MASTER DEVELOPMENT DRAINAGE PLAN

For

THE WOODMEN TOWNE CENTER

COTTONWOOD CREEK DRAINAGE BASIN
SAND CREEK DRAINAGE BASIN

Prepared for:
City of Colorado Springs Subdivision
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On Behalf of:
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October 2008

07.187.003

17881-21

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.

SEAL

Richard A. Eastland
Registered Professional Engineer
State of Colorado
No. 40695

Developer's Statement:

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

Cedarwood Development, Inc.
Business Name

By: _____
Mr. Tim Ridner

Title: DIRECTOR
Director of Development

Address: 1900 S. Harbor City Blvd., Suite 335
Melbourne, FL 32901

City of Colorado Springs:

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

_____ Nov 26, 2008
For the City Engineer Date

Conditions:

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I. INTRODUCTION

A. Project Location

This drainage report presents the final drainage design for the Woodmen Towne Center Development. The Woodmen Towne Center is located in the northeastern Colorado Springs, El Paso County, Colorado (City) as shown in Figure 1: Vicinity Map.

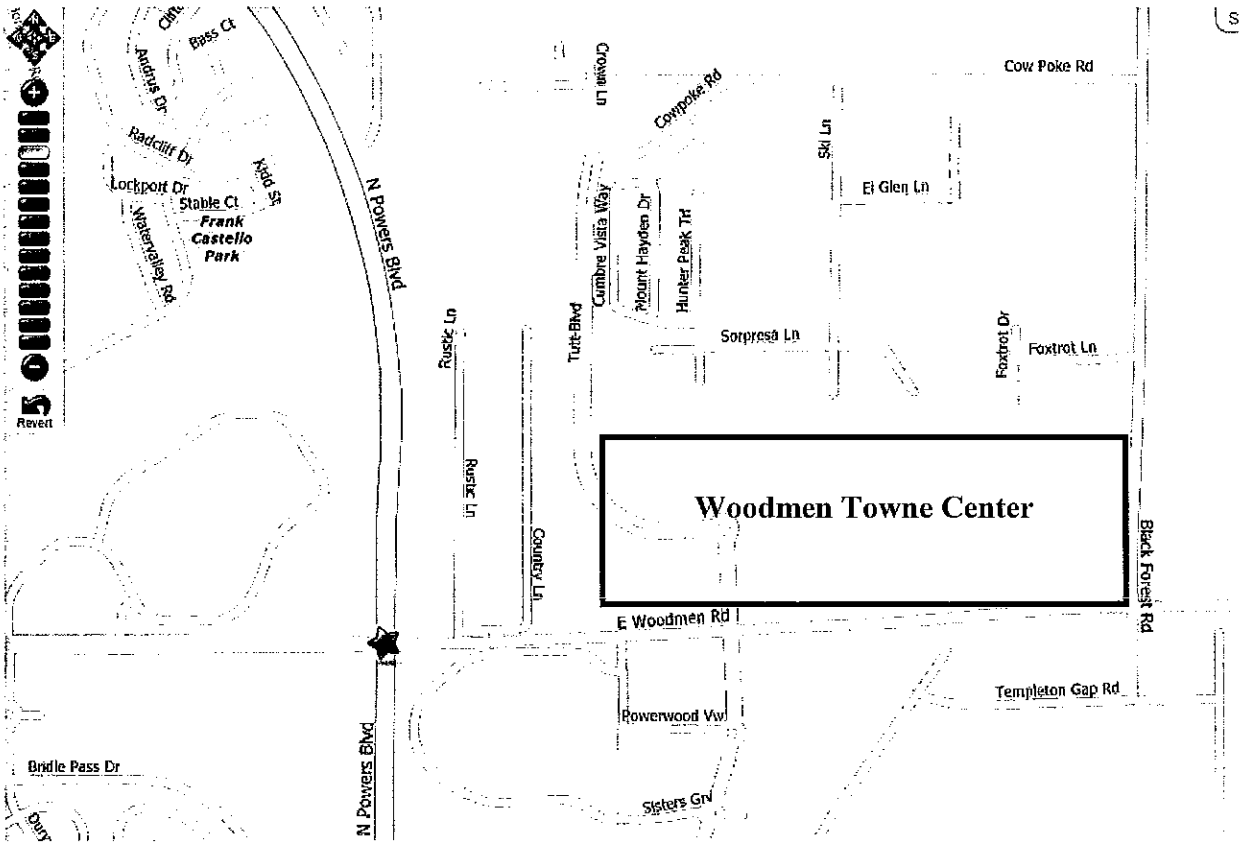


Figure 1. Vicinity Map

1. General Location. Southwest ¼ of Section 6 of Township 13 South, Range 65 West of the Sixth Principal Meridian, El Paso County, State of Colorado.

2. Surrounding Streets. Existing Woodmen Road is south of the site, Black Forest Road borders the project to the east, and Tutt Boulevard bisects the property on the northwest corner. Approximately, a ¼ mile to the west is the Powers Boulevard and Woodmen Road interchange.

3. Drainageway. The site is located within two drainage basins; the Cottonwood Creek and the Sand Creek. The west side of the property will drain to the northwest and south west to the Cottonwood Creek Drainage Basin. The east side of the site will drain to the Sand Creek Drainage Basin.

4. Surrounding Developments. The following developments are located adjacent to the site.

North:	Cumbre Vista Filing No. 1, a single family residential subdivision, and undeveloped land which is zoned for residential development.
South:	Woodmen Road and the subdivision known as Powerwood Filing No. 1.
West:	The Westview Estates is located adjacent to this development. The interchange for Powers Boulevard and Woodmen Road is located approximately a ¼ mile to the west.
East:	Black Forest Road is located adjacent to the east of this development, and east of Black Forest Road is the Woodmen Heights area.

B. Property Description

