slope	Sx =	0.0200 ft/ft
	Street Longitudinal Slope	So =	0.0300 ft/ft
Warning 01	Manning's Roughness	N =	0.013
	Gutter Conveyance Capacity		
	Gutter Cross Slope	Sw =	0.08 ft/ft
	Water Spread Width	T =	2.00 ft
	Water Depth without Gutter Depression	Y =	0.04 ft
	Water Depth with a Gutter Depression	D =	0.17 ft
	Spread for Side Flow on the Street	Tx =	0.00 ft
	Spread for Gutter Flow along Gutter Slope	Ts =	2.00 ft
	Flowrate Carried by Width Ts	Qws =	0.7 cfs
	Flowrate Carried by Width (Ts - W)	Qww =	0.0 cfs
	Gutter Flow	Qw =	0.7 cfs
	Side Flow	Qx =	0.0 cfs
	Total Flow (Check against Qo)	**Qs =**	**0.7 cfs**
	Gutter Flow to Design Flow Ratio	Eo =	1.00
	Equivalent Slope for the Street	Se =	0.08 ft/ft
	Flow Area	As =	0.17 sq ft
	Flow Velocity	Vs =	4.46 fps
	VsD product	**VsD =**	**0.74 ft^2/s**

Warning 01: Manning's n-value does not meet the USDCM recommended criteria.

CURB OPENING INLET IN A SUMP

Project = **03068 Broadmoor MDDP**
Inlet ID = **Ex. 4' Curb Inlet on east side of Lake Circle south of the Roundabout (5-year)**



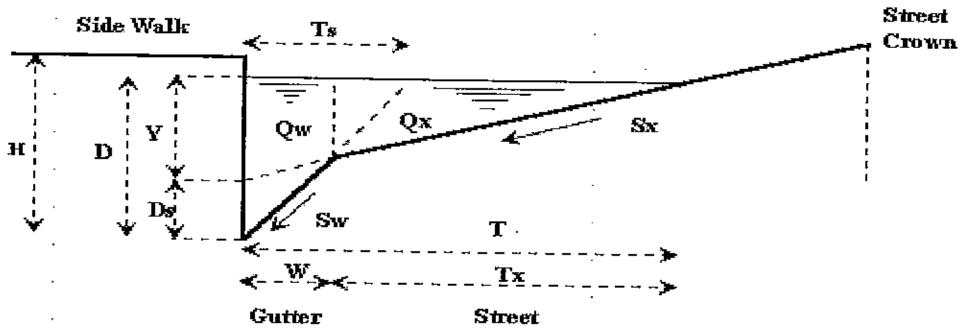
Design Information (Input)		
Design Discharge on the Street (from *Street Hy*)	**Qo =**	**0.3 cfs**
Length of a Unit Inlet	Lu =	4.00 ft
Side Width for Depression Pan	Wp =	3.00 ft
Clogging Factor for a Single Unit	Co =	0.50
Height of Curb Opening in Inches	H =	8.00 inches
Orifice Coefficient	Cd =	0.60
Weir Coefficient	Cw =	3.10
Water Depth for the Design Condition	Yd =	1.00 ft
Angle of Throat (see USDCM Chapter 6, Figure ST-5)	Theta =	63.0 degrees
Number of Curb Opening Inlets	No =	1

Curb Opening Inlet Capacity in a Sump		
As a Weir		
Total Length of Curb Opening Inlet	L =	4.00 ft
Capacity as a Weir without Clogging	Qwi =	29.1 cfs
Clogging Coefficient for Multiple Units	Clog-Coeff =	1.00
Clogging Factor for Multiple Units	Clog =	0.50
Capacity as a Weir with Clogging	Qwa =	22.9 cfs
As an Orifice		
Capacity as an Orifice without Clogging	Qoi =	10.8 cfs
Capacity as an Orifice with Clogging	Qoa =	5.4 cfs
Capacity for Design with Clogging	**Qa =**	**5.4 cfs**
Capacity Percentage for this Inlet = Qa / Qo =	**C% =**	**100.00 %**

Note: Unless additional ponding depth or spilling over the curb is acceptable, a capture percentage of less than 100% in a sump may indicate the need for additional inlet units.

