MASTER DEVELOPMENT DRAINAGE PLAN

AND

FINAL DRAINAGE REPORT

for

"Briargate Crossing West Filing No. 1"

Prepared for:
City of Colorado Springs, Colorado
Engineering Division

On Behalf of:

BRIARGATE CROSSING®

LP47, LLC dba La Plata Investments
2315 Briargate Parkway, Suite 100
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Prepared by:

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September, 2003

03.104.013

10/49

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 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.

Jonathan C. Moore
Registered Professional Engineer
State of Colorado
No. 34944
Prepared by: Angela Howard, E.I.

COLORADO REGISTERED PROFESSIONAL ENGINEER JONATHAN C. MOORE 34944 9/19/03 SEAL

Developer's Statement:

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

LP47, LLC dba La Plata Investments
Business Name

By: ______________________
Thomas Taylor
Title: Director of Development Services
Address: 2315 Briargate Parkway, Suite 100
Colorado Springs, CO 80920

City of Colorado Springs:

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

______________________ Oct 9, 2003
City Engineer Date

Conditions:

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I. INTRODUCTION

Briargate Crossing West is a proposed development consisting of 118 acres on the north side of the City of Colorado Springs, Colorado within the Briargate Development. The land is currently undeveloped. The current owner intends to plat and develop the entire parcel with commercial, multi-family residential, and office sites. This ***MDDP & Final Drainage Report*** analyzes only the roads, including anticipated developed flows for the lots. When each lot is developed, an individual drainage report will be required to ensure the site is developed in accordance with City of Colorado Springs standards. Briargate Crossing West is located in the Pine Creek No-Fee Drainage Basin.

A. Background

The scope of this ***MDDP & Final Drainage Report*** is to provide detailed hydrologic and hydraulic calculations for proposed development and to ensure that City criteria as outlined within the ***City of Colorado Springs & El Paso County Drainage Criteria Manual***, are met for the site.

B. Project Location

This site is located within the City of Colorado Springs in the Pine Creek Drainage No-Fee Basin. See the Vicinity Map, located within the Appendix. More specifically, the location is as follows:

1. General Location. South ½ of Section 26, Northeast ¼ of Section 34, and the North ½ of Section 35, Township 12 South, Range 66 West of the 6^{th} P.M., City of Colorado Springs, County of El Paso, State of Colorado.
2. Street Location. The site is bounded by Union Boulevard on the north and west, Briargate Parkway on the south and Powers Boulevard on the east.
3. Drainageway. Drainage from the site will be collected through an internal storm sewer system which discharges the flows into storm sewer systems in Union Boulevard and Briargate Parkway.
4. Surrounding Developments. Pine Creek Filings No. 16 & 23 to the north are existing and proposed single-family developments respectively; future Penrose Medical Center, Sagewood Filing No. 3, 4, & 6, and undeveloped land are to the south; Powers Boulevard is to the east; and a detention pond is to the west.

C. Property Description

1. Drainage Area. Briargate Crossing West is 118 acres of land located within the Pine Creek Drainage No-Fee Basin.
2. Ground Cover. This site is covered with sparse vegetation including natural grasses. It naturally drains to the southwest.
3. Proposed Land Use. Land use will be for commercial, multi-family residential, and office sites.

4. Soils. Investigation of the Soil Conservation Service Soil Survey for El Paso County reveals that the soils typically exhibit moderate to rapid permeability with Hydrologic Groupings of Type "A" and Type "B" soils. For the purposes of this final drainage report, Type "B" soils characteristics have been assumed for the area. The soils exhibit potential for wind erosion when natural cover is removed. See the Soils Map, located within the Appendix.
5. Major Drainageways. No major drainageways exist on the site.
6. Irrigation Facilities. No known irrigation facilities exist on or around the site that could be influenced by the local drainage.
7. Utilities. Existing utilities within the sites are being relocated before the sites are developed.

II. DRAINAGE BASINS AND SUB-BASINS

A. *Major Basin Description*

Briargate Crossing West is located within the Pine Creek Drainage Basin. The area has been previously studied within the ***Pine Creek Drainage Basin Planning Study***, prepared by Obering, Wurth & Associates Consulting Civil Engineers, revised October 1988. The City of Colorado Springs City Council formally adopted the study in 1988. ***Amendment No. 2 to Pine Creek Drainage Basin Planning Study and Master Development Drainage Plan for Pine Creek Subdivision (Portion Contributing to Pine Creek)*** by JR Engineering was approved by the City of Colorado Springs in October, 1998. ***Amendment No. 3 to Pine Creek Drainage Basin Planning Study*** by JR Engineering was approved by the City of Colorado Springs in March, 2003. This area has also been studied by JR Engineering as documented in the ***Master Development Drainage Plan for Union Boulevard/Briargate Parkway and Preliminary/Final Drainage Report for Portions of Union Boulevard, Briargate Parkway, Family Place and Austin Bluffs Parkway***, approved by the City in January, 2002. The Pine Creek Basin is a "No-Fee" Basin.

The Pine Creek Drainage Basin consists of approximately 3,200 acres of land in the northern portion of the City of Colorado Springs. In general, the basin drains to the southwest and feeds into Monument Creek. The Pine Creek and North Pine Creek drainageways do not flow across this site. See the Floodplain Maps, located within the Appendix.

B. *Floodplain Statement*

The ***Flood Insurance Rate Map Numbers 08041CO507, 08041CO509, 08041CO528,*** and ***08041CO530*** dated March 17, 1997, published by the Federal Emergency Management Agency, reveal that the southern portion of Briargate Crossing West, just along Briargate Parkway, is located within a 100-year designated floodplain. JR Engineering on behalf of La Plata Investments prepared a request for a Conditional Letter of Map Revision (CLOMR) for elimination of the 100-year floodplain that impacts Briargate Crossing West. This CLOMR is based on construction of the proposed storm sewer systems in Briargate Parkway and Union

Boulevard. FEMA issued this CLOMR (FEMA Case No. 01-08-202R) on August 23, 2001. See the Floodplain Maps, located within the Appendix.

C. Sub-Basin Description

Briargate Crossing West has historically drained to the southwest corner of the site, where Union Boulevard and Briargate Parkway intersect. Existing slopes on the site range between 4% and 13%. Historically flows from this area continue overland to Pine Creek.

III. DRAINAGE DESIGN CRITERIA

A. Development Criteria

This report has been prepared in accordance to the *City of Colorado Springs & El Paso County Drainage Criteria Manual*, dated November 1991, including subsequent updates. In addition, requirements that have been given in the *Pine Creek Drainage Basin Planning Study* (October 1998), *Amendment No. 2 to Pine Creek Drainage Basin Planning Study and Master Development Drainage Plan for Pine Creek Subdivision* (October 1998), and the *Amendment No. 3 to Pine Creek Drainage Basin Planning Study* (March 2003) have been used in the preparation of this report.

B. Hydrologic Criteria

Hydrologic analyses of the project drainage have been performed using the Rational Method in accordance with the Criteria Manual for drainage sub-basins less than 100 acres. Rainfall intensity frequency values are from the ***Drainage Criteria Manual***.

The design storm events are:

- Initial Storm = 5-year storm
- Major Storm = 100-year storm.

Runoff coefficients for the proposed site are based upon commercial and multi-family residential uses, and the basis for the undeveloped areas are pasture and meadow coefficients.

Regional detention ponds will provide detention for this site. The regional detention pond that will serve this site is located adjacent to the site on the northwest corner of Union Boulevard and Briargate Parkway. See the location as shown on the Existing and Proposed Drainage Basin Maps in Appendix A.

IV. DRAINAGE FACILITY DESIGN

A. Existing Conditions

The site is currently undeveloped, but roads around the perimeter have been rough-graded and will be constructed by La Plata Investments before the development of this site. Current vegetation includes natural grasses. The site currently drains to the southwest, contributing to Pine Creek. Historic drainage conditions will be maintained.

Existing calculated runoff rates for each sub-basin at the site are summarized as follows:

Basin	Area	Q(5)	Q(100)
	(Acres)	(cfs)	(cfs)
EX-A	66.30	**49.7**	**120.7**
EX-B	36.44	**26.4**	**63.8**
EX-C	14.52	**9.1**	**21.9**

See the Existing Drainage Basin Map, located in the appendix of this report for sub-basin delineations and flow summary.

B. Briargate Crossing West Development

The development will consist of 7 commercial, multi-family residential, and/or office lots. Each site will require a Final Drainage Report to illustrate how the developed lot will collect its drainage in conformance with City standards.

Access to the site is provided along Briargate Parkway at Austin Bluffs Parkway and Royal Pine Drive, along Union Boulevard at Royal Pine Drive, and along Powers Boulevard at Promenade Drive. The extension of Austin Bluffs Parkway, as well as Promenade Drive, and Royal Pine Drive will be public roads. The extension of Promenade Drive west of Austin Bluffs Parkway has not yet been designed and its construction will depend on the development of lots 1, 2, and 7.

The storm sewer systems in Union and Briargate Parkways have been designed by JR Engineering and sized to accommodate 100-year developed flows from Briargate Crossing West. There is a storm sewer system in the Powers Boulevard frontage road that Promenade Drive intersects with. This storm sewer handles the drainage from Powers Boulevard only—contributing no flows to and accepting no flows from Briargate Crossing West. An existing underground telephone line in the southwest corner of the site will be relocated prior to development.

C. Interim Conditions

Once the roads and storm sewer system are built, but the lots are undeveloped, Briargate Crossing West will be in an interim drainage state. Proposed drainage basins D, E, H, I, J, M, N, P, S and T only cover roadway sections and will therefore be the same in the interim condition as in the final (proposed) condition. The remaining basins (including interim-only basins A-1 and

O-1) will develop less flows and be drained differently during the interim condition. La Plata Investments will maintain all sedimentation basins and drainage swales at Briargate Crossing West.

Basin	Design Point	Area	Tc	100 Intensity	100 Comp. C	100 Q
		(Acres)	(Min.)	(In./hr.)		**(cfs)**
A	1	33.37	11.68	6.62	0.25	**55.2**
A-1	1	9.08	10.82	6.84	0.25	**15.5**
C	3	13.09	10.68	6.88	0.25	**22.5**
F	6	14.25	11.13	6.76	0.25	**24.1**
G	7	1.73	9.95	7.09	0.25	**3.1**
O	15	12.36	10.57	6.91	0.25	**21.4**
O-1	15	7.70	10.77	6.86	0.25	**13.2**
Q	17	4.51	10.04	7.06	0.25	**8.0**
R	18	11.17	10.68	6.88	0.25	**19.2**

Table 1. Flows from Drainage Basins for the Interim Condition

Basins A and A-1 encompass the majority of lots 1, 2, and 7. Water will flow overland to the southwest, where it will be collected by drainage swales parallel to Union and Briargate Boulevards and directed to a sedimentation pond. A temporary sedimentation basin will be built in the southwest corner of the site to assist with erosion control from the site prior to construction. Water from the sedimentation basin will enter the Briargate Parkway storm sewer system through an 8-inch riser pipe, connected to a 42-inch RCP storm sewer stub. This basin will be removed when development begins on Lot 1. The pond volume has been calculated to hold 1,800 cubic feet of water per contributing acre as specified by city standards (see Appendix C), creating a total design volume of 76,410 cubic feet for 42.45 acres. See the Interim Drainage Basin Map in Appendix A for locations.

Lot 6 is covered by Basin C. This drainage also flows overland to the southwest, but it is picked up by a drainage swale along the western property line to prevent the flows from flowing onto lot 2. This drainage swale flows through an 8-inch riser pipe, connected to the 36-inch storm pipe stub from Storm MH #3 from a sedimentation pond to prevent site erosion and diminishing pipe capacity. The pond volume has been calculated to hold 1,800 cubic feet of water per contributing acre as specified by city standards (see Appendix C), creating a total design volume of 23,600 cubic feet for 13.09 acres. See the Interim Drainage Basin Map in Appendix A for locations.

The majority of lot 5 is in Basin F, which flows to the northwest. The flows in Basin F will also be collected in a sedimentation pond before entering an 8-inch riser pipe, connected to a 36-inch RCP storm sewer stub that connects into the Union Boulevard storm sewer system. The pond volume has been calculated to hold 1,800 cubic feet of water per contributing acre as specified by city standards (see Appendix C), creating a total design volume of 25,700 cubic feet for 14.25 acres. See the Interim Drainage Basin Map in Appendix A for locations.

The remainder of lot 5 is in Basin G. This basin flows from the ridgeline southwest to an 18-inch RCP storm sewer stub that feeds into the Promenade Drive storm sewer system. Basin P also flows into the Promenade Drive storm sewer system from the ridgeline in Lot 4. The flows enter the system through an 8-inch riser pipe, connected to a 24-inch RCP storm sewer stub.

The sedimentation pond in the southwest corner of Lot 4 will collect the flows from the drainage swale parallel to Briargate Parkway and discharge into an 8-inch riser pipe, connected to a 30-inch RCP storm sewer stub designed by JR Engineering. Water from Basin R will flow overland southwest across the lot into the drainage swale. The pond volume has been calculated to hold 1,800 cubic feet of water per contributing acre as specified by city standards (see Appendix C), creating a total design volume of 20,200 cubic feet for 11.17 acres. See the Interim Drainage Basin Map in Appendix A for locations.

Lot 3 has been divided into 2 basins: O and O-1. Basin O-1 comprises the north and west parts of the site and water flows overland into the swale parallel to Austin Bluffs Parkway. Water from Basin O flows overland across the south and east parts of the lot into the drainage swale parallel to Briargate Parkway. Both these swales discharge into the sedimentation basin in the southwest corner of the lot. Water from this sedimentation basin flows into the Briargate Parkway storm sewer system through an 8-inch riser pipe, connected to a 42-inch RCP storm sewer stub. The pond volume has been calculated to hold 1,800 cubic feet of water per contributing acre as specified by city standards (see Appendix C), creating a total design volume of 36,200 cubic feet for 20.06 acres. See the Interim Drainage Basin Map in Appendix A for locations.

D. Proposed Conditions

Briargate Crossing West has been divided into 20 on-site drainage basins in the final (proposed) condition.

On-site Basin A consists of 18.16 acres at the southwest corner of the site. When the site is developed the temporary drainage swales and sedimentation pond from the interim condition will be removed. It is anticipated that runoff will still be directed to the southwest, now through an interior storm sewer system that will connect into the stub that drained the sedimentation basin during the interim condition. This 42-inch stub connects into the Briargate Parkway storm sewer system. Calculated peak runoff for the 5-year and 100-year storm events are Q(5)=63.7 cfs and Q(100)=116.0 cfs, designated as Design Point 1.

On-site Basin B accounts for Lot 7—13.42 acres of land west of Austin Bluffs and north of the Austin Bluffs and Promenade Drive roundabout. Calculated peak runoff rates are Q(5)= 49.5 cfs and Q(100)=87.0 cfs, designated as Design Point 2. When the site is developed, an interior storm sewer system will be built which will convey flows to Design Point 2. From Design Point 2, flows will be conveyed to Design Point 11, where they will enter the Briargate Parkway storm sewer system via a 30-inch RCP storm sewer stub designed and installed by JR Engineering.

Depending on the state of development of Lot 2, the flows may be conveyed between design points through a temporary drainage swale or a permanent storm sewer system.

On-site Basin C comprises lot 6, between Royal Pine Drive and Promenade Drive, east of the Austin Bluffs and Promenade Drive roundabout. During the interim condition, runoff will be collected in a swale along the western boundary of the basin. When the site is developed, flows will be conveyed through an interior storm sewer system to Design Point 3, with no runoff flowing into Basin B. Flows collected at Design Point 3 will enter the Promenade Drive storm sewer system through a 36-inch RCP stub. At Design Point 3, calculated peak runoff rates are Q(5)=48.3 cfs, and Q(100)=84.8 cfs.

On-site Basin D consists of the southwest half of Royal Pine Drive between the high point north of Promenade Drive and Union Boulevard. Curb and gutter to Union Boulevard will convey flows to capture at Design Point 4. Flows at Design Point 4 enter the Union Boulevard storm sewer system through a 10-foot sump inlet. Calculated runoff rates are Q(5)=3.0 cfs and Q(100)=5.3 cfs.

On-site Basin E accounts for northeast half of Royal Pine Drive between the high point north of Promenade Drive and Union Boulevard. Flows from this basin are conveyed by the curb and gutter to Design Point 5—the 5-foot sump inlet connected to the Union Boulevard storm sewer system. Calculated peak runoff rates are Q(5)= 2.6 cfs and Q(100)=4.6 cfs.