1. Project Area. The Woodmen Towne Center encompasses approximately 90.0 acres of land. Tutt Boulevard bisects the western portion of the property and connects to Woodmen Road. The development is primarily commercial with some high density residential land use.

2. Ground Cover. The majority of the site is covered with sparse vegetation including natural grasses and some shrubs.

3. General Topography. Runoff is directed to either the Cottonwood Creek or the Sand Creek channels from the site. Runoff entering Sand Creek drains in a northwest to southeast direction. The runoff flowing to the Cottonwood Creek drains in an east to west trend. The slopes on the site generally range from 1%-8%.

4. General Soil Conditions. The Web Soil Survey, created by the Natural Resources Conservation Service, was utilized to investigate the existing general soil types within and tributary to the area impacting the site. See Soils Map, Appendix A. The following soil types are present in the development area.

Table 1.1
Soil Conservation Service Soil Survey for El Paso County

Soil ID No.	*Soil*	*Hydrologic Classification*	*Permeability*
8	Blakeland loamy sand	A	Moderately Rapid
85	Stapleton-Bernal Sandy Loams	B	Moderate

Soils can be classified in four different hydrologic groups, A, B, C, or D to help predict stormwater runoff rates. Hydrologic group "A" is characterized by deep, well-drained coarse-grained soils with a rapid infiltration rate when thoroughly wet and having a low

runoff potential. Group "D" typically has a clay layer at or near to the surface, or a very shallow depth to impervious bedrock and has a very slow infiltration rate and a high runoff potential. For the analysis in this report, hydrologic group "B" soil classification was assumed across the entire site.

5. Major Drainageways. The Woodmen Towne Center straddles the basin line between the Cottonwood Creek and the Sand Creek Drainage Basins. Stormwater detention is necessary in both basins to release at historical rates. The site is removed from both channels so no channel improvements are required for this development.

6. Irrigation Facilities. No existing irrigation facilities can be found on or around the site.

7. Maintenance. Maintenance access for all proposed public drainage systems will be provided within any right-of-way or through means of an easement. All stormwater infrastructure within the public roadway will be dedicated and maintained by the City. The remaining stormwater facilities, including the detention ponds, will be privately owned and maintained. It is anticipated that a business district will be formed to maintain the private infrastructure.