GUTTER CONVEYANCE CAPACITY

Project = 03068 Broadmoor MDDP
Street ID = Ex. 4' combo inlet on south side of Lake Avenue (5-year)

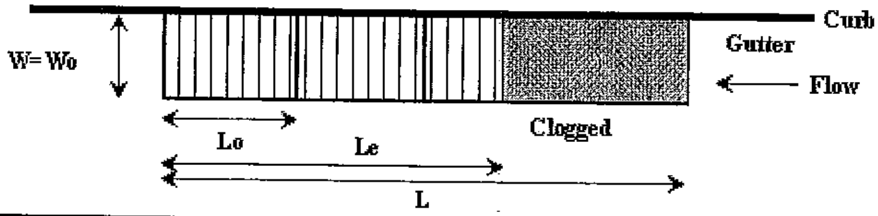


Street Geometry (Input)			
Design Discharge in the Gutter	**Qo =**	**8.2**	**cfs**
Curb Height	H =	8.00	inches
Gutter Width	W =	2.00	ft
Gutter Depression	Ds =	1.50	inches
Street Transverse Slope	Sx =	0.0300	ft/ft
Street Longitudinal Slope	So =	0.0260	ft/ft
Warning 01 Manning's Roughness	N =	0.013	
Gutter Conveyance Capacity			
Gutter Cross Slope	Sw =	0.09	ft/ft
Water Spread Width	T =	8.77	ft
Water Depth without Gutter Depression	Y =	0.26	ft
Water Depth with a Gutter Depression	D =	0.39	ft
Spread for Side Flow on the Street	Tx =	6.77	ft
Spread for Gutter Flow along Gutter Slope	Ts =	4.20	ft
Flowrate Carried by Width Ts	Qws =	6.0	cfs
Flowrate Carried by Width (Ts - W)	Qww =	1.1	cfs
Gutter Flow	Qw =	4.9	cfs
Side Flow	Qx =	3.3	cfs
Total Flow (Check against Qo)	**Qs =**	**8.2**	**cfs**
Gutter Flow to Design Flow Ratio	Eo =	0.60	
Equivalent Slope for the Street	Se =	0.07	ft/ft
Flow Area	As =	1.28	sq ft
Flow Velocity	Vs =	6.43	fps
VsD product	**VsD =**	**2.49**	**ft^2/s**

Warning 01: Manning's n-value does not meet the USDCM recommended criteria.

GRATE INLET ON A GRADE

Project: 03068 Broadmoor MDDP
Inlet ID: Ex. 4' combo inlet on south side of Lake Avenue (5-year)



Design Information (Input)

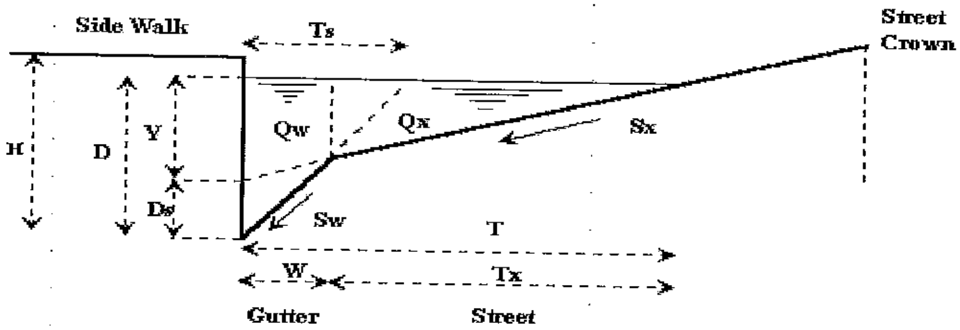
Design Discharge on the Street (from *Street Hy*)	Qo =	**8.2 cfs**
Type of Grate	Type =	Reticuline
Length of a Unit Grate	Lo =	4.00 ft
Width of a Unit Grate	Wo =	2.00 ft
Clogging Factor for a Unit Grate	Co =	0.60
Water Depth for Design Condition	Yd =	8.00 inches
Number of Grates	No =	1

Analysis (Calculated)