On-site Basin F comprises 14.25 acres between Royal Pine Drive, Union Boulevard, Powers Boulevard and the ridgeline north of Promenade Drive. The flows from this basin will continue to be collected by the storm sewer system at Design Point 6. These flows will be conveyed overland or via an interior storm sewer system. The storm sewer connection at Design Point 6 is a 36-inch RCP storm sewer stub connected to the Union Boulevard storm sewer system. At Design Point 6, calculated peak runoff rates are Q(5)=50.0 cfs, and Q(100)=91.0 cfs.

On-site Basin G is 1.73 acres bounded by the ridgeline north of Promenade Drive, Royal Pine Drive, and Promenade Drive. This small portion of Lot 4 will be collected by an 18-inch RCP storm sewer stub connected to the Promenade Drive storm sewer system at Design Point 7. The Final Drainage Report for this lot will establish how flows will be conveyed to the collection point. Calculated runoff rates are Q(5)=6.5 cfs and Q(100)=11.4 cfs.

On-site Basin H accounts for the north half of Promenade Drive between Powers Boulevard and Royal Pine Drive, as well as the east side of Royal Pine Drive from Promenade Drive to the high point. Runoff will flow via curb and gutter to collection at Design Point 8. Collection at Design Point 8 will be through a 5-foot sump inlet on the Promenade Drive storm sewer system. Calculated peak runoff rates are Q(5)= 3.2 cfs and Q(100)=5.6 cfs.

On-site Basin I comprises the north half of Promenade Drive along the on-street parking area. The flows from this Basin will be conveyed via a 4-foot wide crosspan between the roadway and parking area to Design Point 9 for collection. A 10-foot inlet will convey flows into the

Promenade Drive storm sewer system. At Design Point 9, calculated peak runoff rates are Q(5)=6.5 cfs, and Q(100)=11.4 cfs.

On-site Basin J consists of the south half of Promenade Drive along the on-street parking area. A 4-foot wide crosspan between the roadway and parking area will convey flows to capture at Design Point 10. A 10-foot inlet will convey flows into the Promenade Drive storm sewer system via an 18-inch lateral. Calculated runoff rates are Q(5)=6.7 cfs and Q(100)=11.7 cfs.

On-site Basin K accounts for 7.58 acres between Briargate Parkway, Basins A, B, and L. Calculated peak runoff rates are Q(5)=28.0 cfs and Q(100)=49.1 cfs, designated as Design Point 11. Runoff will flow overland to the drainage swale along Briargate Parkway and will be conveyed in the swale to the on-site sedimentation pond until the site is developed.

On-site Basin L comprises the area between Basin K, Austin Bluffs and Briargate Parkway totaling 3.28 acres. Flows from this basin will be conveyed to Design Point 12, either overland or through an interior storm sewer system. Flows will be conveyed into the Briargate Parkway storm sewer system at Design Point 12 through a 36-inch RCP storm sewer stub designed and installed by JR Engineering. At Design Point 12, calculated peak runoff rates are Q(5)=12.3 cfs, and Q(100)=21.3 cfs.

On-site Basin M consists of the west half of Austin Bluffs between Promenade Drive and Briargate Parkway. Curb and gutter to Briargate will convey flows to capture at Design Point 13 from a 10-foot sump inlet. There flows will be conveyed into the Austin Bluffs storm sewer system at Storm MH #1 via an 18-inch RCP lateral. Calculated runoff rates are Q(5)=5.3 cfs and Q(100)=9.9 cfs.

On-site Basin N accounts for the east half of Austin Bluffs between Promenade Drive and Briargate Parkway. Runoff will flow via curb and gutter to capture at Design Point 14. Flows from the curb and gutter will enter a 10-foot sump inlet installed by JR Engineering and be conveyed into the Briargate Parkway storm sewer system. Calculated peak runoff rates are Q(5)= 3.9 cfs and Q(100)=6.8 cfs.

On-site Basin O comprises the lot between Austin Bluffs, Promenade Drive, Royal Pine Drive, and Briargate Parkway. The flows from this basin will join the Briargate Parkway storm sewer system at Design Point 15 through a 42-inch RCP storm sewer stub installed by JR Engineering. Flows will be conveyed to Design Point 15 as specified in the Final Drainage Report for Lot 6. At Design Point 15, calculated peak runoff rates are Q(5)=70.4 cfs, and Q(100)=128.2 cfs.

On-site Basin P consists of the south half of Promenade Drive between Powers Boulevard and Royal Pine Drive, including the east side of Royal Pine Drive from Promenade Drive south to the high point. Curb and gutter will convey flows to capture at Design Point 16, where they will enter a 5-foot sump inlet and enter the Promenade Drive storm sewer system. Calculated runoff rates are Q(5)=3.5 cfs and Q(100)=6.1 cfs.

On-site Basin Q accounts for 4.51 acres of land between Royal Pine Drive, Promenade Drive, Powers Boulevard and the ridgeline south of Promenade Drive. Runoff will flow to collection at Design Point 17 in accordance with the approved Final Drainage Report for Lot 4. At Design Point 17 flows will enter a 24-inch RCP storm sewer stub to join the Promenade Drive storm sewer system. Calculated peak runoff rates are Q(5)= 17.0 cfs and Q(100)=29.6 cfs.

On-site Basin R comprises the lot between Royal Pine Drive, Briargate Parkway, and Powers Boulevard and south of the ridgeline parallel to Promenade Drive. The flows from this basin will enter the Briargate Parkway storm sewer system through a 30-inch RCP storm sewer stub installed by JR Engineering at Design Point 18. Flows will reach the point of collection in accordance to the Final Drainage Report for Lot 4. At Design Point 18, calculated peak runoff rates are Q(5)=41.2 cfs, and Q(100)=72.4 cfs.

On-site Basin S consists of the east half of Royal Pine Drive south of the ridgeline to Briargate Parkway. Curb and gutter to Briargate Parkway will convey flows to capture at Design Point 19. Flows captured at this point will enter a 5-foot sump inlet and join the Briargate Parkway storm sewer system. Calculated runoff rates are Q(5)=2.4 cfs and Q(100)=4.2 cfs.

On-site Basin T accounts for west half of Royal Pine Drive south of the ridgeline to Briargate Parkway. Calculated peak runoff rates are Q(5)= 2.6 cfs and Q(100)=4.6 cfs. Runoff will flow via curb and gutter to capture at Design Point 20. Flows captured at this point will enter a 5-foot sump inlet and join the Briargate Parkway storm sewer system.

Calculated peak runoff rates for the 5-year and 100-year storm events have been calculated for each sub-basin as follows:

Basin	Design Point	Area	Q(5)	Q(100)
		(Acres)	(cfs)	(cfs)
A	1	18.16	**63.7**	**116.0**
B	2	13.42	**49.5**	**87.0**
C	3	13.09	**48.3**	**84.8**
D	4	0.81	**3.0**	**5.3**
E	5	0.71	**2.6**	**4.6**
F	6	14.25	**50.0**	**91.0**
G	7	1.73	**6.5**	**11.4**
H	8	0.86	**3.2**	**5.6**
I	9	1.76	**6.5**	**11.4**
J	10	1.81	**6.7**	**11.7**
K	11	7.58	**28.0**	**49.1**
L	12	3.28	**12.3**	**21.3**
M	13	1.53	**5.6**	**9.9**
N	14	1.04	**3.9**	**6.8**
O	15	20.06	**70.4**	**128.2**
P	16	0.92	**3.5**	**6.1**
Q	17	4.51	**17.0**	**29.6**
R	18	11.17	**41.2**	**72.4**
S	19	0.64	**2.4**	**4.2**
T	20	0.70	**2.6**	**4.6**

Routed Flows				
P, Q	21	5.43	**20.5**	**35.7**
G, H, P, Q	22	8.02	**29.6**	**52.0**
G, H, I, J, P, Q	23	11.58	**40.7**	**71.9**
C, G, H, I, J, P, Q	24	24.68	**84.4**	**151.0**
C, G, H, I, J, M, P, Q	25	26.21	**87.3**	**158.0**

See the Proposed Drainage Basin Map, Appendix A, for basin delineations. The proposed development will continue to follow historic drainage patterns at the site.

E. Cost Estimate

All proposed drainage facilities within roads or utility easements will be publicly-owned and maintained. The estimated, non-reimbursable construction cost for the Briargate Crossing West drainage facilities is as follows:

Opinion of Probable Construction Cost--Briargate Crossing Drainage System

Item (Unit)	Unit Cost	Quantity	Total Cost
18" RCP (feet)	$ 36.00	290	$ 10,440.00
24" RCP (feet)	$ 48.00	25	$ 1,200.00
30" RCP (feet)	$ 60.00	1060	$ 63,600.00
36" RCP (feet)	$ 76.00	65	$ 4,940.00
42" RCP (feet)	$ 95.00	800	$ 76,000.00
66" RCP (feet)	$ 200.00	10	$ 2,000.00
Storm Manhole (each)	$ 3,750.00	6	$ 22,500.00
5' Inlet (each)	$ 3,725.00	6	$ 22,350.00
10' Inlet (each)	$ 4,600.00	5	$ 23,000.00
		Total	***$ 226,030.00***

Since the engineer has no control over the cost of labor, materials, equipment or services furnished by others, or over the contactor's method of determining prices, or over the competitive bidding or market conditions, the opinion of probable construction costs provided herein are made on the basis of the engineer's experience and qualifications and represents the best judgment as an experienced and qualified professional familiar with the construction industry. The engineer cannot, and does not guarantee that proposals, bids or actual construction costs will not vary from the opinion of probable costs.

F. Drainage and Bridge Fees

The Pine Creek Drainage Basin is designated as a "No-Fee" basin. Therefore, no drainage or bridge fees are required for this project.

V. CONCLUSIONS

A. Compliance with Standards

The proposed Briargate Crossing West development complies with the criteria set forth in the *City of Colorado Springs & El Paso County Drainage Criteria Manual*, dated November 1991, the *Pine Creek Drainage Basin Planning Study*, *Amendment No. 2 to Pine Creek Drainage Basin Planning Study and Master Development Drainage Plan for Pine Creek Subdivision (Portion Contributing to Pine Creek)*, and the *Amendment No. 3 to Pine Creek Drainage Basin Planning Study*.

B. Drainage Concept

1. The developed drainage system for Briargate Crossing West will continue to follow historic drainage patterns.

2. This Master Development Drainage Plan (MDDP) is in compliance with the Basin Planning Study and the City of Colorado Springs' Criteria Manual.
3. Regional detention ponds will provide detention for the site. Temporary sedimentation basins will be used during construction.

VI. REFERENCES

1. ***City of Colorado Springs & El Paso County Drainage Criteria Manual***, dated November 1991.

2. ***FEMA Flood Insurance Rate Map***, El Paso County Colorado and Incorporated Areas, Panels 507 and 509 of 1300. March 17, 1997.

3. ***Pine Creek Drainage Basin Planning Study***, Obering, Wurth & Associates Consulting Civil Engineers, revised October 1988.

4. ***Amendment No. 2 to Pine Creek Drainage Basin Planning Study and Master Development Drainage Plan for Pine Creek Subdivision (Portion Contributing to Pine Creek)***, JR Engineering, October 1998.

5. ***Amendment No. 3 to Pine Creek Drainage Basin Planning Study***, JR Engineering, March 2003.

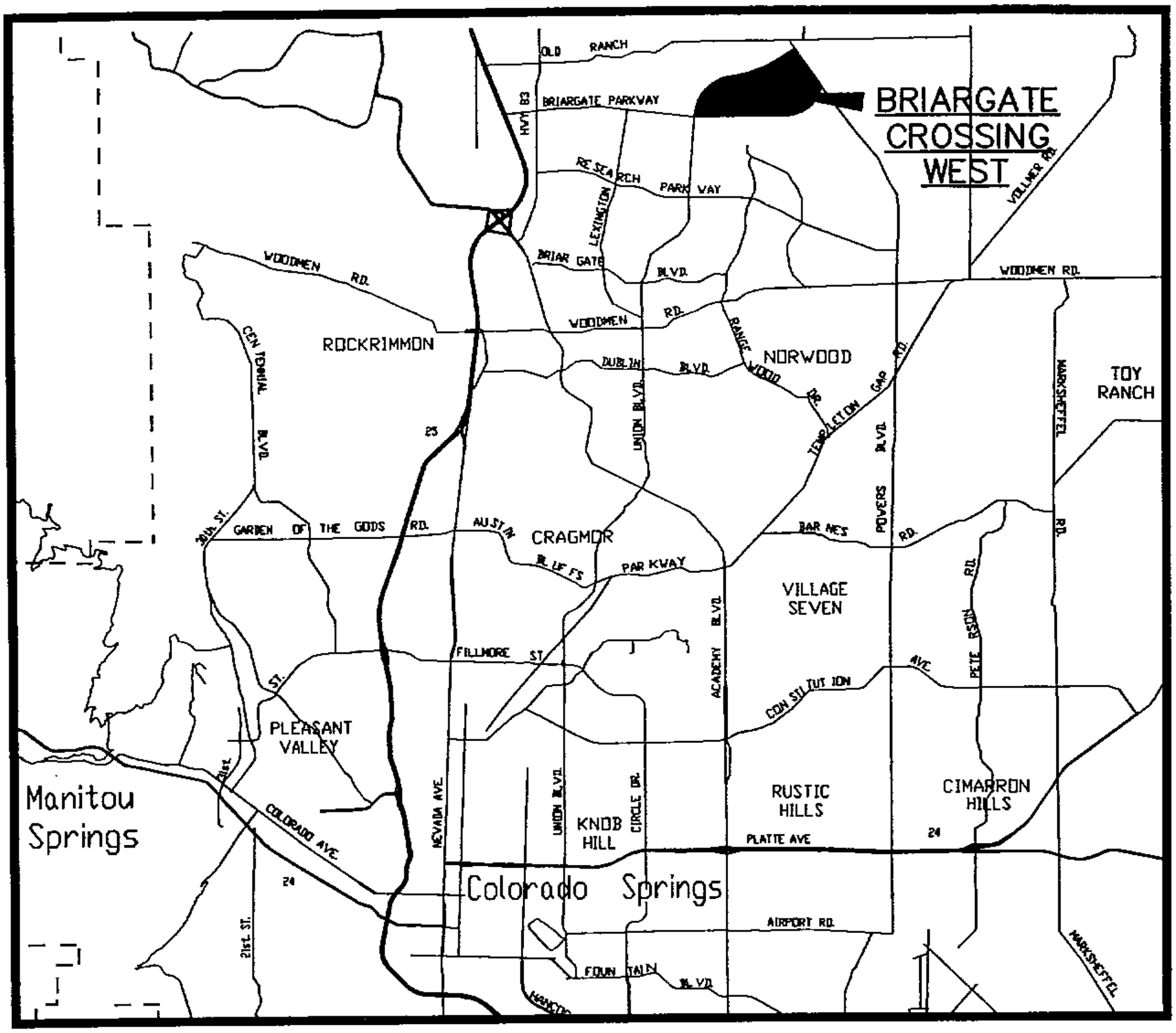
6. ***Master Development Drainage Plan for Union Boulevard/Briargate Parkway and Preliminary/Final Drainage Report for Portions of Union Boulevard, Briargate Parkway, Family Place and Austin Bluffs Parkway***, JR Engineering, January 2002.

7. ***Soil Survey of El Paso County Area, Colorado***. United States Department of Agriculture Soil Conservation Service. Issued June 1981.