II. HYDROLOGIC AND HYDRAULIC ANALYSIS

A. Major Basin Description

The ridgeline dividing the Cottonwood Creek and the Sand Creek Drainage Basins is located within the Woodmen Towne Center. The Cottonwood Creek drainage area is approximately 19 square miles located in the upper central region of El Paso County. The Sand Creek drainage area is approximately 54 square miles, and is located in the east central portions of El Paso County. Runoff generated on the western portion of the site will follow historic drainage patterns flowing to the southwest towards Cottonwood Creek. Runoff accumulated in the eastern portion of the site will also follow historic drainage patterns flowing to the southeast towards the Sand Creek Channel.

B. Floodplain Statement

Review of the ***Flood Insurance Rate Map Panel 529 (08041CO529 F)***, effective date March 17, 1997, published by the Federal Emergency Management Agency (FEMA), shows no portion of the 100-year floodplain from either the Cottonwood Creek or the Sand Creek within the area of the proposed construction. See Appendix A for Floodplain maps.

C. Drainage Regulations

This report has been prepared in accordance to the criteria set forth in the ***City of Colorado Springs and El Paso County Drainage Criteria Manual*** (Drainage Criteria Manual), dated November 1991 and ***Volume 2*** of the City Drainage Criteria Manual, dated November 1, 2002. In addition to the City Criteria Manual, the ***Urban Storm Drainage Criteria Manuals, Volumes 1-3***, published by the Urban Drainage and Flood Control District, latest update, have also been used to supplement the Drainage Criteria Manual.

D. Design Frequency

The design frequency is based on the Drainage Criteria Manual. The 100-year storm event was used as the major storm for the project, and the 5-year storm event was used as the minor storm.

E. Design Discharge

1. Method of Analysis

The hydrology for this project uses the Rational Method as recommended by the Drainage Criteria Manual for the minor and major storms. The Rational Method is used for drainage basins less than 100-acres in size.

2. Runoff Coefficient

Rational Method coefficients are from Table 5-1 of the Drainage Criteria Manual for developed land use such as roadway and commercial areas, as well as undeveloped areas. See Appendix C for more information.

3. Time of Concentration

The time of concentration for the Rational Method was taken from the Drainage Criteria Manual. The time of concentration consists of the initial time of overland flow and the travel time in a channel to the inlet or point of interest. A minimum time of concentrations of 5 minutes was used for the final calculations.

4. Rainfall Intensity

The hypothetical rainfall depths for the 24-hour storm duration were estimated from the NOAA Atlas 2, Volume III-Colorado Isopluvial Figures 27 and 31. Table 1 lists the rainfall depth for each of the 24-hour storm events.

Table 1: Rainfall Depth in Colorado Springs in the 24 Hour Storm Event

Storm Recurrence Interval	Rainfall Depth (inches)
5-year	2.6
100-year	4.4

The rainfall intensity equation for the Rational Method was taken from Drainage Criteria Manual updated Storm Intensity Curves Memo.

Intensity Equation: $$I = 26.65 * \frac{P_1}{(10 + T_d)^{0.76}}$$

The Rational Method uses the following equation: Q=C*I*A
Where:

Q = Maximum runoff rate in cubic feet per second (cfs)
C = Runoff coefficient
I = Average rainfall intensity in inches per hour
A = Area of drainage sub-basin in acres

5. Detention Sizing

The detention volume was determined by using the time of concentration and peak flow rates from the Rational Method analysis and fitting a synthetic SCS unit hydrograph curve to these parameters. The required storage volume is then determined by specifying the peak release rate. The available volume of each detention pond was sized by averaging the area multiplied by the difference in elevation, and then summing the volumetric sections. Refer to Appendix B for runoff volume requirements and pond sizing.

F. Hydraulic Criteria

Storm sewer infrastructure was sized using Haestad Methods' Flowmaster computer program. A slope of one percent was assumed as well as a roughness coefficient that corresponds to a pipe material of concrete. Peak runoff rates were used to size the pipes for the normal flow depth. Refer to Appendix B for Routed Hydraulic Calculations.

III. EXISTING FACILITIES

The Woodmen Towne Center is currently undeveloped and contains several utilities. Refer to drainage map DR01 located within Appendix D. The historic conditions of the site were previously studied within the Master Development Drainage Plan for the Ridge at Woodmen, by Law and Mariotti Consulting, dated March 2004 (The Ridge at Woodmen MDDP). Since the approval of this report, several adjacent developments have submitted their own master development drainage plans and final drainage reports which have revised the analysis from The Ridge at Woodmen MDDP. The assumptions made in this report are listed with the corresponding stormwater douments below.