Total Length of Grate Inlet	L =	4.00 ft
Ratio of Gutter Flow to Design Flow Eo (from *Street Hy*)	Eo =	0.60
Equivalent Slope Se (from *Street Hy*)	Se =	0.0700 ft/ft
Flow Velocity Vs (from *Street Hy*)	Vs =	6.43 fps
Spash-over Velocity	Vo =	6.62 fps
Under No-Clogging Condition		
Interception Rate of Gutter Flow	Rf =	1.00
Effective Length of Grate Inlet	L =	4.00 ft
Interception Rate of Side Flow Rx (from *Street Hy*)	Rx =	0.15
Interception Capacity	Qi =	5.4 cfs
Under Clogging Condition		
Interception Rate of Gutter Flow	Rf =	1.00
Clogging Coefficient for Multiple-unit Grate Inlet	Coef =	1.99
Clogging Factor for Multiple-unit Grate Inlet	Clog =	0.10
Effective (unclogged) Length of Multiple-unit Grate Inlet	Le =	3.60 ft
Interception Rate of Side Flow Rx (from *Street Hy*)	Rx =	0.12
Actual Interception Capacity	**Qa =**	**5.3 cfs**
Carry-Over Flow = Qo-Qa =	**Q-co =**	**2.9 cfs**
Capture Percentage = Qa/Qo =	**C% =**	**64.72 %**

GUTTER CONVEYANCE CAPACITY

Project = Project #03068 Broadmoor MDDP
Street ID = Gutter Flow on South side of Lake Avenue @ 1st Street (5-year)



Street Geometry (Input)		
Design Discharge in the Gutter	**Qo =**	**5.5 cfs**
Curb Height	H =	8.00 inches
Gutter Width	W =	2.00 ft
Gutter Depression	Ds =	1.50 inches
Street Transverse Slope	Sx =	0.0300 ft/ft
Street Longitudinal Slope	So =	0.0260 ft/ft
Manning's Roughness	N =	0.015
Gutter Conveyance Capacity		
Gutter Cross Slope	Sw =	0.09 ft/ft
Water Spread Width	T =	7.81 ft
Water Depth without Gutter Depression	Y =	0.23 ft
Water Depth with a Gutter Depression	D =	0.36 ft
Spread for Side Flow on the Street	Tx =	5.81 ft
Spread for Gutter Flow along Gutter Slope	Ts =	3.88 ft
Flowrate Carried by Width Ts	Qws =	4.2 cfs
Flowrate Carried by Width (Ts - W)	Qww =	0.6 cfs
Gutter Flow	Qw =	3.6 cfs
Side Flow	Qx =	1.9 cfs
Total Flow (Check against Qo)	**Qs =**	**5.5 cfs**
Gutter Flow to Design Flow Ratio	Eo =	0.66
Equivalent Slope for the Street	Se =	0.07 ft/ft
Flow Area	As =	1.04 sq ft
Flow Velocity	Vs =	5.30 fps
VsD product	**VsD =**	**1.90 ft^2/s**

Broadmoor Hotel Campus
Existing 2-24 CMPs (Lake Overflow)

Site

Inlet Elev	Outlet Elev	Culvert Length	Barrels/	Shape	Material	Span	Rise	n	Inlet Type
100	98	200.01	1	circular	CM Steel	2	2	0.024	CONVENTIONAL
100	98	200.01	1	circular	CM Steel	2	2	0.024	CONVENTIONAL

Roadway Overtopping Data

Pavement Condition	user defined
Weir Coefficient	2.75
Embankment Top Width	10
Crest Length	30
Overtopping Crest Elevation	108

Profile

Station	Elevation
0	108
30	108

Summary of Culvert Flows

Elevation Headwater	Total Flow	Culvet 1	Culvet 2	Culvet 3	Culvet 4	Culvet 5	Culvet 6	Roadway	It
100	0	0	0	0	0	0	0	0	0
101.24	8.74	4.41	4.41	0	0	0	0	0	4
102.19	17.48	8.74	8.74	0	0	0	0	0	4
102.51	26.22	13.13	13.13	0	0	0	0	0	4
102.96	34.96	17.55	17.55	0	0	0	0	0	5
103.56	41	20.52	20.52	0	0	0	0	0	3
105.42	52.44	27.52	27.52	0	0	0	0	0	18
106.48	61.18	30.61	30.61	0	0	0	0	0	3
108.09	69.92	33.38	33.38	0	0	0	0	2.53	11
108.26	78.66	33.4	33.4	0	0	0	0	11.53	5
108.37	87.4	33.37	33.37	0	0	0	0	20.23	4
108	66.75	33.37	33.37	0	0	0	0		