VII. APPENDICIES

APPENDIX A:

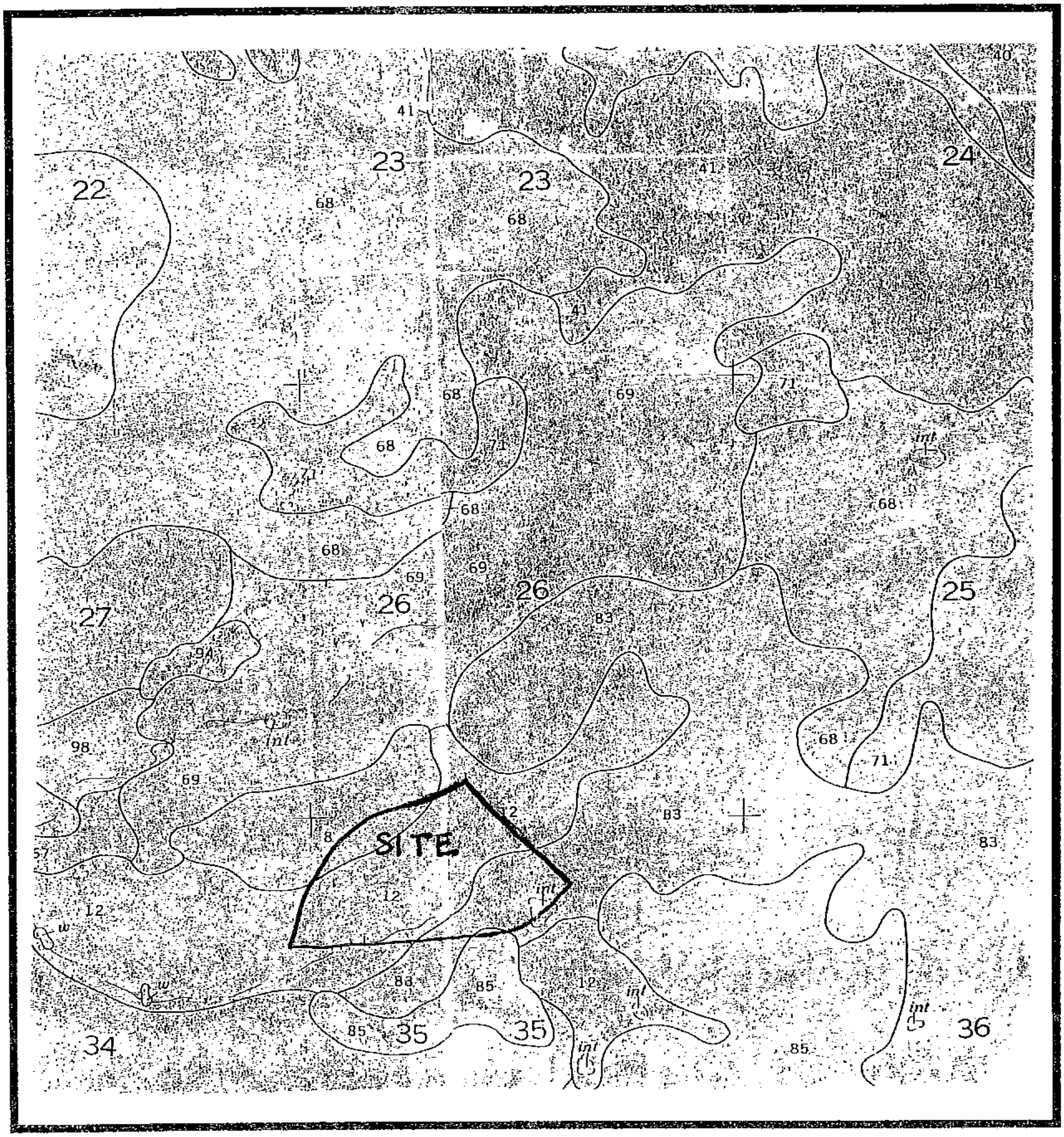
MAPS



VICINITY MAP

NORTH
N.T.S.

Matrix Design Group, Inc.
Integrated Design Solutions
2925 Professional Place, Suite 202
Colorado Springs, CO 80904
Phone 719-575-0100
Fax 719-575-0208



SOILS MAP

Matrix Design Group, Inc.
Integrated Design Solutions
2925 Professional Place, Suite 202
Colorado Springs, CO 80904
Phone 719-575-0100
Fax 719-575-0208

APPENDIX B:

HYDROLOGIC AND HYDRAULIC CALCULATIONS

Matrix Design Group, Inc.
Integrated Design Solutions

100-Year Storm Runoff (Existing)

Basin	Area	Q(5)	Q(100)
	(Acres)	(cfs)	(cfs)
EX-A	66.3	**49.7**	**120.7**
EX-B	36.44	**26.4**	**63.8**
EX-C	14.52	**9.1**	**21.9**

Matrix Design Group, Inc.
Integrated Design Solutions

Composite "C" Values (Interim)

Basin	Design Point	Area	Area	100 Composite
		(SF)	(Acres)	"C"
A	1	1,453,792	33.37	0.25
A-1	1	395,347	9.08	0.25
C	3	570,337	13.09	0.25
D	4	35,486	0.81	0.90
E	5	31,060	0.71	0.90
F	6	620,582	14.25	0.25
G	7	75,261	1.73	0.25
H	8	37,413	0.86	0.90
I	9	76,605	1.76	0.90
J	10	78,707	1.81	0.90
M	13	66,563	1.53	0.90
N	14	45,250	1.04	0.90
O	15	538,409	12.36	0.25
O-1	15	335,323	7.70	0.25
P	16	40,163	0.92	0.90
Q	17	196,455	4.51	0.25
R	18	486,679	11.17	0.25
S	19	27,666	0.64	0.90
T	20	30,379	0.70	0.90

A, A-1	21	1,849,139	42.45	0.25
O, O-1	22	873,732	20.06	0.25

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By: Angela Howard
Project: Briargate Crossing West
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Matrix Design Group, Inc.
Integrated Design Solutions

Time of Concentration (Interim)

Sub-Basin Data			Initial/Overland Time (Ti)			Pavement Travel Time (Tt)				Pipe Travel Time (Tt)				Grass Swale Travel Time (Tt)					Tc Check (Urbanized Basins)		Tc=Ti+Tt	Final Tc	Remarks
Basin	Design Point	Area (ac)	Length (ft)	Slope (%)	*Ti (min)	Length (ft)	Slope (%)	Vel. (fps)	Tt (min)	Length (ft)	Slope (%)	Vel. (fps)	Tt (min)	Length (ft)	Slope (%)	Vel. (fps)	Tt (min)	Total Tt (min)	Total Length (ft)	Tc=(L/180)+10 (min)	(min)	(min)	
A	1	33 37	50	2.00	8.94	1500	2.40	9.13	2.74									2.74	1550	18.61	11 68	**11.68**	
A-1	1	9 08	50	2.00	8.94	1030	2.40	9.13	1 88									1 88	1080	16 00	10.82	**10.82**	
C	3	13 09	50	2.00	8.94	950	2.40	9.13	1.73									1.73	1000	15.56	10.68	**10.68**	
D	4	0 81	50	2.00	8 94	750	2.40	9 13	1.37									1.37	800	14 44	10 31	**10.31**	
E	5	0 71	50	2.00	8.94	750	2.40	9.13	1.37									1 37	800	14 44	10 31	**10.31**	
F	6	14 25	50	2.00	8.94	1200	2.40	9.13	2.19									2.19	1250	16.94	11 13	**11.13**	
G	7	1 73	50	2.00	8.94	550	2.40	9 13	1 00									1.00	600	13.33	9.95	**9.95**	
H	8	0 86	50	2.00	8.94	550	2.40	9 13	1.00									1.00	600	13.33	9 95	**9.95**	
I	9	1 76	50	2.00	8 94	640	2.40	9.13	1 53									1 53	890	14.94	10 47	**10.47**	
J	10	1 81	50	2.00	8 94	680	2.40	9.13	1.61									1 61	930	15 17	10 55	**10.55**	
M	13	1 53	50	2 00	8.94	700	2.40	9.13	1.28									1.28	750	14.17	10 22	**10.22**	
N	14	1 04	50	2.00	8.94	580	2.40	9.13	1.06									1.06	630	13.50	10 00	**10.00**	
O	15	12 36	50	2.00	8.94	890	2.40	9.13	1.62									1.62	940	15.22	10 57	**10.57**	
O-1	15	7 70	50	2.00	8.94	1000	2.40	9.13	1.83									1.83	1050	15.83	10.77	**10.77**	
P	16	0 92	50	2.00	8.94	550	2.40	9.13	1 00									1 00	600	13.33	9.95	**9.95**	
Q	17	4 51	50	2.00	8.94	600	2.40	9.13	1.10									1.10	650	13.61	10.04	**10.04**	
R	18	11 17	50	2.00	8.94	950	2.40	9.13	1.73									1.73	1000	15.56	10.68	**10.68**	
S	19	0 64	50	2.00	8.94	670	2.40	9.13	1.22									1.22	720	14.00	10.16	**10.16**	
T	20	0 70	50	2.00	8.94	670	2.40	9.13	1.22									1.22	720	14 00	10.16	**10.16**	
CUMULATIVE AREAS FLOWS																							
A, A-1	21	42 45		2.00	11 68		2.40	9.13	0.00		2.70	9.68	0.00	1488	3.00	1.03	24.02	24.02	1488	18.27	35.70	**18.27**	
O, O-1	22	20 06		2.00	10 77		2.40	9.13	0.00		2.70	9.68	0.00	1357	2.90	1.01	22 28	22.28	1357	17.54	33 05	**17.54**	
0	0	0 00		2.00	0.00		2.40	9.13	0.00		2.70	8.68	0.00					0.00	0	10.00	0 00	**5.00**	
0	0	0 00		2.00	0.00		2.40	9.13	0.00		2.70	9.68	0.00					0.00	0	10 00	0 00	**5.00**	
0	0	0 00		2.00	0 00		2.40	9.13	0.00		2.70	9.68	0.00					0 00	0	10 00	0 00	**5.00**	

C5 = 0 25
Ti=(1 87(1 1-C10)*(L)^ 5)/(s)^ 33
n (street) 0 016
n (RCP) 0,013
R (street & pipe) 0 5
Tc min of 5 min

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Project: Briargate Crossing West
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Matrix Design Group, Inc.
Integrated Design Solutions

100-Year Storm Runoff (Interim)

Basin	Design Point	Area	Tc	100 Intensity	100 Comp. C	100 Q
		(Acres)	(Min.)	(In./hr.)		**(cfs)**
A	1	33.37	11.68	6.62	0.25	**55.2**
A-1	1	9.08	10.82	6.84	0.25	**15.5**
C	3	13.09	10.68	6.88	0.25	**22.5**
F	6	14.25	11.13	6.76	0.25	**24.1**
G	7	1.73	9.95	7.09	0.25	**3.1**
O	15	12.36	10.57	6.91	0.25	**21.4**
O-1	15	7.70	10.77	6.86	0.25	**13.2**
Q	17	4.51	10.04	7.06	0.25	**8.0**
R	18	11.17	10.68	6.88	0.25	**19.2**

Routed Flows

A, A-1	21	42.45	18.27	5.34	0.25	**56.6**
O, O-1	22	20.06	17.54	5.45	0.25	**27.3**

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By: Angela Howard
Project: Briargate Crossing West
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Integrated Design Solutions

Temporary Sediment Basin Volume
Basins A and A-1

Contour	Area	Volume	Acc. Vol.	Acc. Vol.
Ft.	Ft.^2	Ft.^3	Ft.^3	Ac-Ft.
6896		-	-	-
6898	14,800		-	-
6900	19,093	33,802	33,802	0.78
6902	23,687	42,698	76,500	1.76

Temporary Sediment Basin Volume
Basins O and O-1

Contour	Area	Volume	Acc. Vol.	Acc. Vol.
Ft.	Ft.^2	Ft.^3	Ft.^3	Ac-Ft.
6938	7,235	-	-	-
6940	10,119	17,274	17,274	0.40
6942	13,213	23,263	40,537	0.93

Temporary Sediment Basin Volume
Basin C

Contour	Area	Volume	Acc. Vol.	Acc. Vol.
Ft.	Ft.^2	Ft.^3	Ft.^3	Ac-Ft.
6956	4,037	-	-	-
6958	6,064	10,033	10,033	0.23
6960	9,146	15,105	25,137	0.58

Temporary Sediment Basin Volume
Basin F

Contour	Area	Volume	Acc. Vol.	Acc. Vol.
Ft.	Ft.^2	Ft.^3	Ft.^3	Ac-Ft.
6966	4,052	-	-	-
6968	6,968	10,889	10,889	0.25
6970	8,940	15,867	26,756	0.61

Temporary Sediment Basin Volume
Basin R

Contour	Area	Volume	Acc. Vol.	Acc. Vol.
Ft.	Ft.^2	Ft.^3	Ft.^3	Ac-Ft.
6470	3,524	-	-	-
6472	5,133	8,607	8,607	0.20
6474	7,069	12,150	20,757	0.48

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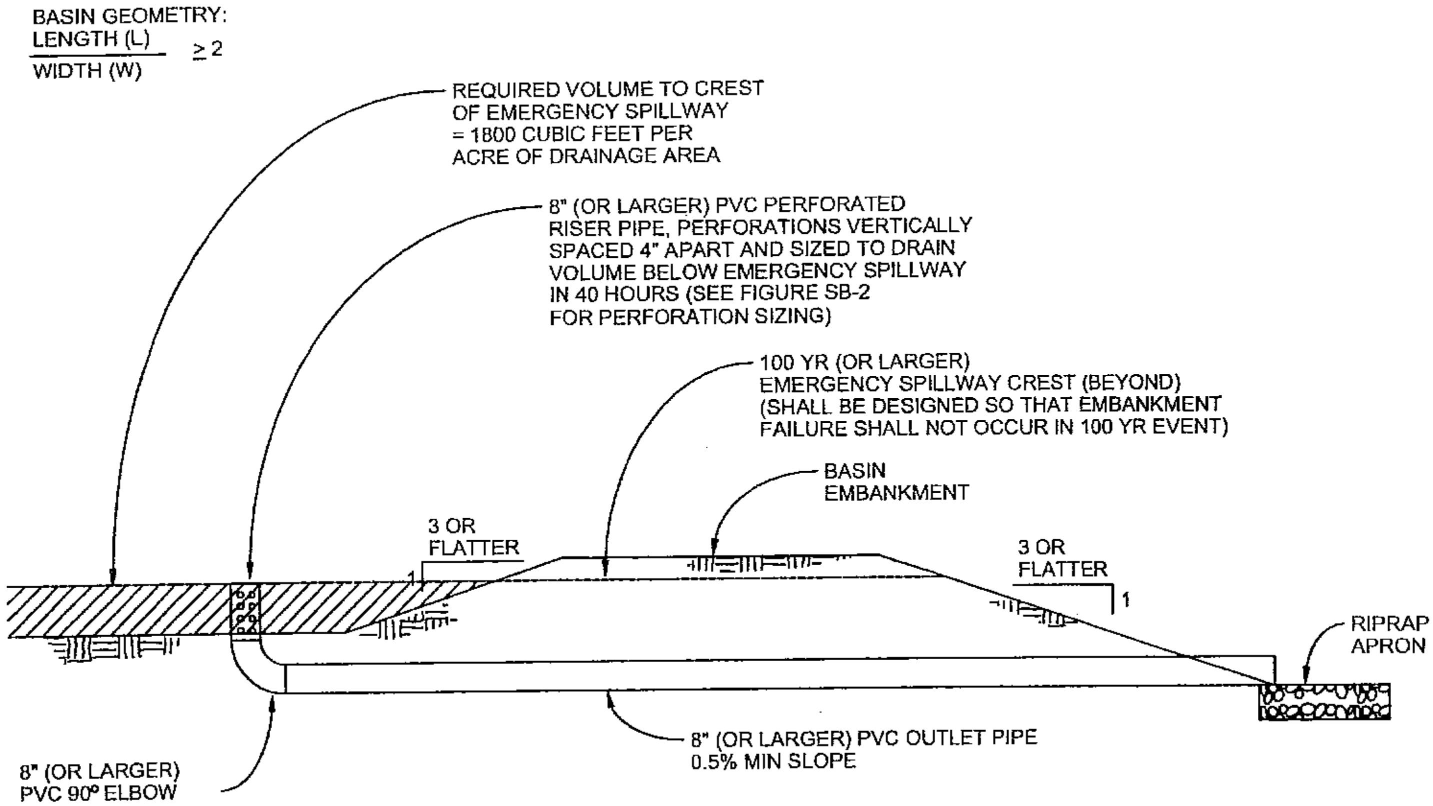
By: Angela Howard
Date: 7/08/03
Project: Briargate Crossing West



SEDIMENT BASIN

NTS

SEDMENT BASIN NOTES

INSTALLATION REQUIREMENTS

1. SEDIMENT BASINS SHALL BE INSTALLED BEFORE ANY CLEARING AND/OR GRADING IS UNDERTAKEN.

2. THE AREA UNDER WHICH THE EMBANKMENT IS TO BE INSTALLED SHALL BE CLEARED, GRUBBED, AND STRIPPED OF ALL VEGETATION AND ROOT MAT.

3. THE OUTLET OF THE BASIN SHALL BE DESIGNED TO DRAIN ITS VOLUME IN 40 HOURS.

4. THE OUTLET IS TO BE LOCATED AT THE FURTHEST DISTANCE FROM THE INLET OF THE BASIN. BAFFLES MAY BE NEEDED TO INCREASE THE FLOW LENGTH AND SETTLING TIME.

5. EMBANKMENT MATERIAL SHALL CONSIST OF SOIL WITH A MINIMUM OF 15% PASSING A #200 SIEVE. EXCAVATED SOIL CAN BE USED IF IT MEETS THIS REQUIREMENT.