A. Cottonwood Creek Drainage Structures

1. Tutt Boulevard and Woodmen Towne Center

A 30-inch reinforced concrete pipe (RCP) storm system is located within Tutt Boulevard. The storm sewer system was designed to accept developed flows from the Woodmen Towne Center. This system outlets into Cottonwood Creek upstream of the Powers Bridge. The Preliminary/Final Drainage Report for Tutt Boulevard Filing No. 4, Woodmen Road to Cowpoke Road, by Matrix Design Group, dated April 2005 (Tutt FDR), outlines the design of this system. Two basins were used to determine the runoff generated by Tutt Boulevard, D30 (2.55 acres, Q(5) = 5.9 cfs, Q(100) = 11.9 cfs) and D31 (3.81 acres, Q(5) = 8.8 cfs, Q(100) = 17.8 cfs). Design Point 14 from the Tutt FDR is located at the intersection of Tutt Boulevard and Sorpressa Lane, and combines the flow from Tutt Boulevard and approximately 63.5 acres to the east. The routed peak flowrates within the 54-inch RCP storm sewer are Q(5) = 120.6 cfs and Q(100) = 249.8 cfs.

2. Woodmen Vista

A portion of the runoff from the Woodmen Towne Center drains to the north through the Woodmen Vista subdivision. Berms were created with the development of the Woodmen Vista subdivision to direct the runoff to a concrete chase located between lots 15 and 16 of this subdivision. The 8-foot curb chase routes the stormwater to Crestone Peak Trail where it flows along the curb and gutter to enter the storm sewer system within Sorpressa Lane. The Final Drainage Report for Woodmen Vista Filing No. 1 & 2 and Amendment to the Master Development Drainage Report for Cumbra Vista Subdivision, by Matrix Design Group, dated November 2007 (Woodmen Vista FDR), specified that this development will accept the peak historic flow through their site. Design Point 11 from the Woodmen Vista FDR identified the peak historic flowrates as Q(5) = 11.6 cfs and Q(100) = 24.7 cfs.

3. Woodmen Road

Woodmen Road is currently under construction to be a six lane street section from Powers Boulevard to Tutt Boulevard and then transition to a four lane section from Tutt to US Highway 24. The Final Hydrology and Hydraulics Report for Woodmen Road Powers to US 24, prepared by DMJM Harris, dated October 2007 (Woodmen FDR), outlined the installation of curb and gutter, roadside ditches, curb inlets, and Colorado Department of Transportation (CDOT) Type C

and D inlets as part of this project. Water quality will be provided through the roadside ditches, which will be utilized as grass swale biofilters. According to the Woodmen FDR, the swales were designed to accommodate historic flow from the Woodmen Towne Center in addition to the developed flow from the Woodmen Road improvements.

The swales for Woodmen Road that are adjacent to the Woodmen Towne Center, are routed in three directions; to the west, to the south, and to the east. The runoff flowing to the east is part of the Sand Creek Basin, which is described later in this report. Stormwater routed to the west is collected by the storm sewer infrastructure that was installed as part of the Powers Boulevard/Woodmen Road Interchange. The Woodmen FDR designed the swales to accommodate runoff from the roadway and historic flowrates from the adjacent properties including the Woodmen Towne Center. The Woodmen FDR classified the land use of the Woodmen Towne Center as undeveloped agriculture. This report will utilize the same land classification for analyzing the undeveloped basins and will detain developed flows to historic rates. Design Point 4 of the Woodmen FDR estimated peak flowrates to be Q(5) = 3.3 cfs, and Q(100) = 10.7 cfs.

The Woodmen Road swale draining to the south is captured by an existing 36" RCP located at the high point of Woodmen Road. The stormwater entering the 36" RCP is routed south of Woodmen Road to the Cottonwood Creek Channel. It is not anticipated that this outfall will be utilized with this development, however there is a potential to release at the historic rates outlined in the Woodmen FDR; at Design Point 11, Q(5) = 3.3 cfs, and Q(100) = 8.4 cfs.