Summary of Iterative Solution Errors

Headwater Elevation	Headwater Error	Total Flow	Flow Error	% Flow Error
100	0	0	0	0
101.24	0.005	8.74	-0.08	-0.89
102.19	0	17.48	0	0
102.51	0.002	26.22	-0.05	-0.19
102.96	0.008	34.96	-0.15	-0.43
103.56	0.004	41	-0.04	-0.09
105.42	0	52.44	-2.61	-4.97
106.48	0.006	61.18	-0.03	-0.06
108.09	-0.009	69.92	0.62	0.89
108.26	-0.008	78.66	0.32	0.41
108.37	-0.009	87.4	0.43	0.49

Channel Type: trapezoidal
Channel slope (Y : 1)verticle/horizontal: 0.0100
Channel.invert elevation: 100.00
Culvert 1 outletinvert elevation: 98.00
Bottom width: 4.00
Side slope (X : 1)horizontal/verticle: 3.00
Manning n: 0.0300

	Left	Main	Right
ChannelBoundary			edtCnlBndryL
Manning n	edtTWIrrManL	edtTWIrrManMain	edtTWIrrManR

Tail Water

Flow	Water surface Elevation	Depth	Velocity	Shear	Froude
0	100	0	0	0	0
8.74	100.56	0.56	2.77	0.347	0.746
17.48	100.8	0.8	3.39	0.501	0.783
26.22	100.99	0.99	3.8	0.618	0.804
34.96	101.14	1.14	4.11	0.714	0.819
41	101.24	1.24	4.29	0.772	0.828
52.44	101.4	1.4	4.59	0.871	0.841
61.18	101.5	1.5	4.78	0.939	0.849
69.92	101.6	1.6	4.95	1.001	0.857
78.66	101.7	1.7	5.11	1.058	0.863
87.4	101.78	1.78	5.25	1.112	0.869

Cross Section

Station	Elevation

Performance Curve

Flow	Headwater Elev	Control Depth Inlet	Control Depth Outlet	Flow Type	Depths Normal	Depths Critical	Depths Outlet	Depths TW	Velocities Outlet	Velocities TW
0	100	0	0	0 - NF	0	0	0	2	0	0
4.41	101.23	1.1	1.23	3 - M1f	0.83	0.73	2	2.56	1.4	2.77
8.74	102.17	1.66	2.17	3 - M1f	1.25	1.05	2	2.8	2.78	3.39
13.13	102.52	2.24	2.52	3 - M1f	2	1.3	2	2.99	4.18	3.8
17.55	102.96	2.96	2.92	3 - M1f	2	1.5	2	3.14	5.59	4.11
20.52	103.55	3.55	3.26	3 - M1f	2	1.62	2	3.24	6.53	4.29
27.52	105.41	5.41	4.26	3 - M1f	2	1.83	2	3.4	8.76	4.59
30.61	106.45	6.45	4.8	3 - M1f	2	1.92	2	3.5	9.74	4.78
33.38	107.49	7.49	5.33	3 - M1f	2	2	2	3.6	10.63	4.95
33.4	107.49	7.49	5.34	3 - M1f	2	2	2	3.7	10.63	5.11
33.37	107.48	7.48	5.33	3 - M1f	2	2	2	3.78	10.62	5.25

Description
Inlet Depression: No
Inlet Type: Conventional
Inlet Edge: Thin edge projecting

Culvert Data Summary
Elevation Inlet Face Invert 100.00
Elevation Outlet Invert: 98.00
Elevation Inlet Throat Invert: 0.00
Elevation Inlet Crest: 100.00
Barrel Shape: circular
Barrel Material: CM Steel
Barrel Span: 2.00
Barrel Rise: 2.00
Barrel Maning n: 0.0240
Number of Barrels: 1