6. EMBANKMENT IS TO BE COMPACTED TO AT LEAST 90% OF MAXIMUM DENSITY AND WITHIN 2% OF OPTIMUM MOISTURE CONTENT ACCORDING TO ASTM D 698.

7. WHEN A BASIN IS INSTALLED NEAR A RESIDENTIAL AREA, FOR SAFETY REASONS, A SIGN SHALL BE POSTED AND THE AREA SECURED WITH A FENCE.

MAINTENANCE REQUIREMENTS

1. CONTRACTOR SHALL INSPECT SEDIMENT BASINS AFTER EACH RAINFALL, AT LEAST DAILY DURING PROLONGED RAINFALL, AND WEEKLY DURING PERIODS NO RAINFALL.

2. SEDIMENT BASINS SHALL BE CLEANED OUT BEFORE SEDIMENT HAS FILLED HALF THE VOLUME OF THE BASIN.

3. SEDIMENT BASINS SHALL REMAIN OPERATIONAL AND PROPERLY MAINTAINED UNTIL THE SITE AREA IS PERMANENTLY STABILIZED WITH ADEQUATE VEGETATIVE COVER AND/OR OTHER PERMANENT STRUCTURE AS APPROVED BY THE CITY.

City of Colorado Springs Stormwater Quality	Figure SB-1 Sediment Basin Construction Detail and Maintenance Requirements

Required Area per Row (in^2)

		Depth at Outlet (ft)							
		1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5
Design Volume (acre-ft)	2	15.04	7.71	5.10	3.76	2.95	2.41	2.02	1.73
	1	7.52	3.86	2.55	1.88	1.48	1.21	1.01	0.87
	0.6	4.51	2.31	1.53	1.13	0.89	0.72	0.61	0.52
	0.4	3.01	1.54	1.02	0.75	0.59	0.48	0.40	0.35
	0.2	1.50	0.77	0.51	0.38	0.30	0.24	0.20	0.17
	0.1	0.75	0.39	0.26	0.19	0.15	0.12	0.10	0.09
	0.06	0.45	0.23	0.15	0.11	0.09	0.07	0.06	0.05
	0.04	0.30	0.15	0.10	0.08	0.06	0.05	0.04	0.03
	0.02	0.15	0.08	0.05	0.04	0.03	0.02	0.02	0.02
	0.01	0.08	0.04	0.03	0.02	0.01	0.01	0.01	0.01

TABLE SB-1

Circular Perforation Sizing

Hole Diameter (in)	Hole Diameter (in)	Area per Row (in^2)		
		n = 1	n = 2	n = 3
1/4	0.250	0.05	0.10	0.15
5/16	0.313	0.08	0.15	0.23
3/8	0.375	0.11	0.22	0.33
7/16	0.438	0.15	0.30	0.45
1/2	0.500	0.20	0.39	0.59
9/16	0.563	0.25	0.50	0.75
5/8	0.625	0.31	0.61	0.92
11/16	0.688	0.37	0.74	1.11
3/4	0.750	0.44	0.88	1.33
7/8	0.875	0.60	1.20	1.80
1	1.000	0.79	1.57	2.36
1 1/8	1.125	0.99	1.99	2.98
1 1/4	1.250	1.23	2.45	3.68
1 3/8	1.375	1.48	2.97	4.45
1 1/2	1.500	1.77	3.53	5.30
1 5/8	1.625	2.07	4.15	6.22
1 3/4	1.750	2.41	4.81	7.22
1 7/8	1.875	2.76	5.52	8.28
2	2.000	3.14	6.28	9.42
n = Number of columns of perforations				
Minimum steel plate thickness		1/4"	5/16"	3/8"

TABLE SB-2

Matrix Design Group, Inc.
Integrated Design Solutions

Swale Section	Q(100)	Slope	Channel Depth	Channel Capacity	Flow Depth	Freeboard
	cfs	%	ft	cfs	ft	ft
A	15.5	1.63	2.00	73.5	1.12	0.88
B	55.2	1.92	3.33	311.1	1.74	1.59
C	22.5	0.79	2.00	51.1	1.47	0.53
D	13.2	2.88	2.00	97.6	0.95	1.05
E	21.4	1.92	2.00	79.8	1.22	0.78
F	24.1	1.08	2.00	59.8	1.42	0.58
G	19.2	2.96	2.00	99.0	1.08	0.92

Assumptions: n= 0.030

S:\03.104.013\Drainage Reports\Final\[Pond Vols.xls]Swale Calcs
By: Angela Howard
Date: 8/12/2003
Project: Briargate Crossing West

Matrix Design Group, Inc.
Integrated Design Solutions

Composite "C" Values (Proposed)

Basin	Design Point	Area	Area	5 Comp.	100 Composite
		(SF)	(Acres)	"C"	"C"
A	1	790,942	18.16	0.90	0.90
B	2	584,746	13.42	0.90	0.90
C	3	570,337	13.09	0.90	0.90
D	4	35,486	0.81	0.90	0.90
E	5	31,060	0.71	0.90	0.90
F	6	620,582	14.25	0.90	0.90
G	7	75,261	1.73	0.90	0.90
H	8	37,413	0.86	0.90	0.90
I	9	76,605	1.76	0.90	0.90
J	10	78,707	1.81	0.90	0.90
K	11	330,382	7.58	0.90	0.90
L	12	143,069	3.28	0.90	0.90
M	13	66,563	1.53	0.90	0.90
N	14	45,250	1.04	0.90	0.90
O	15	873,732	20.06	0.90	0.90
P	16	40,163	0.92	0.90	0.90
Q	17	196,455	4.51	0.90	0.90
R	18	486,679	11.17	0.90	0.90
S	19	27,666	0.64	0.90	0.90
T	20	30,379	0.70	0.90	0.90

P, Q	21	236,618	5.43	0.90	0.90
G, H, P, Q	22	349,292	8.02	0.90	0.90
G, H, I, J, P, Q	23	504,604	11.58	0.90	0.90
C, G, H, I, J, P, Q	24	1,074,941	24.68	0.90	0.90
C, G, H, I, J, M, P, Q	25	1,141,504	26.21	0.90	0.90

5 Impervious "C"	0.90
5 Pervious "C"	0.90
100 Impervious "C"	0.90
100 Pervious "C"	0.90

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By: Jonathan Moore
Project: Briargate Crossing West
Printed: 4/11/2003 10:14

Matrix Design Group, Inc.
Integrated Design Solutions

Time of Concentration (Proposed)

Sub-Basin Data			Initial/Overland Time (Ti)			Pavement Travel Time (Tt)				Pipe Travel Time (Tt)					Tc Check (Urbanized Basins)		Tc=Ti+Tt	Final Tc	Remarks
Basin	Design Point	Area (ac)	Length (ft)	Slope (%)	*Ti (min)	Length (ft)	Slope (%)	Vel. (fps)	Tt (min)	Length (ft)	Slope (%)	Vel. (fps)	Tt (min)	Total Tt (min)	Total Length (ft)	Tc=(L/180)+10 (min)	(min)	(min)	
A	1	18.16	50	2.00	8.94	1175	2.40	9.13	2.14					2.14	1225	16.81	11.09	**11.09**	
B	2	13.42	50	2.00	8.94	820	2.40	9.13	1.50					1.50	870	14.83	10.44	**10.44**	
C	3	13.09	50	2.00	8.94	950	2.40	9.13	1.73					1.73	1000	15.56	10.68	**10.68**	
D	4	0.81	50	2.00	8.94	750	2.40	9.13	1.37					1.37	800	14.44	10.31	**10.31**	
E	5	0.71	50	2.00	8.94	750	2.40	9.13	1.37					1.37	800	14.44	10.31	**10.31**	
F	6	14.25	50	2.00	8.94	1200	2.40	9.13	2.19					2.19	1250	16.94	11.13	**11.13**	
G	7	1.73	50	2.00	8.94	550	2.40	9.13	1.00					1.00	600	13.33	9.95	**9.95**	
H	8	0.86	50	2.00	8.94	550	2.40	9.13	1.00					1.00	600	13.33	9.95	**9.95**	
I	9	1.76	50	2.00	8.94	840	2.40	9.13	1.53					1.53	890	14.94	10.47	**10.47**	
J	10	1.81	50	2.00	8.94	880	2.40	9.13	1.61					1.61	930	15.17	10.55	**10.55**	
K	11	7.58	50	2.00	8.94	900	2.40	9.13	1.64					1.64	950	15.28	10.58	**10.58**	
L	12	3.28	50	2.00	8.94	680	2.40	9.13	1.24					1.24	730	14.06	10.18	**10.18**	
M	13	1.53	50	2.00	8.94	700	2.40	9.13	1.28					1.28	750	14.17	10.22	**10.22**	
N	14	1.04	50	2.00	8.94	580	2.40	9.13	1.06					1.06	630	13.50	10.00	**10.00**	
O	15	20.06	50	2.00	8.94	1155	2.40	9.13	2.11					2.11	1205	16.69	11.05	**11.05**	
P	16	0.92	50	2.00	8.94	550	2.40	9.13	1.00					1.00	600	13.33	9.95	**9.95**	
Q	17	4.51	50	2.00	8.94	600	2.40	9.13	1.10					1.10	650	13.61	10.04	**10.04**	
R	18	11.17	50	2.00	8.94	950	2.40	9.13	1.73					1.73	1000	15.56	10.68	**10.68**	
S	19	0.64	50	2.00	8.94	670	2.40	9.13	1.22					1.22	720	14.00	10.16	**10.16**	
T	20	0.70	50	2.00	8.94	670	2.40	9.13	1.22					1.22	720	14.00	10.16	**10.16**	

CUMULATIVE AREAS FLOWS

P, Q	21	5.43	50	2.00	8.94	600	2.40	9.13	1.10	40	2.70	9.68	0.07	1.16	690	13.83	10.11	**10.11**	
G, H, P, Q	22	8.02	50	2.00	8.94	600	2.40	9.13	1.10	160	2.70	9.68	0.26	1.37	810	14.50	10.31	**10.31**	
G, H, I, J, P, Q	23	11.58	50	2.00	8.94	600	2.40	9.13	1.10	931	2.70	9.68	1.60	2.70	1581	18.78	11.64	**11.64**	
C, G, H, I, J, P, Q	24	24.68	50	2.00	8.94	600	2.40	9.13	1.10	1076	2.70	9.68	1.85	2.95	1726	19.59	11.89	**11.89**	
C, G, H, I, J, M, P, Q	25	26.21	50	2.00	8.94	600	2.40	9.13	1.10	1679	2.70	9.68	2.89	3.98	2329	22.94	12.93	**12.93**	

C5 = 0.25
Ti=(1 87(1 1-C10)*(L)^ 5)/(s)^.33
n (street) 0.016
n (RCP) 0.013
R (street & pipe) 0.5
Tc min of 5 min.

S:\03 104 013\Drainage Reports\Final\[Inlet xls]Curb-S
By Jonathan Moore
Project Briargate Crossing West
Printed 4/11/2003 10 14

Matrix Design Group, Inc.
Integrated Design Solutions

5-Year & 100-Year Storm Runoff (Proposed)

Basin	Design Point	Area	Tc	5 Intensity	100 Intensity	5 Comp. C	100 Comp. C	5 Q	100 Q
		(Acres)	(Min.)	(In./hr.)	(In./hr.)			(cfs)	(cfs)
A	1	18.16	11.09	3.90	7.10	0.90	0.90	**63.7**	**116.0**
B	2	13.42	10.44	4.10	7.20	0.90	0.90	**49.5**	**87.0**
C	3	13.09	10.68	4.10	7.20	0.90	0.90	**48.3**	**84.8**
D	4	0.81	10.31	4.10	7.20	0.90	0.90	**3.0**	**5.3**
E	5	0.71	10.31	4.10	7.20	0.90	0.90	**2.6**	**4.6**
F	6	14.25	11.13	3.90	7.10	0.90	0.90	**50.0**	**91.0**
G	7	1.73	9.95	4.20	7.30	0.90	0.90	**6.5**	**11.4**
H	8	0.86	9.95	4.20	7.30	0.90	0.90	**3.2**	**5.6**
I	9	1.76	10.47	4.10	7.20	0.90	0.90	**6.5**	**11.4**
J	10	1.81	10.55	4.10	7.20	0.90	0.90	**6.7**	**11.7**
K	11	7.58	10.58	4.10	7.20	0.90	0.90	**28.0**	**49.1**
L	12	3.28	10.18	4.15	7.20	0.90	0.90	**12.3**	**21.3**
M	13	1.53	10.22	4.10	7.20	0.90	0.90	**5.6**	**9.9**
N	14	1.04	10.00	4.20	7.30	0.90	0.90	**3.9**	**6.8**
O	15	20.06	11.05	3.90	7.10	0.90	0.90	**70.4**	**128.2**
P	16	0.92	9.95	4.20	7.30	0.90	0.90	**3.5**	**6.1**
Q	17	4.51	10.04	4.20	7.30	0.90	0.90	**17.0**	**29.6**
R	18	11.17	10.68	4.10	7.20	0.90	0.90	**41.2**	**72.4**
S	19	0.64	10.16	4.15	7.30	0.90	0.90	**2.4**	**4.2**
T	20	0.70	10.16	4.15	7.30	0.90	0.90	**2.6**	**4.6**

Routed Flows

P, Q	21	5.43	10.11	4.20	7.30	0.90	0.90	**20.5**	**35.7**
G, H, P, Q	22	8.02	10.31	4.10	7.20	0.90	0.90	**29.6**	**52.0**
G, H, I, J, P, Q	23	11.58	11.64	3.90	6.90	0.90	0.90	**40.7**	**71.9**
C, G, H, I, J, P, Q	24	24.68	11.89	3.80	6.80	0.90	0.90	**84.4**	**151.0**
C, G, H, I, J, M, P, Q	25	26.21	12.93	3.70	6.70	0.90	0.90	**87.3**	**158.0**

S:\03.104.013\Drainage Reports\Final\[Inlet.xls]Curb-S
By: Jonathan Moore
Project: Briargate Crossing West
Printed: 4/11/2003 10:14

Matrix Design Group, Inc.
Integrated Design Solutions

Preliminary Street Capacity Analysis Summary

Briargate West Crossing

Design Point	Road Section	From Capacity Analysis						
		Slope	Initial Storm Reduction Factor	Minor Storm Capacity* (cfs)	Max. Design Q5 (cfs)	Major Storm Reduction Factor	Major Storm Capacity** (cfs)	Max. Design Q100 (cfs)
Auston Bluffs Parkway	Local	3.00%	0.80	11.3	5.6	0.70	80.8	16.7
Promenade Drive	Local	3.05%	0.80	11.4	6.7	0.70	81.5	23.1
Royal Pine Drive (to BP)	Local	1.47%	0.80	7.9	2.6	0.70	56.6	8.8
Royal Pine Drive (SHP to Rndabt)	Local	1.98%	0.80	9.1	6.7	0.70	65.7	17.8
Royal Pine Drive (NHP to Rndabt)	Local	2.50%	0.80	10.3	6.5	0.70	73.8	17.0
Royal Pine Drive (to Union)	Local	1.42%	0.80	7.7	3.0	0.70	55.6	9.9
Promenade Drive East	Local	2.50%	0.80	10.3	3.5	0.70	73.8	11.7

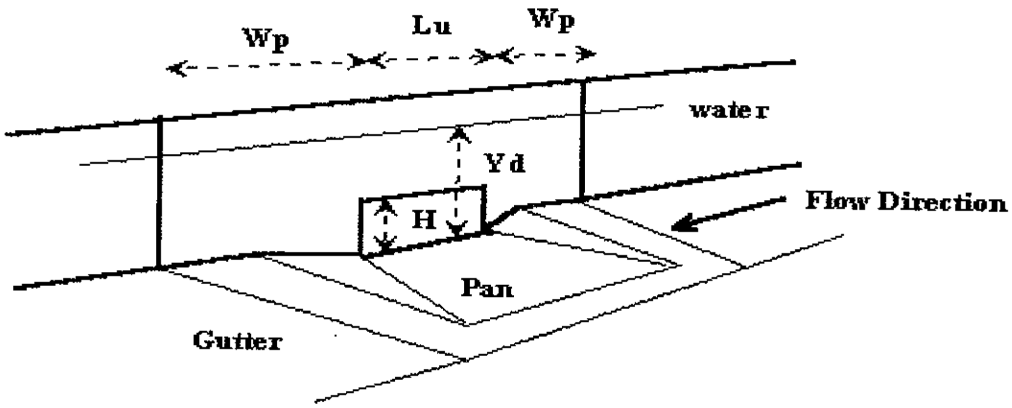
* Minor Capacity with reduction factor is for one side of the road.
** Major Capacity with reduction factor is for the entire width of the road