B. Sand Creek Drainage Structures

As previously mentioned in this report, runoff flowing to the east is conveyed along the swale for Woodmen Road to the Sand Creek Channel. A 48-inch RCP is located approximately 600 feet north of the intersection of Black Forest Road and Woodmen Road which conveys the runoff to the Woodmen Heights development, located to the east. The Master Development Drainage Plan for Woodmen Heights, by Classic Consulting Engineers and Surveyors, dated June 2004 (Woodmen Heights MDDP) specified that their development will accept historic flowrates. The Woodmen Heights MDDP identified the historic peak flowrates as Q(5) = 20.5 cfs and Q(100) = 52.5 cfs.

C. Other Existing Facilities

On the south end of the property is an overhead electric transmission line adjacent to Woodmen Road. Currently, an easement on the north end of the site contains water and electric utilities. CSU also plans on constructing two water storage tanks in the northwest area of the property. The approximate location of the water tanks are shown on the Drainage Sub-Basin Map DR01 in Appendix D.

IV. DRAINAGE FACILITY DESIGN

The Woodmen Towne Center is a proposed 90.51 acre residential and commercial development. The site has been divided into 17 sub-basins, which were used to size detention facilities. This report recommends the utilization of five locations for detention. Refer to the Drainage Map DR02 located in Appendix D.

A. Cottonwood Creek Analysis

1. Tutt Boulevard and Woodmen Towne Center

In the northwestern corner of the Woodmen Towne Center site are sub-basins D21 (1.71 acres, Q(5) = 6.64 cfs, Q(100) = 12.70 cfs), D22 (3.96 acres, Q(5) = 15.30 cfs, Q(100) = 29.10 cfs), and D23 (2.68 acres, Q(5) = 10.20 cfs, Q(100) = 19.10 cfs). These basins were named to match the basins from the Tutt FDR. Runoff generated in these basins will be routed to the storm sewer system within Tutt Boulevard. It was assumed that retaining walls would be used to minimize the area draining to Tutt Boulevard. Design points 11 (Q(5) = 25.52 cfs, Q(100) = 48.16 cfs) and 12 (Q(5) = 32.16 cfs, Q(100) = 60.88 cfs) are the routed flows from basins D21, D22, and D23 and represent fully developed conditions. It is estimated that no detention will be required for the runoff from these basins, however, water quality treatment is expected to take place on-site.

The roadway basins for Tutt Boulevard were named D30 (2.48 acres, Q(5) = 7.25 cfs, Q(100) = 14.10 cfs) and D31 (2.69 acres, Q(5) = 7.90 cfs, Q(100) = 15.20 cfs) to match the nomenclature of the Tutt FDR. These basins drain to the north to curb inlets located at the corner of Tutt Boulevard and Sorpressa Lane.

Sub-basin D50 (0.53 acres, Q(5) = 2.40 cfs, Q(100) = 4.54 cfs) is the area draining to Tutt Boulevard roadway from the Colorado Springs Utilities access road for the 12" waterline located along the western edge of the property. It was assumed that grading activities would employ retaining walls to limit the area draining to Tutt Boulevard. The additional runoff from this basin has been routed at Design Point 14 and compared to the Tutt FDR in *Table 2.*

2. Woodmen Vista and Pond #3

As previously mentioned in this report, the Woodmen Vista subdivision will receive historic flow from the Woodmen Towne Center development; Q(5) = 11.6 cfs and Q(100) = 24.7 cfs. An 8-foot concrete chase located between lots 15 and 16 of the Woodmen Vista currently routes the historic flow from the Woodmen Towne Center. Sub-basin WV01 (13.70 acres, Q(5) = 26.40 cfs, Q(100) = 54.90 cfs) is multifamily residential land use, which will utilize the Woodmen Vista curb chase as its outfall. A private detention pond with a sand filter basin is recommended for basin WV01, and is labeled Pond #3. A 36-inch RCP trunk storm sewer line is recommend for conveying the runoff to Pond #3, and a 30-inch RCP storm line is recommended for conveying the release from the pond to the Woodmen Vista subdivision. The flow entering the Woodmen Vista subdivision shall not exceed historic rates.