Invert Data
Inlet Station: 0.00
Inlet Elevation:
Outlet Station: 200.00
Outlet Elevation: 98.00
Slope: 0.0100
Length Along Slope: 200.01
Type: Conventional
Face Width: 0.00
Side Taper: 0.00
Height: 0.00
Fall Slope: 0.00
Mitered Height: 0.00
Throat Elev.: 0.0000
Crest Elev.: 100.0000

Improved Inlet

Flow	Headwater Elev	Control Depth Inlet	Control Depth Outlet	Flow Type	Control Elevations Crest	Control Elevations Face	Control Elevations Throat	Elevation TW
0	100	0	0	0 - NF	100	100	0	100
4.41	101.23	1.1	1.23	3 - M1f	0	0	0	100.56
8.74	102.17	1.66	2.17	3 - M1f	0	0	0	100.8
13.13	102.52	2.24	2.52	3 - M1f	0	0	0	100.99
17.55	102.96	2.96	2.92	3 - M1f	0	0	0	101.14
20.52	103.55	3.55	3.26	3 - M1f	0	0	0	101.24
27.52	105.41	5.41	4.26	3 - M1f	0	0	0	101.4
30.61	106.45	6.45	4.8	3 - M1f	0	0	0	101.5
33.38	107.49	7.49	5.33	3 - M1f	0	0	0	101.6
33.4	107.49	7.49	5.34	3 - M1f	0	0	0	101.7
33.37	107.48	7.48	5.33	3 - M1f	0	0	0	101.78

BROADMOOR HOTEL CAMPUS
EXISTING 36" CMP CULVERT
HY8 CALCULATIONS

under Pourtales Road

Site

Inlet Elev	Outlet Elev	Culvert Length	Barrels/	Shape	Material	Span	Rise	n	Inlet Type
6192	6186	100.18	1	circular	CM Steel	3	3	0.024	CONVENTIONAL

Roadway Overtopping Data

Pavement Condition	user defined
Weir Coefficient	2.75
Embankment Top Width	40
Crest Length	30
Overtopping Crest Elevation	6197.5

Profile

Station	Elevation
0	6197.5
30	6197.5

Summary of Culvert Flows

Elevation Headwater	Total Flow	Culvet 1	Culvet 2	Culvet 3	Culvet 4	Culvet 5	Culvet 6	Roadway	It
6192	0	0	0	0	0	0	0	0	1
6194.91	31.1	31.1	0	0	0	0	0	0	1
6197.59	59.3	59.3	0	0	0	0	0	2.66	10
6197.98	62.28	62.28	0	0	0	0	0	30.56	4
6198.14	63.46	63.46	0	0	0	0	0	47.57	3
6198.48	65.87	65.87	0	0	0	0	0	88.67	3
6198.69	67.31	67.31	0	0	0	0	0	118.64	3
6198.88	68.61	68.61	0	0	0	0	0	148.62	3
6199.06	69.79	69.79	0	0	0	0	0	178.61	3
6199.23	70.89	70.89	0	0	0	0	0	208.64	3
6199.4	71.92	71.92	0	0	0	0	0	238.8	3
6197.5	58.51	58.51	0	0	0	0	0		

Summary of Iterative Solution Errors

Headwater Elevation	Headwater Error	Total Flow	Flow Error	% Flow Error
6192	0	0	0	0
6194.91	0	31.1	0	0
6197.6	-0.01	62.2	0.24	0.38
6197.98	-0.003	93.3	0.46	0.49
6198.15	-0.007	112	0.97	0.87
6198.48	-0.006	155.5	0.95	0.61
6198.69	-0.003	186.6	0.65	0.35
6198.89	-0.002	217.7	0.47	0.22
6199.07	-0.002	248.8	0.39	0.16
6199.24	-0.002	279.9	0.38	0.13
6199.4	-0.001	311	0.28	0.09

Channel Type: trapezoidal
Channel slope (Y : 1)verticle/horizontal:0.0600
Channel.invert elevation: 6186.00
Culvert 1 outletinvert elevation: 6186.00
Bottom width: 4.00
Side slope (X : 1)horizontal/verticle:3.00
Manning n: 0.0300