S:\03.104.013\Drainage Reports\Final\[RATIONAL.xls]Street Capacity
By: Jonathan Moore
Project: Briargate Crossing West

Printed: 4/9/2003 19:10

CURB OPENING INLET IN A SUMP

Project = Briargate Crossing West
Inlet ID = 10' Inlet at the southwest corner of Union Blvd and Royal Pine Dr (DP 4)



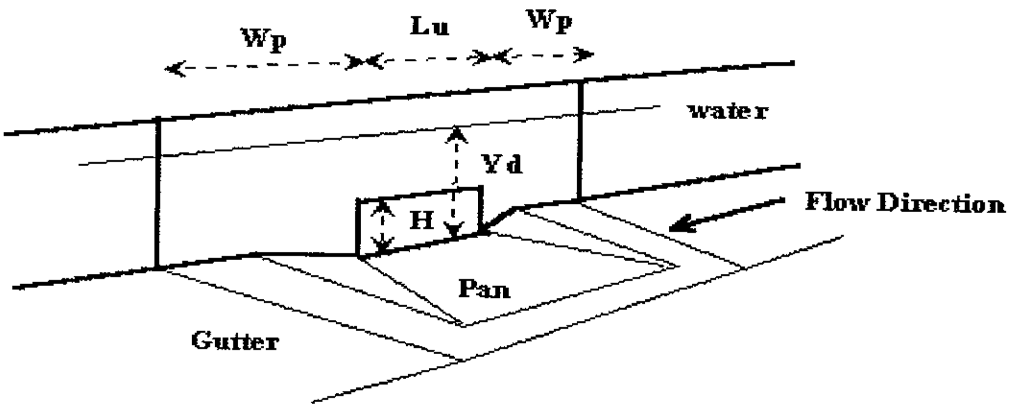
Design Information (Input)	
Design Discharge on the Street (from *Street Hy*)	**Qo = 5.3 cfs**
Length of a Unit Inlet	Lu = 10.00 ft
Side Width for Depression Pan	Wp = 3.00 ft
Clogging Factor for a Single Unit	Co = 0.20
Height of Curb Opening in Inches	H = 6.00 inches
Orifice Coefficient	Cd = 0.65
Weir Coefficient	Cw = 3.40
Water Depth for the Design Condition	Yd = 0.67 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 = 28.7 cfs
Clogging Coefficient for Multiple Units	Clog-Coeff = 1.00
Clogging Factor for Multiple Units	Clog = 0.20
Capacity as a Weir with Clogging	Qwa = 25.0 cfs
As an Orifice	
Capacity as an Orifice without Clogging	Qoi = 17.4 cfs
Capacity as an Orifice with Clogging	Qoa = 14.0 cfs
Capacity for Design with Clogging	**Qa = 14.0 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.

CURB OPENING INLET IN A SUMP

Project = Briargate Crossing West
Inlet ID = 5' Inlet at the southeast corner of Union Blvd and Royal Pine Dr (DP 5)



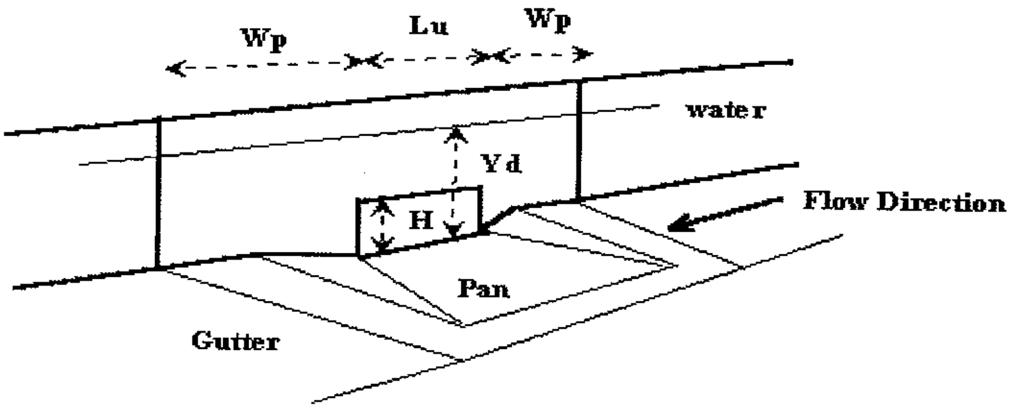
Design Information (Input)			
Design Discharge on the Street (from *Street Hy*)	Qo =	4.6	cfs
Length of a Unit Inlet	Lu =	5.00	ft
Side Width for Depression Pan	Wp =	3.00	ft
Clogging Factor for a Single Unit	Co =	0.20	
Height of Curb Opening in Inches	H =	6.00	inches
Orifice Coefficient	Cd =	0.65	
Weir Coefficient	Cw =	3.40	
Water Depth for the Design Condition	Yd =	0.67	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 =	19.4	cfs
Clogging Coefficient for Multiple Units	Clog-Coeff =	1.00	
Clogging Factor for Multiple Units	Clog =	0.20	
Capacity as a Weir with Clogging	Qwa =	17.5	cfs
As an Orifice			
Capacity as an Orifice without Clogging	Qoi =	8.7	cfs
Capacity as an Orifice with Clogging	Qoa =	7.0	cfs
Capacity for Design with Clogging	Qa =	7.0	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.

CURB OPENING INLET IN A SUMP

Project = Briargate Crossing West
Inlet ID = 5' Inlet at Promenade Dr and Royal Pine Dr (DP 8)



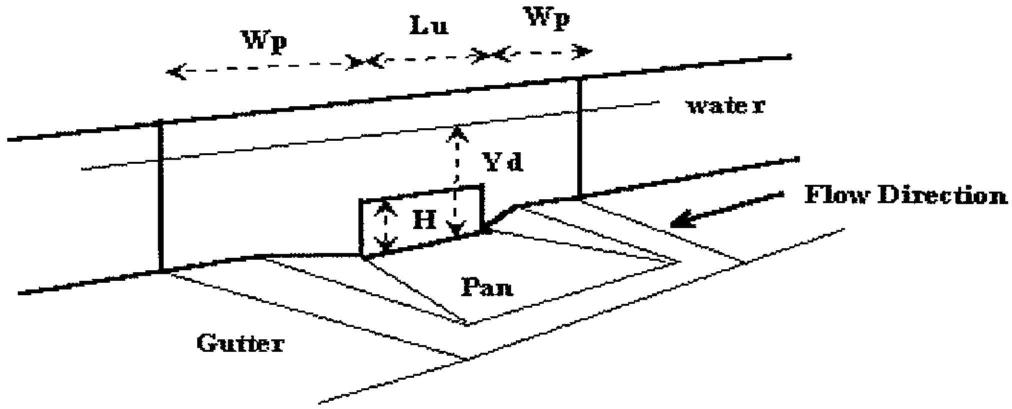
Design Information (Input)		
Design Discharge on the Street (from *Street Hy*)	**Qo =**	**5.6 cfs**
Length of a Unit Inlet	Lu =	5.00 ft
Side Width for Depression Pan	Wp =	3.00 ft
Clogging Factor for a Single Unit	Co =	0.20
Height of Curb Opening in Inches	H =	6.00 inches
Orifice Coefficient	Cd =	0.65
Weir Coefficient	Cw =	3.40
Water Depth for the Design Condition	Yd =	0.67 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 =	19.4 cfs
Clogging Coefficient for Multiple Units	Clog-Coeff =	1.00
Clogging Factor for Multiple Units	Clog =	0.20
Capacity as a Weir with Clogging	Qwa =	17.5 cfs
As an Orifice		
Capacity as an Orifice without Clogging	Qoi =	8.7 cfs
Capacity as an Orifice with Clogging	Qoa =	7.0 cfs
Capacity for Design with Clogging	**Qa =**	**7.0 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.

CURB OPENING INLET IN A SUMP

Project = Briargate Crossing West
Inlet ID = 5' Inlet at Promenade Drive East and Royal Pine Drive (DP 17)



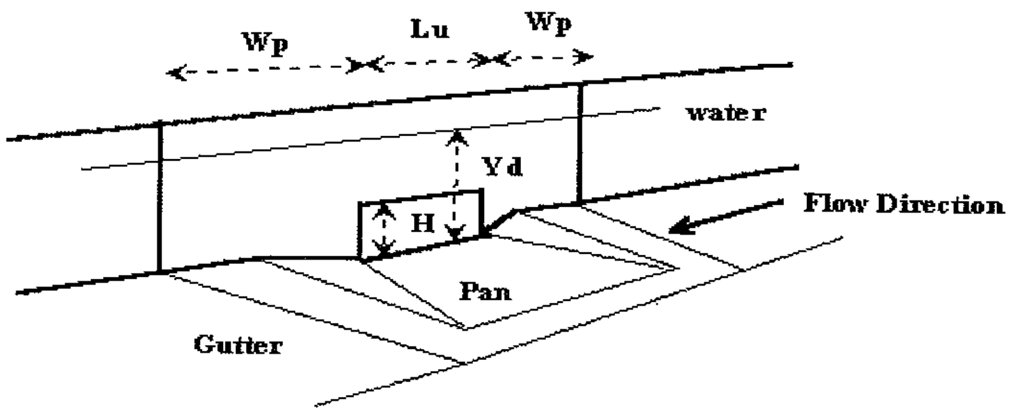
Design Information (Input)			
Design Discharge on the Street (from *Street Hy*)	**Qo =**	**6.1**	**cfs**
Length of a Unit Inlet	Lu =	5.00	ft
Side Width for Depression Pan	Wp =	3.00	ft
Clogging Factor for a Single Unit	Co =	0.20	
Height of Curb Opening in Inches	H =	6.00	inches
Orifice Coefficient	Cd =	0.65	
Weir Coefficient	Cw =	3.40	
Water Depth for the Design Condition	Yd =	0.67	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 =	19.4	cfs
Clogging Coefficient for Multiple Units	Clog-Coeff =	1.00	
Clogging Factor for Multiple Units	Clog =	0.20	
Capacity as a Weir with Clogging	Qwa =	17.5	cfs
As an Orifice			
Capacity as an Orifice without Clogging	Qoi =	8.7	cfs
Capacity as an Orifice with Clogging	Qoa =	7.0	cfs
Capacity for Design with Clogging	**Qa =**	**7.0**	**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.

CURB OPENING INLET IN A SUMP

Project = Briargate Crossing West
Inlet ID = 5' Inlet at the northeast corner of Royal Pine Dr and Briargate Pkwy (DP 19)



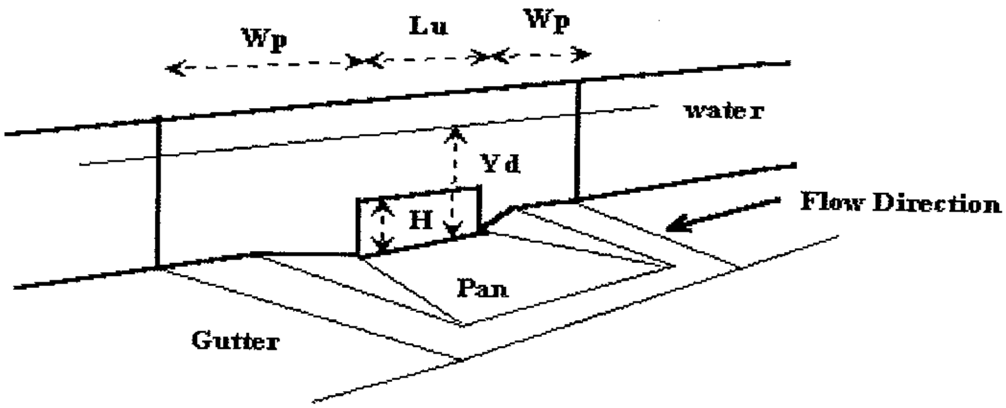
Design Information (Input)			
Design Discharge on the Street (from *Street Hy*)	**Qo =**	**4.6**	**cfs**
Length of a Unit Inlet	Lu =	5.00	ft
Side Width for Depression Pan	Wp =	3.00	ft
Clogging Factor for a Single Unit	Co =	0.20	
Height of Curb Opening in Inches	H =	6.00	inches
Orifice Coefficient	Cd =	0.65	
Weir Coefficient	Cw =	3.40	
Water Depth for the Design Condition	Yd =	0.67	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 =	19.4	cfs
Clogging Coefficient for Multiple Units	Clog-Coeff =	1.00	
Clogging Factor for Multiple Units	Clog =	0.20	
Capacity as a Weir with Clogging	Qwa =	17.5	cfs
As an Orifice			
Capacity as an Orifice without Clogging	Qoi =	8.7	cfs
Capacity as an Orifice with Clogging	Qoa =	7.0	cfs
Capacity for Design with Clogging	**Qa =**	**7.0**	**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.

CURB OPENING INLET IN A SUMP

Project = Briargate Crossing West
Inlet ID = 10' Inlet at DP9



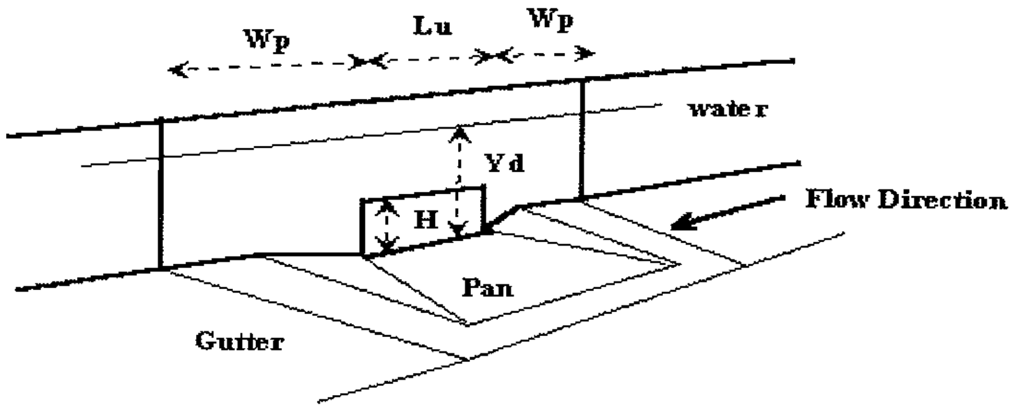
Design Information (Input)			
Design Discharge on the Street (from *Street Hy*)	**Qo =**	**11.4**	**cfs**
Length of a Unit Inlet	Lu =	10.00	ft
Side Width for Depression Pan	Wp =	3.00	ft
Clogging Factor for a Single Unit	Co =	0.20	
Height of Curb Opening in Inches	H =	6.00	inches
Orifice Coefficient	Cd =	0.65	
Weir Coefficient	Cw =	3.40	
Water Depth for the Design Condition	Yd =	0.67	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 =	28.7	cfs
Clogging Coefficient for Multiple Units	Clog-Coeff =	1.00	
Clogging Factor for Multiple Units	Clog =	0.20	
Capacity as a Weir with Clogging	Qwa =	25.0	cfs
As an Orifice			
Capacity as an Orifice without Clogging	Qoi =	17.4	cfs
Capacity as an Orifice with Clogging	Qoa =	14.0	cfs
Capacity for Design with Clogging	**Qa =**	**14.0**	**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.

CURB OPENING INLET IN A SUMP

Project = Briargate Crossing West
Inlet ID = 10' Inlet at DP 10



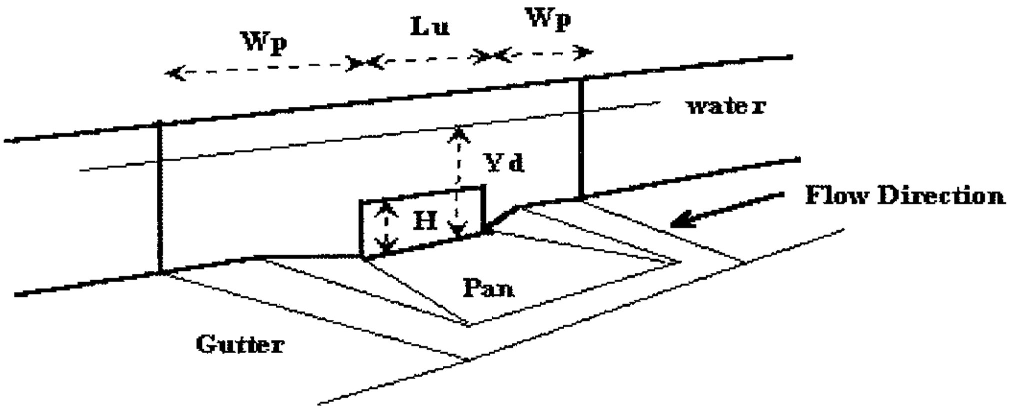
Design Information (Input)	
Design Discharge on the Street (from *Street Hy*)	**Qo = 11.7 cfs**
Length of a Unit Inlet	Lu = 10.00 ft
Side Width for Depression Pan	Wp = 3.00 ft
Clogging Factor for a Single Unit	Co = 0.20
Height of Curb Opening in Inches	H = 6.00 inches
Orifice Coefficient	Cd = 0.65
Weir Coefficient	Cw = 3.40
Water Depth for the Design Condition	Yd = 0.67 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 = 28.7 cfs
Clogging Coefficient for Multiple Units	Clog-Coeff = 1.00
Clogging Factor for Multiple Units	Clog = 0.20
Capacity as a Weir with Clogging	Qwa = 25.0 cfs
As an Orifice	
Capacity as an Orifice without Clogging	Qoi = 17.4 cfs
Capacity as an Orifice with Clogging	Qoa = 14.0 cfs
Capacity for Design with Clogging	**Qa = 14.0 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.