	Left	Main	Right
ChannelBoundary			edtCnlBndryL
Manning n	edtTWIrrManL	edtTWIrrManMain	edtTWIrrManR

Tail Water

Flow	Water surface Elevation	Depth	Velocity	Shear	Froude
0	6186	0	0	0	0
31.1	6186.68	0.68	7.58	2.543	1.876
62.2	6186.97	0.97	9.23	3.646	1.965
93.3	6187.19	1.19	10.31	4.469	2.018
112	6187.31	1.31	10.83	4.89	2.042
155.5	6187.53	1.53	11.82	5.732	2.085
186.6	6187.67	1.67	12.4	6.253	2.109
217.7	6187.8	1.8	12.91	6.724	2.13
248.8	6187.91	1.91	13.37	7.157	2.148
279.9	6188.02	2.02	13.78	7.559	2.164
311	6188.12	2.12	14.16	7.936	2.178

Cross Section

Station	Elevation

BROADMOOR HOTEL CAMPUS
EXISTING 36" CMP CULVERT
HY8 CALCULATIONS

Performance Curve

Flow	Headwater Elev	Control Depth Inlet	Control Depth Outlet	Flow Type	Depths Normal	Depths Critical	Depths Outlet	Depths TW	Velocities Outlet	Velocities TW
0	6192	0	0	0 - NF	0	0	0	0	0	0
31.1	6194.91	2.91	2.91	1 - S2n	1.23	1.81	1.11	0.68	13.09	7.59
59.3	6197.59	5.59	5.59	5 - S2n	1.79	2.47	1.8	0.97	13.37	9.23
62.28	6197.98	5.98	5.98	5 - S2n	1.86	2.52	1.87	1.19	13.5	10.31
63.46	6198.14	6.14	6.14	5 - S2n	1.88	2.54	1.89	1.31	13.54	10.83
65.87	6198.48	6.48	6.48	5 - S2n	1.93	2.58	1.88	1.53	14.15	11.82
67.31	6198.69	6.69	6.69	5 - S2n	1.96	2.6	1.9	1.67	14.25	12.4
68.61	6198.88	6.88	6.88	5 - S2n	1.98	2.62	1.92	1.8	14.35	12.91
69.79	6199.06	7.06	7.06	5 - S2n	2.01	2.64	1.94	1.91	14.43	13.37
70.89	6199.23	7.23	7.23	5 - S2n	2.03	2.66	1.96	2.02	14.51	13.78
71.92	6199.4	7.4	7.4	5 - S2n	2.05	2.68	1.98	2.12	14.58	14.16

Description
Inlet Depression: No
Inlet Type: Conventional
Inlet Edge: Thin edge projecting

Culvert Data Summary
Elevation Inlet Face Invert 6192.00
Elevation Outlet Invert: 6186.00
Elevation Inlet Throat Invert: 0.00
Elevation Inlet Crest: 6192.00
Barrel Shape: circular
Barrel Material: CM Steel
Barrel Span: 3.00
Barrel Rise: 3.00
Barrel Maning n: 0.0240
Number of Barrels: 1

Invert Data
Inlet Station: 0.00
Inlet Elevation:
Outlet Station: 100.00
Outlet Elevation: 6186.00
Slope: 0.0600
Length Along Slope: 100.18
Type: Conventional
Face Width: 0.00
Side Taper: 0.00
Height: 0.00
Fall Slope: 0.00
Mitered Height: 0.00
Throat Elev.: 0.0000
Crest Elev.: 6192.0000

Improved Inlet

Flow	Headwater Elev	Control Depth Inlet	Control Depth Outlet	Flow Type	Control Elevations Crest	Control Elevations Face	Control Elevations Throat	Elevation TW
0	6192	0	0	0 - NF	6192	6192	0	6186
31.1	6194.91	2.91	2.91	1 - S2n	0	0	0	6186.68
59.3	6197.59	5.59	5.59	5 - S2n	0	0	0	6186.97
62.28	6197.98	5.98	5.98	5 - S2n	0	0	0	6187.19
63.46	6198.14	6.14	6.14	5 - S2n	0	0	0	6187.31
65.87	6198.48	6.48	6.48	5 - S2n	0	0	0	6187.53
67.31	6198.69	6.69	6.69	5 - S2n	0	0	0	6187.67
68.61	6198.88	6.88	6.88	5 - S2n	0	0	0	6187.8
69.79	6199.06	7.06	7.06	5 - S2n	0	0	0	6187.91
70.89	6199.23	7.23	7.23	5 - S2n	0	0	0	6188.02
71.92	6199.4	7.4	7.4	5 - S2n	0	0	0	6188.12