CURB OPENING INLET IN A SUMP

Project = **Briargate Crossing West**
Inlet ID = **10' Inlet at northwest corner of Austin Bluffs and Briargate Parkway (DP 13)**



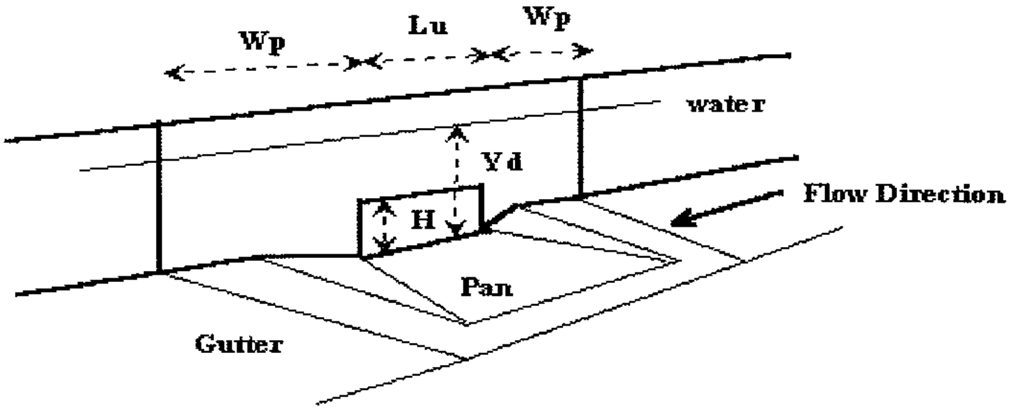
Design Information (Input)			
Design Discharge on the Street (from *Street Hy*)	**Qo =**	**9.9**	**cfs**
Length of a Unit Inlet	Lu =	10.00	ft
Side Width for Depression Pan	Wp =	3.00	ft
Clogging Factor for a Single Unit	Co =	0.20	
Height of Curb Opening in Inches	H =	6.00	inches
Orifice Coefficient	Cd =	0.65	
Weir Coefficient	Cw =	3.40	
Water Depth for the Design Condition	Yd =	0.67	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 =	28.7	cfs
Clogging Coefficient for Multiple Units	Clog-Coeff =	1.00	
Clogging Factor for Multiple Units	Clog =	0.20	
Capacity as a Weir with Clogging	Qwa =	25.0	cfs
As an Orifice			
Capacity as an Orifice without Clogging	Qoi =	17.4	cfs
Capacity as an Orifice with Clogging	Qoa =	14.0	cfs
Capacity for Design with Clogging	**Qa =**	**14.0**	**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.

CURB OPENING INLET IN A SUMP

Project = Briargate Crossing West
Inlet ID = 5' Inlet at northeast corner of Austin Bluffs and Briargate Pkwy (DP 14)



Design Information (Input)			
Design Discharge on the Street (from *Street Hy*)	Qo =	6.8	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 =	0.20	
Height of Curb Opening in Inches	H =	6.00	inches
Orifice Coefficient	Cd =	0.65	
Weir Coefficient	Cw =	3.40	
Water Depth for the Design Condition	Yd =	0.67	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 =	28.7	cfs
Clogging Coefficient for Multiple Units	Clog-Coeff =	1.00	
Clogging Factor for Multiple Units	Clog =	0.20	
Capacity as a Weir with Clogging	Qwa =	25.0	cfs
As an Orifice			
Capacity as an Orifice without Clogging	Qoi =	17.4	cfs
Capacity as an Orifice with Clogging	Qoa =	14.0	cfs
Capacity for Design with Clogging	**Qa =**	**14.0**	**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.

Manning Pipe Calculator

```
Given Input Data:
     Shape ..........................  Circular
     Solving for ....................  Depth of Flow
     Diameter .......................  42.0000 in
     Flowrate .......................  128.2000 cfs
     Slope ..........................  0.0284 ft/ft
     Manning's n ....................  0.0130

Computed Results:
     Depth ..........................  27.2926 in
     Area ...........................  9.6211 ft2
     Wetted Area ....................  6.6181 ft2
     Wetted Perimeter ...............  78.7551 in
     Perimeter ......................  131.9469 in
     Velocity .......................  19.3712 fps
     Hydraulic Radius ...............  12.1008 in
     Percent Full ...................  64.9824 %
     Full flow Flowrate .............  169.5506 cfs
     Full flow velocity .............  17.6227 fps
```

Lateral F--At Lot Line between Lots 1 and 7.txt

Manning Pipe Calculator

```
Given Input Data:
     Shape .........................  Circular
     Solving for ...................  Depth of Flow
     Diameter ......................  48.0000 in
     Flowrate ......................  136.1000 cfs
     Slope .........................  0.0100 ft/ft
     Manning's n ...................  0.0130

Computed Results:
     Depth .........................  37.2542 in
     Area ..........................  12.5664 ft2
     Wetted Area ...................  10.4651 ft2
     Wetted Perimeter ..............  103.4816 in
     Perimeter .....................  150.7964 in
     Velocity ......................  13.0052 fps
     Hydraulic Radius ..............  14.5627 in
     Percent Full ..................  77.6129 %
     Full flow Flowrate ............  143.6433 cfs
     Full flow velocity ............  11.4308 fps
```

Manning Pipe Calculator

Given Input Data:

Shape	Circular
Solving for	Depth of Flow
Diameter	42.0000 in
Flowrate	76.6000 cfs
Slope	0.0075 ft/ft
Manning's n	0.0130

Computed Results:

Depth	30.5526 in
Area	9.6211 ft2
Wetted Area	7.4974 ft2
Wetted Perimeter	85.8076 in
Perimeter	131.9469 in
Velocity	10.2169 fps
Hydraulic Radius	12.5820 in
Percent Full	72.7442 %
Full flow Flowrate	87.1306 cfs
Full flow velocity	9.0562 fps

Manning Pipe Calculator

```
Given Input Data:
     Shape ........................... Circular
     Solving for ..................... Depth of Flow
     Diameter ........................ 18.0000 in
     Flowrate ........................ 4.2000 cfs
     Slope ........................... 0.0901 ft/ft
     Manning's n ..................... 0.0130

Computed Results:
     Depth ........................... 4.4370 in
     Area ............................ 1.7671 ft2
     Wetted Area ..................... 0.3387 ft2
     Wetted Perimeter ................ 18.7038 in
     Perimeter ....................... 56.5487 in
     Velocity ........................ 12.4012 fps
     Hydraulic Radius ................ 2.6075 in
     Percent Full .................... 24.6501 %
     Full flow Flowrate .............. 31.5305 cfs
     Full flow velocity .............. 17.8426 fps
```

Manning Pipe Calculator

```
Given Input Data:
     Shape ..........................  Circular
     Solving for ....................  Depth of Flow
     Diameter .......................  30.0000 in
     Flowrate .......................  35.7000 cfs
     Slope ..........................  0.0070 ft/ft
     Manning's n ....................  0.0130

Computed Results:
     Depth ..........................  25.8423 in
     Area ...........................  4.9087 ft2
     Wetted Area ....................  4.4971 ft2
     Wetted Perimeter ...............  71.3602 in
     Perimeter ......................  94.2478 in
     Velocity .......................  7.9384 fps
     Hydraulic Radius ...............  9.0749 in
     Percent Full ...................  86.1411 %
     Full flow Flowrate .............  34.3174 cfs
     Full flow velocity .............  6.9911 fps
```

Manning Pipe Calculator

Given Input Data:

Shape	Circular
Solving for	Depth of Flow
Diameter	18.0000 in
Flowrate	11.7000 cfs
Slope	0.0297 ft/ft
Manning's n	0.0130

Computed Results:

Depth	10.5325 in
Area	1.7671 ft2
Wetted Area	1.0742 ft2
Wetted Perimeter	31.3543 in
Perimeter	56.5487 in
Velocity	10.8918 fps
Hydraulic Radius	4.9335 in
Percent Full	58.5137 %
Full flow Flowrate	18.1028 cfs
Full flow velocity	10.2441 fps

Manning Pipe Calculator

```
Given Input Data:
     Shape ..........................  Circular
     Solving for ....................  Depth of Flow
     Diameter .......................  18.0000 in
     Flowrate .......................  11.7000 cfs
     Slope ..........................  0.0155 ft/ft
     Manning's n ....................  0.0130

Computed Results:
     Depth ..........................  13.2837 in
     Area ...........................  1.7671 ft2
     Wetted Area ....................  1.3981 ft2
     Wetted Perimeter ...............  37.2034 in
     Perimeter ......................  56.5487 in
     Velocity .......................  8.3687 fps
     Hydraulic Radius ...............  5.4114 in
     Percent Full ...................  73.7982 %
     Full flow Flowrate .............  13.0778 cfs
     Full flow velocity .............  7.4005 fps
```

Manning Pipe Calculator

```
Given Input Data:
     Shape ..........................  Circular
     Solving for ....................  Depth of Flow
     Diameter .......................  24.0000 in
     Flowrate .......................  29.6000 cfs
     Slope ..........................  0.0151 ft/ft
     Manning's n ....................  0.0130

Computed Results:
     Depth ..........................  21.5511 in
     Area ...........................  3.1416 ft2
     Wetted Area ....................  2.9732 ft2
     Wetted Perimeter ...............  59.7920 in
     Perimeter ......................  75.3982 in
     Velocity .......................  9.9557 fps
     Hydraulic Radius ...............  7.1605 in
     Percent Full ...................  89.7963 %
     Full flow Flowrate .............  27.7989 cfs
     Full flow velocity .............  8.8487 fps
```

Manning Pipe Calculator

Given Input Data:

```
     Shape ..........................  Circular
     Solving for ....................  Depth of Flow
     Diameter .......................  18.0000 in
     Flowrate .......................  9.9000 cfs
     Slope ..........................  0.0138 ft/ft
     Manning's n ....................  0.0130
```

Computed Results:

```
     Depth ..........................  12.2040 in
     Area ...........................  1.7671 ft2
     Wetted Area ....................  1.2754 ft2
     Wetted Perimeter ...............  34.8260 in
     Perimeter ......................  56.5487 in
     Velocity .......................  7.7620 fps
     Hydraulic Radius ...............  5.2738 in
     Percent Full ...................  67.7999 %
     Full flow Flowrate .............  12.3398 cfs
     Full flow velocity .............  6.9829 fps
```

Manning Pipe Calculator

Given Input Data:

```
     Shape ........................... Circular
     Solving for ..................... Depth of Flow
     Diameter ........................ 42.0000 in
     Flowrate ........................ 135.0000 cfs
     Slope ........................... 0.0478 ft/ft
     Manning's n ..................... 0.0130
```

Computed Results:

```
     Depth ........................... 23.7821 in
     Area ............................ 9.6211 ft2
     Wetted Area ..................... 5.6196 ft2
     Wetted Perimeter ................ 71.5541 in
     Perimeter ....................... 131.9469 in
     Velocity ........................ 24.0229 fps
     Hydraulic Radius ................ 11.3093 in
     Percent Full .................... 56.6241 %
     Full flow Flowrate .............. 219.9653 cfs
     Full flow velocity .............. 22.8627 fps
```

Manning Pipe Calculator

```
Given Input Data:
     Shape ..........................  Circular
     Solving for ....................  Depth of Flow
     Diameter .......................  42.0000 in
     Flowrate .......................  151.0000 cfs
     Slope ..........................  0.0240 ft/ft
     Manning's n ....................  0.0130

Computed Results:
     Depth ..........................  33.3006 in
     Area ...........................  9.6211 ft2
     Wetted Area ....................  8.1810 ft2
     Wetted Perimeter ...............  92.2569 in
     Perimeter ......................  131.9469 in
     Velocity .......................  18.4575 fps
     Hydraulic Radius ...............  12.7693 in
     Percent Full ...................  79.2872 %
     Full flow Flowrate .............  155.8640 cfs
     Full flow velocity .............  16.2002 fps
```

Manning Pipe Calculator

Given Input Data:

Shape	Circular
Solving for	Depth of Flow
Diameter	42.0000 in
Flowrate	71.9000 cfs
Slope	0.0220 ft/ft
Manning's n	0.0130

Computed Results:

Depth	20.5487 in
Area	9.6211 ft2
Wetted Area	4.6789 ft2
Wetted Perimeter	65.0707 in
Perimeter	131.9469 in
Velocity	15.3667 fps
Hydraulic Radius	10.3544 in
Percent Full	48.9254 %
Full flow Flowrate	149.2284 cfs
Full flow velocity	15.5105 fps

Manning Pipe Calculator

Given Input Data:

Shape	Circular
Solving for	Depth of Flow
Diameter	36.0000 in
Flowrate	52.0000 cfs
Slope	0.0628 ft/ft
Manning's n	0.0130

Computed Results:

Depth	13.7877 in
Area	7.0686 ft2
Wetted Area	2.4909 ft2
Wetted Perimeter	48.0451 in
Perimeter	113.0973 in
Velocity	20.8760 fps
Hydraulic Radius	7.4657 in
Percent Full	38.2991 %
Full flow Flowrate	167.1457 cfs
Full flow velocity	23.6463 fps

Manning Pipe Calculator

```
Given Input Data:
     Shape ...........................  Circular
     Solving for .....................  Depth of Flow
     Diameter ........................  30.0000 in
     Flowrate ........................  52.0000 cfs
     Slope ...........................  0.0293 ft/ft
     Manning's n .....................  0.0130

Computed Results:
     Depth ...........................  19.2164 in
     Area ............................  4.9087 ft2
     Wetted Area .....................  3.3211 ft2
     Wetted Perimeter ................  55.6718 in
     Perimeter .......................  94.2478 in
     Velocity ........................  15.6576 fps
     Hydraulic Radius ................  8.5902 in
     Percent Full ....................  64.0546 %
     Full flow Flowrate ..............  70.2100 cfs
     Full flow velocity ..............  14.3031 fps
```

Manning Pipe Calculator

```
Given Input Data:
     Shape ..........................  Circular
     Solving for .....................  Depth of Flow
     Diameter ........................  18.0000 in
     Flowrate ........................  11.4000 cfs
     Slope ...........................  0.0180 ft/ft
     Manning's n .....................  0.0130

Computed Results:
     Depth ...........................  12.2782 in
     Area ............................  1.7671 ft2
     Wetted Area .....................  1.2841 ft2
     Wetted Perimeter ................  34.9850 in
     Perimeter .......................  56.5487 in
     Velocity ........................  8.8779 fps
     Hydraulic Radius ................  5.2854 in
     Percent Full ....................  68.2120 %
     Full flow Flowrate ..............  14.0930 cfs
     Full flow velocity ..............  7.9750 fps
```

Manning Pipe Calculator

Given Input Data:

Shape	Circular
Solving for	Depth of Flow
Diameter	30.0000 in
Flowrate	52.7000 cfs
Slope	0.0233 ft/ft
Manning's n	0.0130

Computed Results:

Depth	21.0862 in
Area	4.9087 ft2
Wetted Area	3.6866 ft2
Wetted Perimeter	59.6577 in
Perimeter	94.2478 in
Velocity	14.2949 fps
Hydraulic Radius	8.8987 in
Percent Full	70.2873 %
Full flow Flowrate	62.6099 cfs
Full flow velocity	12.7548 fps

Manning Pipe Calculator

Given Input Data:

Shape	Circular
Solving for	Depth of Flow
Diameter	30.0000 in
Flowrate	52.0000 cfs
Slope	0.0363 ft/ft
Manning's n	0.0130

Computed Results:

Depth	17.8874 in
Area	4.9087 ft2
Wetted Area	3.0522 ft2
Wetted Perimeter	52.9349 in
Perimeter	94.2478 in
Velocity	17.0370 fps
Hydraulic Radius	8.3029 in
Percent Full	59.6246 %
Full flow Flowrate	78.1481 cfs
Full flow velocity	15.9202 fps

Manning Pipe Calculator

Given Input Data:

Shape	Circular
Solving for	Depth of Flow
Diameter	36.0000 in
Flowrate	91.0000 cfs
Slope	0.0200 ft/ft
Manning's n	0.0130

Computed Results:

Depth	28.4259 in
Area	7.0686 ft2
Wetted Area	5.9866 ft2
Wetted Perimeter	78.7883 in
Perimeter	113.0973 in
Velocity	15.2005 fps
Hydraulic Radius	10.9417 in
Percent Full	78.9609 %
Full flow Flowrate	94.3258 cfs
Full flow velocity	13.3444 fps

Manning Pipe Calculator

Given Input Data:

Shape	Circular
Solving for	Depth of Flow
Diameter	36.0000 in
Flowrate	95.6000 cfs
Slope	0.0200 ft/ft
Manning's n	0.0130

Computed Results:

Depth	29.9667 in
Area	7.0686 ft2
Wetted Area	6.2880 ft2
Wetted Perimeter	82.7295 in
Perimeter	113.0973 in
Velocity	15.2036 fps
Hydraulic Radius	10.9450 in
Percent Full	83.2407 %
Full flow Flowrate	94.3258 cfs
Full flow velocity	13.3444 fps

Manning Pipe Calculator

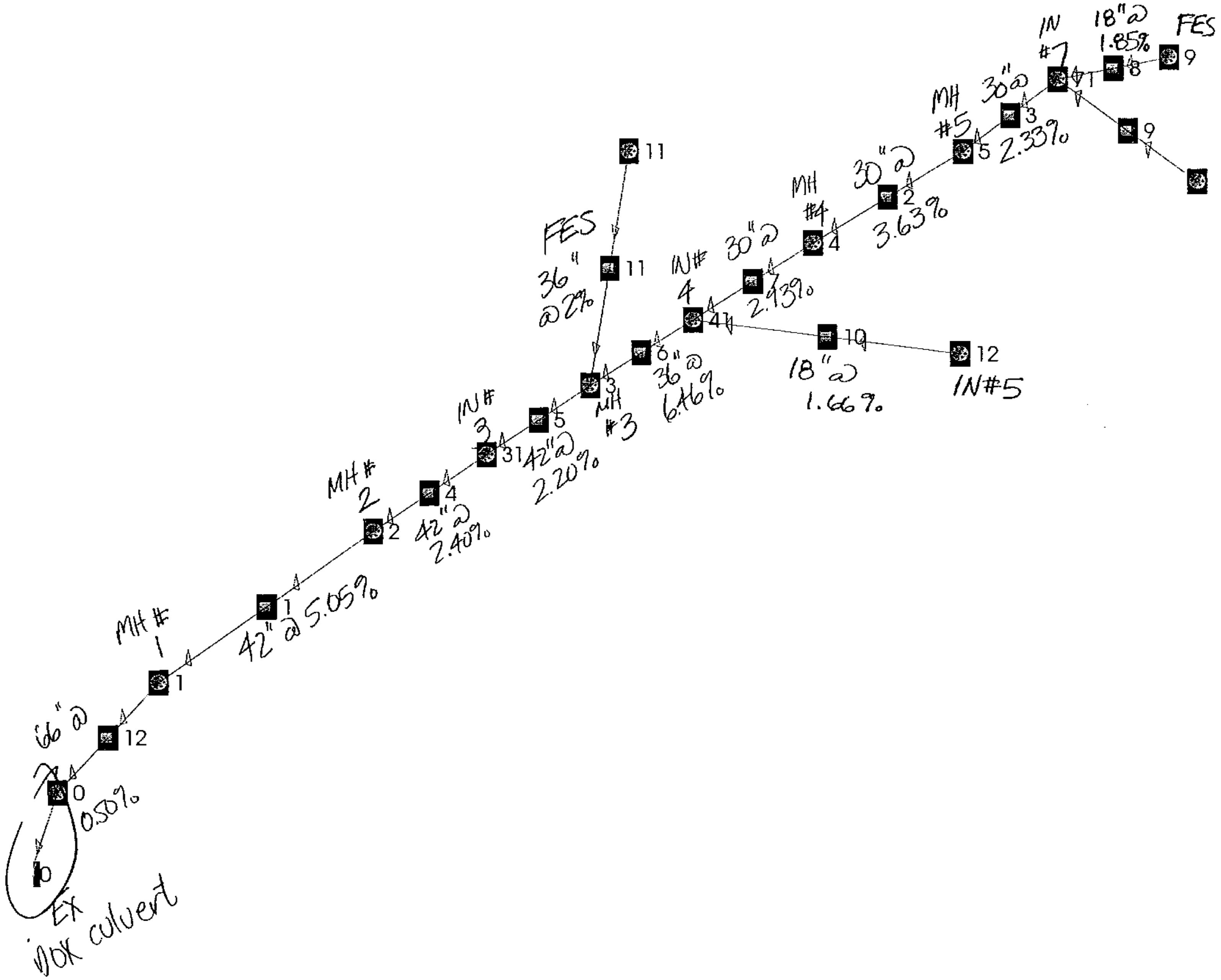
Given Input Data:

Shape	Circular
Solving for	Depth of Flow
Diameter	42.0000 in
Flowrate	100.9000 cfs
Slope	0.0142 ft/ft
Manning's n	0.0130

Computed Results:

Depth	29.5175 in
Area	9.6211 ft2
Wetted Area	7.2249 ft2
Wetted Perimeter	83.5139 in
Perimeter	131.9469 in
Velocity	13.9655 fps
Hydraulic Radius	12.4577 in
Percent Full	70.2798 %
Full flow Flowrate	119.8904 cfs
Full flow velocity	12.4612 fps

Neo UDS Model
Promenade/Austin Bluffs Storm Sewer System



NeoUDS Results Summary

Project Title: BXW-Prom
Project Description: Briargate Crossing West Promenade/Austin Bluffs Storm Sewer System
Output Created On: 8/12/2003 at 3:27:38 PM
Using NeoUDSewer Version 1.1.
Rainfall Intensity Formula **Used.**
Return Period of Flood is 0 **Years.**

Sub Basin Information

Manhole ID #	Basin Area * C	Peak Flow (CFS)
1	1.38	7.0
71	0.00	52.0
4	0.00	52.0
41	1.58	8.2
3	0.00	151.0
31	0.00	151.0
2	0.00	151.0
5	0.00	52.0
9	2.33	35.7
10	4.89	16.3
11	11.78	79.1
12	1.63	11.7
0	0.00	158.0

Summary of Manhole Hydraulics

Manhole ID #	Contributing Area * C	Rainfall Duration (Minutes)	Rainfall Intensity (Inch/Hour)	Design Peak Flow (CFS)	Ground Elevation (Feet)	Water Elevation (Feet)	Comments
1	23.59	5.0	6.70	158.0	6940.21	6928.17	

71	7.22	5.0	7.20	52.0	6983.66	6980.67	
4	7.22	5.0	7.20	52.0	6973.20	6968.99	
41	10.43	5.0	6.89	71.9	6961.16	6957.63	
3	22.21	5.0	6.80	151.0	6959.40	6954.00	
31	22.21	5.0	6.80	151.0	6954.90	6946.07	
2	22.21	5.0	6.80	151.0	6946.79	6940.14	
5	7.22	5.0	7.20	52.0	6982.05	6978.08	
9	2.33	5.0	15.32	35.7	6983.66	6983.79	**Surface Water Present - Inlet**
10	4.89	5.0	3.34	16.3	6983.97	6982.71	
11	11.78	5.0	6.71	79.1	6952.00	6957.15	**Surface Water Present - Flared End Section**
12	1.63	5.0	7.18	11.7	6961.00	6960.47	
0	0	0.0	0.00	158.0	6940.00	6927.44	

Summary of Sewer Hydraulics

Note: The given depth to flow ratio is 0.9.

	Manhole ID Number			Existing	
Sewer ID #	**Upstream**	**Downstream**	**Sewer Shape**	**Diameter (Rise) (Inches) (FT)**	**Width (FT)**
1	2	1	Round	42	N/A
2	5	4	Round	30	N/A
3	71	5	Round	30	N/A
4	31	2	Round	42	N/A
5	3	31	Round	42	N/A
6	41	3	Round	36	N/A
7	4	41	Round	30	N/A
8	9	71	Round	18	N/A
9	10	71	Round	30	N/A
10	12	41	Round	18	N/A

11	11	3	Round	36	N/A
12	1	0	Round	66	N/A

Round and arch sewers are measured in inches.
All hydraulics where calculated using the existing parameters.

Sewer ID	Design Flow (CFS)	Full Flow (CFS)	Normal Depth (Feet)	Normal Velocity (FPS)	Critical Depth (Feet)	Critical Velocity (FPS)	Full Velocity (FPS)	Froude Number	Comment
1	151.0	226.7	2.09	25.2	3.33	16.0	15.7	3.37	Velocity Is High
2	52.0	78.4	1.49	17.1	2.29	11.1	10.6	2.7	
3	52.0	54.4	1.96	12.6	2.29	11.1	10.6	1.57	
4	151.0	156.3	2.77	18.5	3.33	16.0	15.7	1.93	Velocity Is High
5	151.0	149.6	3.50	15.7	3.33	16.0	15.7	N/A	
6	71.9	170.0	1.36	23.0	2.65	10.9	10.2	3.97	Velocity Is High
7	52.0	70.4	1.60	15.7	2.29	11.1	10.6	2.35	
8	35.7	14.3	1.50	20.2	1.49	20.2	20.2	N/A	Velocity Is High
9	16.3	34.9	1.20	7.0	1.37	5.9	3.3	1.27	
10	11.7	13.6	1.07	8.6	1.29	7.2	6.6	1.52	
11	79.1	94.6	2.10	15.0	2.72	11.7	11.2	1.91	
12	158.0	238.1	3.27	10.7	3.50	9.9	6.7	1.14	

A Froude number = 0 indicated that a pressured flow occurs.

Summary of Sewer Design Information

		Invert Elevation		Buried Depth		
Sewer ID	Slope %	Upstream (Feet)	Downstream (Feet)	Upstream (Feet)	Downstream (Feet)	Comment
1	5.05	6936.81	6926.08	6.48	10.63	
2	3.63	6975.80	6966.90	3.75	3.81	
3	2.33	6978.38	6976.02	2.78	3.53	

4	2.40	6942.74	6937.01	8.66	6.28	
5	2.20	6946.95	6942.94	8.95	8.46	
6	6.46	6954.70	6947.45	3.46	8.95	
7	2.93	6966.70	6955.20	4.00	3.46	
8	1.85	6980.00	6979.56	2.16	2.60	
9	0.72	6980.00	6978.55	1.47	2.61	Sewer Too Shallow
10	1.66	6958.00	6956.00	1.50	3.66	
11	2.00	6951.96	6951.20	-2.96	5.20	Flared End Section
12	0.50	6924.08	6923.80	10.63	10.70	

Summary of Hydraulic Grade Line

			Invert Elevation		Water Elevation		
Sewer ID #	Sewer Length (Feet)	Surcharged Length (Feet)	Upstream (Feet)	Downstream (Feet)	Upstream (Feet)	Downstream (Feet)	Condition
1	212.52	0	6936.81	6926.08	6940.14	6928.17	Jump
2	245.31	0	6975.80	6966.90	6978.08	6968.99	Jump
3	101.34	0	6978.38	6976.02	6980.67	6978.08	Jump
4	238.94	0	6942.74	6937.01	6946.07	6940.14	Jump
5	182.23	182.23	6946.95	6942.94	6954.00	6946.07	Pressured
6	112.19	111.16	6954.70	6947.45	6957.63	6954.00	Pressured
7	392.44	0	6966.70	6955.20	6968.99	6957.63	Jump
8	23.79	23.79	6980.00	6979.56	6983.79	6980.67	Pressured
9	201.21	201.21	6980.00	6978.55	6982.71	6980.67	Pressured
10	120.19	120.19	6958.00	6956.00	6960.47	6957.63	Pressured
11	38.05	38.05	6951.96	6951.20	6957.15	6954.00	Pressured
12	55.24	0	6924.08	6923.80	6928.17	6927.44	Jump

Summary of Energy Grade Line

	Upstream Manhole			Juncture Losses				Downstream Manhole	
Sewer ID #	Manhole ID #	Energy Elevation	Sewer Friction	Bend K Coefficient	Bend Loss	Lateral K Coefficient	Lateral Loss	Manhole ID #	Energy Elevation

		(Feet)	(Feet)		(Feet)		(Feet)		(Feet)
1	2	6944.11	15.13	0.03	0.11	0.00	0.00	1	6928.86
2	5	6979.98	8.73	0.21	0.37	0.00	0.00	4	6970.88
3	71	6982.56	2.49	0.05	0.09	0.00	0.00	5	6979.98
4	31	6950.04	5.82	0.03	0.11	0.00	0.00	2	6944.11
5	3	6957.83	4.08	0.97	3.71	0.00	0.00	31	6950.04
6	41	6959.24	1.28	0.08	0.13	0.00	0.00	3	6957.83
7	4	6970.88	11.56	0.05	0.09	0.00	0.00	41	6959.24
8	9	6990.13	7.25	0.05	0.32	0.00	0.00	71	6982.56
9	10	6982.88	0.32	0.03	0.01	0.00	0.00	71	6982.56
10	12	6961.15	1.48	0.63	0.43	0.00	0.00	41	6959.24
11	11	6959.10	0.53	0.38	0.74	0.00	0.00	3	6957.83
12	1	6928.86	1.42	0.05	0.00	0.00	0.00	0	6927.44

Bend loss = Bend K * Flowing full vhead in sewer.
Lateral loss = Outflow full vhead - Junction Loss K * Inflow full vhead.
A friction loss of 0 means it was negligible or possible error due to jump.
Friction loss includes sewer invert drop at manhole.
Notice: Vhead denotes the velocity head of the full flow condition.
A minimum junction loss of 0.05 Feet would be introduced unless Lateral K is 0.
Friction loss was estimated by backwater curve computations.

Run: stm-prom-e

************************ Headloss View ************************

Node Label	Pipe Label	HGL Elev In [ft]	HGL Elev Out [ft]	EGL Elev In [ft]	EGL Elev Out [ft]
PIPE END		6983.1404	6983.1404	6983.1404	6983.1404
INLET #8		6983.0165	6982.2725	6983.5816	6982.8375
INLET #7		6980.7138		6981.5358	

Hydraulic Calculations from Downstream to Upstream:

Node: 1
Diameter .... 30.00 in
Flowrate, Qo .... 0.000 cfs
Flowrate, Qi .... 35.700 cfs
Velocity, Vi .... 7.94 fps
Velocity head, Vi^2/2*G .... 0.98 ft
Contraction loss .... 0.00 ft
Cntrl expansion loss (Vh*0.35) .. 0.29 ft

Hydraulic Grade Line (HGL) Totals:
Depth in .... 0.00 ft
Elevation in .... 6980.71 ft

Energy Grade Line (EGL) Totals:
Depth in .... 0.82 ft
Elevation in .... 6981.54 ft

Node: 2
Diameter .... 30.00 in
Flowrate, Qo .... 35.700 cfs
Flowrate, Qi .... 29.600 cfs
Velocity, Vo .... 7.94 fps
Velocity, Vi .... 10.69 fps
Velocity head, Vo^2/2*G .... 0.98 ft
Velocity head, Vi^2/2*G .... 1.77 ft
Length .... 205.75 ft
Slope friction .... 0.0076 ft/ft
Slope friction * Length .... 1.56 ft
Greatest bendloss 0.603
Greatest bendloss head .... 0.34 ft
Contraction loss .... 0.21 ft
Cntrl expansion loss (Vh*0.35) .. 0.20 ft

Hydraulic Grade Line (HGL) Totals:
Depth in .... 2.30 ft
Depth out .... 1.56 ft

```
    Elevation in ....................  6983.02 ft
    Elevation out ...................  6982.27 ft

  Energy Grade Line (EGL) Totals:
    Depth in ........................  2.87 ft
    Depth out .......................  2.12 ft
    Elevation in ....................  6983.58 ft
    Elevation out ...................  6982.84 ft

Node: 3
    Flowrate, Qo ....................  29.600 cfs

  Hydraulic Grade Line (HGL) Totals:
    Depth in ........................  0.12 ft
    Depth out .......................  0.12 ft
    Elevation in ....................  6983.14 ft
    Elevation out ...................  6983.14 ft

  Energy Grade Line (EGL) Totals:
    Depth in ........................  0.12 ft
    Depth out .......................  0.12 ft
    Elevation in ....................  6983.14 ft
    Elevation out ...................  6983.14 ft
```