BROADMOOR HOTEL CAMPUS
PROPOSED 2-36" RCP CULVERT
HY8 CALCULATIONS

under Pourtales Road

Site

Inlet Elev	Outlet Elev	Culvert Length	Barrels/	Shape	Material	Span	Rise	n	Inlet Type
6192	6186	100.18	2	circular	Concrete	3	3	0.012	CONVENTIONAL

Roadway Overtopping Data

Pavement Condition	user defined
Weir Coefficient	2.75
Embankment Top Width	40
Crest Length	30
Overtopping Crest Elevation	6197.5

Profile

Station	Elevation
0	6197.5
30	6197.5

Summary of Culvert Flows

Elevation Headwater	Total Flow	Culvet 1	Culvet 2	Culvet 3	Culvet 4	Culvet 5	Culvet 6	Roadway	It
6192	0	0	0	0	0	0	0	0	1
6193.71	31.1	31.1	0	0	0	0	0	0	1
6194.68	62.2	62.2	0	0	0	0	0	0	1
6195.66	93.3	93.3	0	0	0	0	0	0	1
6196.4	112	112	0	0	0	0	0	0	1
6197.79	140.02	140.02	0	0	0	0	0	14.42	5
6198.08	145.06	145.06	0	0	0	0	0	40.11	3
6198.32	149.17	149.17	0	0	0	0	0	67.55	3
6198.53	152.69	152.69	0	0	0	0	0	95.43	3
6198.72	155.8	155.8	0	0	0	0	0	123.55	3
6198.91	158.67	158.67	0	0	0	0	0	151.93	3
6197.5	134.55	134.55	0	0	0	0	0		

Summary of Iterative Solution Errors

Headwater Elevation	Headwater Error	Total Flow	Flow Error	% Flow Error
6192	0	0	0	0
6193.71	0	31.1	0	0
6194.68	0	62.2	0	0
6195.66	0	93.3	0	0
6196.4	0	112	0	0
6197.8	-0.009	155.5	1.06	0.68
6198.08	-0.01	186.6	1.43	0.76
6198.32	-0.006	217.7	0.98	0.45
6198.53	-0.004	248.8	0.67	0.27
6198.73	-0.003	279.9	0.55	0.2
6198.91	-0.002	311	0.39	0.13

Channel Type: trapezoidal
Channel slope (Y : 1)verticle/horizontal:0.0600
Channel.invert elevation:6186.00
Culvert 1 outletinvert elevation:6186.00
Bottom width: 4.00
Side slope (X : 1)horizontal/verticle:3.00
Manning n: 0.0300

	Left	Main	Right
ChannelBoundary			edtCnlBndryL
Manning n	edtTWIrrManL	edtTWIrrManMain	edtTWIrrManR

Tail Water

Flow	Water surface Elevation	Depth	Velocity	Shear	Froude
0	6186	0	0	0	0
31.1	6186.68	0.68	7.58	2.543	1.876
62.2	6186.97	0.97	9.23	3.646	1.965
93.3	6187.19	1.19	10.31	4.469	2.018
112	6187.31	1.31	10.83	4.89	2.042
155.5	6187.53	1.53	11.82	5.732	2.085
186.6	6187.67	1.67	12.4	6.253	2.109
217.7	6187.8	1.8	12.91	6.724	2.13
248.8	6187.91	1.91	13.37	7.157	2.148
279.9	6188.02	2.02	13.78	7.559	2.164
311	6188.12	2.12	14.16	7.936	2.178