Run: stm-rpine-nw

************************ Headloss View ************************

Node Label	Pipe Label	HGL Elev In [ft]	HGL Elev Out [ft]	EGL Elev In [ft]	EGL Elev Out [ft]
PIPE END		6972.8783	6972.8783	6972.8783	6972.8783
INLET #10		6972.4201	6969.7154	6974.9957	6972.2910
INLET #9		6968.4065	6965.4141	6971.2491	6968.2567
EX. PIPE		6964.9625		6966.6717	

Hydraulic Calculations from Downstream to Upstream:

Node: 1
Diameter .... 42.00 in
Flowrate, Qo .... 0.000 cfs
Flowrate, Qi .... 100.900 cfs
Velocity, Vi .... 11.92 fps
Velocity head, Vi^2/2*G .... 2.21 ft
Contraction loss .... 0.00 ft
Cntrl expansion loss (Vh*0.35) .. 0.60 ft

Hydraulic Grade Line (HGL) Totals:
Depth in .... 0.00 ft
Elevation in .... 6964.96 ft

Energy Grade Line (EGL) Totals:
Depth in .... 1.71 ft
Elevation in .... 6966.67 ft

Node: 2
Diameter .... 36.00 in
Flowrate, Qo .... 100.900 cfs
Flowrate, Qi .... 95.600 cfs
Velocity, Vo .... 11.92 fps
Velocity, Vi .... 15.20 fps
Velocity head, Vo^2/2*G .... 2.21 ft
Velocity head, Vi^2/2*G .... 3.59 ft
Length .... 44.90 ft
Slope friction .... 0.0101 ft/ft
Slope friction * Length .... 0.45 ft
Greatest bendloss 0.424
Greatest bendloss head .... 1.21 ft
Contraction loss .... 0.79 ft
Cntrl expansion loss (Vh*0.35) .. 0.99 ft

Hydraulic Grade Line (HGL) Totals:

```
      Depth in ........................  3.44 ft
      Depth out .......................  0.45 ft
      Elevation in ....................  6968.41 ft
      Elevation out ...................  6965.41 ft

    Energy Grade Line (EGL) Totals:
      Depth in ........................  6.29 ft
      Depth out .......................  3.29 ft
      Elevation in ....................  6971.25 ft
      Elevation out ...................  6968.26 ft

Node: 3
      Diameter ........................  36.00 in
      Flowrate, Qo ....................  95.600 cfs
      Flowrate, Qi ....................  91.000 cfs
      Velocity, Vo ....................  15.20 fps
      Velocity, Vi ....................  15.20 fps
      Velocity head, Vo^2/2*G .........  3.59 ft
      Velocity head, Vi^2/2*G .........  3.59 ft
      Length ..........................  63.71 ft
      Slope friction ..................  0.0205 ft/ft
      Slope friction * Length .........  1.31 ft
      Greatest bendloss ...............  0.424
      Greatest bendloss head ..........  1.09 ft
      Contraction loss ................  0.71 ft
      Cntrl expansion loss (Vh*0.35) ..  0.90 ft

    Hydraulic Grade Line (HGL) Totals:
      Depth in ........................  4.01 ft
      Depth out .......................  1.31 ft
      Elevation in ....................  6972.42 ft
      Elevation out ...................  6969.72 ft

    Energy Grade Line (EGL) Totals:
      Depth in ........................  6.59 ft
      Depth out .......................  3.88 ft
      Elevation in ....................  6975.00 ft
      Elevation out ...................  6972.29 ft

Node: 4
      Flowrate, Qo ....................  91.000 cfs

    Hydraulic Grade Line (HGL) Totals:
      Depth in ........................  0.46 ft
      Depth out .......................  0.46 ft
      Elevation in ....................  6972.88 ft
      Elevation out ...................  6972.88 ft

    Energy Grade Line (EGL) Totals:
      Depth in ........................  0.46 ft
      Depth out .......................  0.46 ft
      Elevation in ....................  6972.88 ft
      Elevation out ...................  6972.88 ft
```

Hydraulic Design of Storm Sewers
Final Design - Hydraulic Calculation Sheet

Briargate Crossing West
Project # 03.104.013

Mannings Value= 0.013

Location	Invert (ft)	Diameter (ft)	H.G.L. (ft)	Area (s.f.)	K	Velocity (f.p.s.)	Q(100) (c.f.s.)	Vel. Head (ft)	E.G.L. (ft)	S(f) (ft/ft)	Avg. S(f) (ft/ft)	L (ft)	H(f) (ft)	H(m) (ft)	K (loss)	H(b) (ft)	Pipe Slope (%)	Rim Elev (ft)	Freeboard (ft)
EX. PIPE	6967.21	1.5	6968.71	1.8	0.0049	5.0	8.8	0.39	6969.10	0.007	0.007	8.77	0.06				9.01%	6975.00	6.3
IN 11, d/s	6968.00	1.5	6968.77	1.8	0.0049	5.0	8.8	0.39	6969.15	0.007	0.004			0.02	0.20	0.08		6975.28	6.5
IN 11, u/s	6971.33	1.5	6972.44	1.8	0.0049	2.4	4.2	0.09	6972.53	0.002	0.002	63.89	0.10				1.46%	6975.28	2.8
IN 12, d/s	6972.26	1.5	6972.54	1.8	0.0049	2.4	4.2	0.09	6972.63	0.002				0.00		0.00		6975.76	3.2

Assume:
1. Starting HGL set at top of pipe for 100-year storm event; for pipes flow less than 80% full, normal depth used.
2. HGL set below proposed rim elevations
3. Mannings roughness Coefficent =0.013
4. Storm sewer pipes flowing full during 100-year storm event
5. K coefficents (loss) from Figure 8-13 in the County Drainage Criteria Manual

APPENDIX C:

STANDARD DESIGN CHARTS AND TABLES

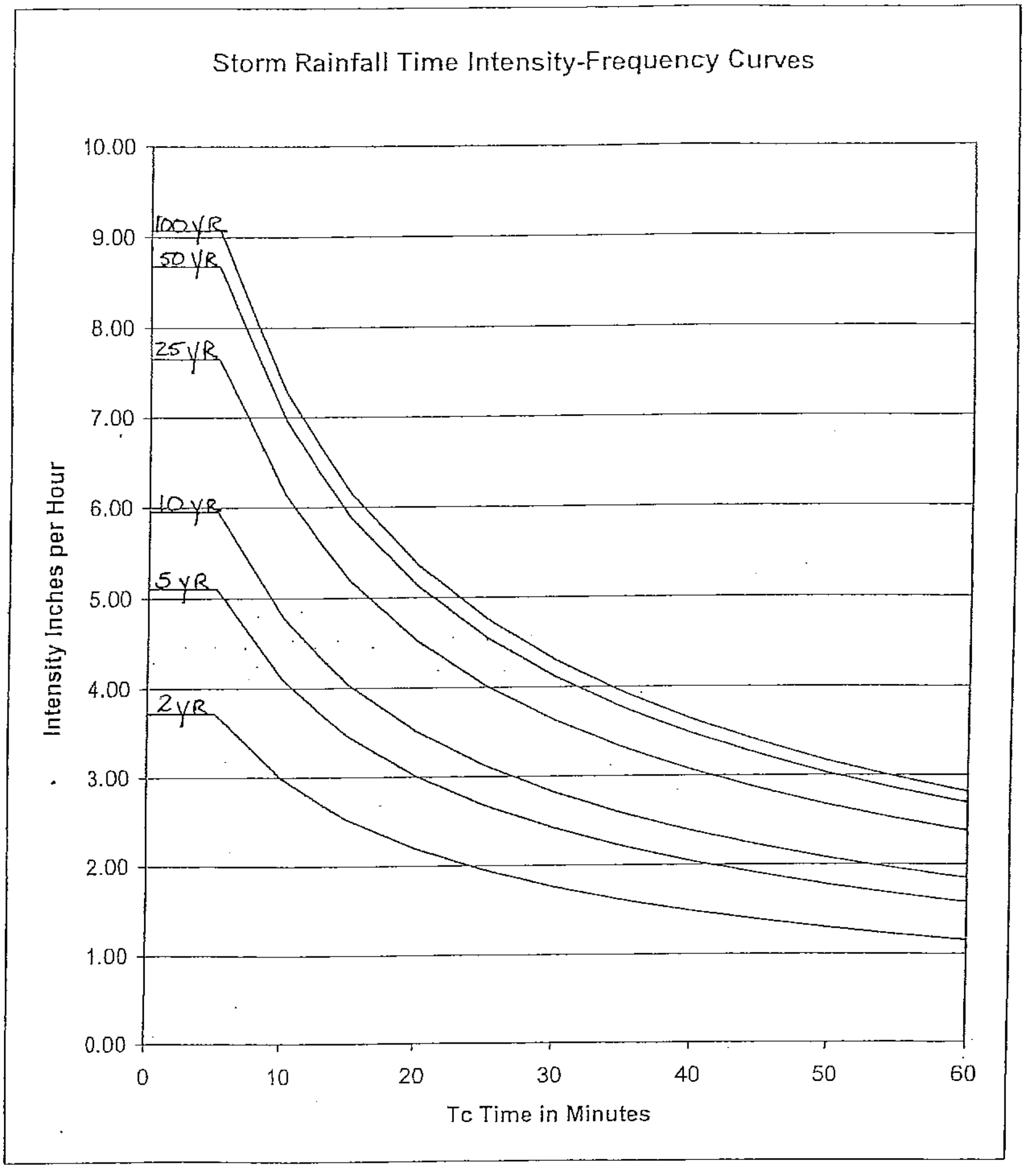
TABLE 5-1

RECOMMENDED AVERAGE RUNOFF COEFFICIENTS AND PERCENT IMPERVIOUS

LAND USE OR SURFACE CHARACTERISTICS	PERCENT IMPERVIOUS	"C" FREQUENCY 10 A&B*	"C" FREQUENCY 10 C&D*	"C" FREQUENCY 100 A&B*	"C" FREQUENCY 100 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

9/30/90



Rainfall Depth - Duration - Frequency Table derived from Rainfall Atlas III for Colorado
Resource: Guo, James C.Y., (2001) "Urban Storm Water Modeling", Chapter 5: Runoff Prediction for Small Catchment, published by Auraria Campus Book Company, University of Colorado at Denver, Denver, Colorado.

Run: stm-austin-cnr

************************* Headloss View *************************

Node Label	Pipe Label	HGL Elev In [ft]	HGL Elev Out [ft]	EGL Elev In [ft]	EGL Elev Out [ft]
PIPE END (P		6935.3094	6935.3094	6935.3094	6935.3094
INLET #2		6934.8576	6931.8900	6937.6168	6934.6493
EX. PIPE		6931.3614		6934.4212	

Hydraulic Calculations from Downstream to Upstream:

```
Node: 1
     Diameter .......................  42.00 in
     Flowrate, Qo ...................  0.000 cfs
     Flowrate, Qi ...................  135.000 cfs
     Velocity, Vi ...................  26.06 fps
     Velocity head, Vi^2/2*G ........  10.56 ft
     Contraction loss ...............  0.00 ft
     Cntrl expansion loss (Vh*0.35) ..  1.07 ft

   Hydraulic Grade Line (HGL) Totals:
     Depth in .......................  0.00 ft
     Elevation in ...................  6931.36 ft

   Energy Grade Line (EGL) Totals:
     Depth in .......................  3.06 ft
     Elevation in ...................  6934.42 ft

Node: 2
     Diameter .......................  42.00 in
     Flowrate, Qo ...................  135.000 cfs
     Flowrate, Qi ...................  128.200 cfs
     Velocity, Vo ...................  26.06 fps
     Velocity, Vi ...................  16.74 fps
     Velocity head, Vo^2/2*G ........  10.56 ft
     Velocity head, Vi^2/2*G ........  4.35 ft
     Length .........................  29.36 ft
     Slope friction .................  0.0180 ft/ft
     Slope friction * Length ........  0.53 ft
     Greatest bendloss ..............  0.448
     Greatest bendloss head .........  1.24 ft
     Contraction loss ...............  0.76 ft
     Cntrl expansion loss (Vh*0.35) ..  0.97 ft

   Hydraulic Grade Line (HGL) Totals:
     Depth in .......................  3.50 ft
     Depth out ......................  0.53 ft
```

```
      Elevation in ...................  6934.86 ft
      Elevation out ..................  6931.89 ft

    Energy Grade Line (EGL) Totals:
      Depth in .......................  6.26 ft
      Depth out ......................  3.29 ft
      Elevation in ...................  6937.62 ft
      Elevation out ..................  6934.65 ft

Node: 3
      Flowrate, Qo ...................  128.200 cfs

    Hydraulic Grade Line (HGL) Totals:
      Depth in .......................  0.45 ft
      Depth out ......................  0.45 ft
      Elevation in ...................  6935.31 ft
      Elevation out ..................  6935.31 ft

    Energy Grade Line (EGL) Totals:
      Depth in .......................  0.45 ft
      Depth out ......................  0.45 ft
      Elevation in ...................  6935.31 ft
      Elevation out ..................  6935.31 ft
```

Run: stm-prom-cr

************************ Headloss View ************************

Node Label	Pipe Label	HGL Elev In [ft]	HGL Elev Out [ft]	EGL Elev In [ft]	EGL Elev Out [ft]
INLET #5		6958.7082	6958.7082	6958.7082	6958.7082
INLET #4		6957.1071		6957.7883	

Hydraulic Calculations from Downstream to Upstream:

```
Node: 1
     Diameter ........................  18.00 in
     Flowrate, Qo ....................  0.000 cfs
     Flowrate, Qi ....................  11.700 cfs
     Velocity, Vi ....................  8.37 fps
     Velocity head, Vi^2/2*G .........  1.09 ft
     Contraction loss ................  0.00 ft
     Cntrl expansion loss (Vh*0.35) ..  0.24 ft

   Hydraulic Grade Line (HGL) Totals:
     Depth in ........................  0.00 ft
     Elevation in ....................  6957.11 ft

   Energy Grade Line (EGL) Totals:
     Depth in ........................  0.68 ft
     Elevation in ....................  6957.79 ft

Node: 2
     Flowrate, Qo ....................  11.700 cfs

   Hydraulic Grade Line (HGL) Totals:
     Depth in ........................  1.60 ft
     Depth out .......................  1.60 ft
     Elevation in ....................  6958.71 ft
     Elevation out ...................  6958.71 ft

   Energy Grade Line (EGL) Totals:
     Depth in ........................  1.60 ft
     Depth out .......................  1.60 ft
     Elevation in ....................  6958.71 ft
     Elevation out ...................  6958.71 ft
```

Hydraulic Design of Storm Sewers
Final Design - Hydraulic Calculation Sheet

Briargate Crossing West
Project # 03.104.013

Mannings Value= 0.013

Location	Invert (ft)	Diameter (ft)	H.G.L. (ft)	Area (s.f.)	K	Velocity (f.p.s.)	Q(100) (c.f.s.)	Vel. Head (ft)	E.G.L. (ft)	S(f) (ft/ft)	Avg. S(f) (ft/ft)	L (ft)	H(f) (ft)	H(m) (ft)	K (loss)	H(b) (ft)	Pipe Slope (%)	Rim Elev (ft)	Freeboard (ft)
EX. PIPE	6953.24	5.5	6960.46	23.8	0.0049	4.6	109.3	0.33	6960.79	0.001	0.001	58.94	0.06				1.43%	6968.00	7.5
IN 9, d/s	6954.08	5.5	6960.52	23.8	0.0049	4.6	109.3	0.33	6960.85	0.001	0.006			0.02	0.40	0.13		6966.91	6.4
IN 9, u/s	6960.03	3.5	6961.14	9.6	0.0049	10.8	104.0	1.81	6962.96	0.011	0.009	63.71	0.60				2.51%	6966.91	5.8
IN 10, d/s	6961.63	3.5	6962.74	9.6	0.0049	10.8	104.0	1.81	6964.56	0.011	0.009			0.09		0.00		6966.90	4.2
IN 10, u/s	6961.83	3.5	6962.94	9.6	0.0049	9.5	91.0	1.39	6964.33	0.008	0.008	24.61	0.20				1.99%	6966.90	4.0
FES, d/s	6962.32	3.5	6963.43	9.6	0.0049	9.5	91.0	1.39	6964.82	0.008				0.07		0.00		6971.00	7.6

Assume:
1. Starting HGL set at top of pipe for 100-year storm event; for pipes flow less than 80% full, normal depth used.
2. HGL set below proposed rim elevations
3. Mannings roughness Coefficent =0.013
4. Storm sewer pipes flowing full during 100-year storm event
5. K coefficents (loss) from Figure 8-13 in the County Drainage Criteria Manual