Cross Section

Station	Elevation

BROADMOOR HOTEL CAMPUS
PROPOSED 2-36" RCP CULVERT
HY8 CALCULATIONS

Performance Curve

Flow	Headwater Elev	Control Depth Inlet	Control Depth Outlet	Flow Type	Depths Normal	Depths Critical	Depths Outlet	Depths TW	Velocities Outlet	Velocities TW
0	6192	0	0	0 - NF	0	0	0	0	0	0
31.1	6193.71	1.71	1.71	1 - S2n	0.6	1.25	0.62	0.68	14.87	7.59
62.2	6194.68	2.68	2.68	1 - S2n	0.84	1.81	0.9	0.97	17.51	9.23
93.3	6195.66	3.66	3.66	5 - S2n	1.04	2.22	1.16	1.19	18.55	10.31
112	6196.4	4.4	4.4	5 - S2n	1.15	2.42	1.29	1.31	19.23	10.83
140.02	6197.79	5.79	5.79	5 - S2n	1.31	2.65	1.49	1.53	20.04	11.82
145.06	6198.08	6.08	6.08	5 - S2n	1.33	2.69	1.52	1.67	20.24	12.4
149.17	6198.32	6.32	6.32	5 - S2n	1.35	2.72	1.55	1.8	20.26	12.91
152.69	6198.53	6.53	6.53	5 - S2n	1.37	2.75	1.57	1.91	20.43	13.37
155.8	6198.72	6.72	6.72	5 - S2n	1.39	2.77	1.57	2.02	20.77	13.78
158.67	6198.91	6.91	6.91	5 - S2n	1.4	2.8	1.6	2.12	20.77	14.16

Description
Inlet Depression: No
Inlet Type: Conventional
Inlet Edge: Square edge with headwall

Culvert Data Summary
Elevation Inlet Face Invert6192.00
Elevation Outlet Invert:6186.00
Elevation Inlet Throat Invert:0.00
Elevation Inlet Crest:6192.00
Barrel Shape: circular
Barrel Material: Concrete
Barrel Span: 3.00
Barrel Rise: 3.00
Barrel Maning n: 0.0120
Number of Barrels: 2

Invert Data
Inlet Station: 0.00
Inlet Elevation:
Outlet Station: 100.00
Outlet Elevation: 6186.00
Slope: 0.0600
Length Along Slope: 100.18
Type: Conventional
Face Width: 0.00
Side Taper: 0.00
Height: 0.00
Fall Slope: 0.00
Mitered Height: 0.00
Throat Elev.: 0.0000
Crest Elev.: 6192.0000

Improved Inlet

Flow	Headwater Elev	Control Depth Inlet	Control Depth Outlet	Flow Type	Control Elevations Crest	Control Elevations Face	Control Elevations Throat	Elevation TW
0	6192	0	0	0 - NF	6192	6192	0	6186
31.1	6193.71	1.71	1.71	1 - S2n	0	0	0	6186.68
62.2	6194.68	2.68	2.68	1 - S2n	0	0	0	6186.97
93.3	6195.66	3.66	3.66	5 - S2n	0	0	0	6187.19
112	6196.4	4.4	4.4	5 - S2n	0	0	0	6187.31
140.02	6197.79	5.79	5.79	5 - S2n	0	0	0	6187.53
145.06	6198.08	6.08	6.08	5 - S2n	0	0	0	6187.67
149.17	6198.32	6.32	6.32	5 - S2n	0	0	0	6187.8
152.69	6198.53	6.53	6.53	5 - S2n	0	0	0	6187.91
155.8	6198.72	6.72	6.72	5 - S2n	0	0	0	6188.02
158.67	6198.91	6.91	6.91	5 - S2n	0	0	0	6188.12

Reimbursable Costs

Client: COG Land and Development
Project: Broadmoor Hotel Campus
Project No. 03068

Table 1: Opinion of Cost - Public Storm Drainage Facilities

Item	Quantity	Unit	Unit Cost	Item Total
36-inch Reinforced Concrete Pipe	200	lf	$65.00	**$ 13,000.00**
Concrete Headwall	2	ea	$22,500.00	**$ 45,000.00**

Estimated Storm Drainage Facilities Cost	$ 58,000.00
Engineering 10%	$ 5,800.00
Contingency 5%	$ 2,900.00
Total Estimated Cost	**$ 66,700.00**