The Woodmen Vista concrete chase routes the stormwater to Crestone Peak Trail, where the runoff is conveyed to the north via the curb and gutter of the roadway. Comparing the proposed

hydrograph with the historic hydrograph yielded the additional time that runoff would be present in Crestone Peak Trail. It was assumed that 1.0 cfs could be considered minimal or nuisance flow, and thus act as a baseline. In the historic condition, the peak flowrate exceed the 1.0 cfs threshold for approximately 86 minutes. In the developed condition, the routed flowrate exceeded the 1.0 cfs threshold for approximately 162 minutes. Therefore, the additional amount of time the residents of Crestone Peak Trial would see runoff within their street would be approximately 76 minutes.

3. Prairie Vista

The Woodmen Vista FDR assumed only historic runoff would be released from the Prairie Vista subdivision. The area was divided into two historic sub-basins: OS-4 (8.15 acres, Q(5) = 6.7 cfs, Q(100)= 14.3 cfs) and OS-5 (15.54 acres, Q(5) = 12.4 cfs, Q(100)= 26.5 cfs). The Prairie Vista Final Drainage Report (Prairie Vista FDR) has been reviewed by the City. The assumption made in the Woodmen Towne Center MDDP is that the Prairie Vista development will construct an extended detention basin, and the peak release will be Q(5) = 24.5 cfs, Q(100) = 48.2 cfs. Design Point 13 is the combination of flow from the Woodmen Vista FDR and the Prairie Vista FDR resulting in the following peak flowrates; Q(5) = 27.19 cfs, and Q(100) = 69.06 cfs.

4. Tutt Boulevard and Sorpressa Lane

The Tutt FDR assumed that approximately 18 acres of the Woodmen Towne Center would outlet through the Woodmen Vista subdivision. The flow was assumed to be from a fully developed commercial area without detention. The Woodmen Vista FDR specified that they would only accept historic flow rates from the Woodmen Towne Center. Therefore the peak runoff listed at design point 14 in the Woodmen Vista FDR is for the ultimate condition with historic flow from the Woodmen Towne Center. The peak flow rate at Design Point 14 of the Woodmen Vista FDR was determined to be Q(5) = 9.20 cfs, Q(100) = 32.60 cfs at a time of concentration of 35.2 minutes.

Design Point 14 routes the flows from Tutt Boulevard and Woodmen Towne Center (sub-basins D21, D22, D23, D30, D31, D50), the Woodmen Vista subdivision and the Prairie Vista subdivision. Peak flowrates were determined to be substantially less than the runoff estimated in the Tutt FDR, resulting in no detention for basins D21, D22, and D23. Much of this decrease in flow can be attributed to the decrease in drainage area as well as the detention of area draining through the Woodmen Vista subdivision. *Table 2* provides a comparison of the peak runoff presented in this report with the flows estimated in the Tutt FDR.

Table 2: Peak Runoff Comparison for Tutt Boulevard

Basin	Tutt FDR Peak Runoff			Proposed Peak Runoff		
	Area	Q(5)	Q(100)	Area	Q(5)	Q(100)
D21	1.47	3.8	7.6	1.71	6.64	12.7
D22	3.48	8.7	17.8	3.96	15.3	29.1
D23	6.27	15.4	31.4	2.68	10.2	19.1
D30	2.55	5.9	11.9	2.48	7.25	14.1
D31	3.81	8.8	17.8	2.69	7.9	15.2
D50	-	-	-	0.53	2.4	4.54
Design Points	**Tutt FDR Peak Runoff**			**Proposed Peak Runoff**		
DP11	9.75	23.3	47.4	2.68	25.52	48.16
DP12	11.22	25.8	52.4	4.39	32.16	60.88
DP13	63.67	92.6	194.1	51.30	27.19	68.06
DP14	81.25	**120.6**	**249.8**	61.39	**52.29**	**115.99**

5. Woodmen Road and Pond #4

Sub-basin WW01 (9.57 acres, Q(5) = 35.00 cfs, Q(100) = 66.70 cfs) is located in the southwestern corner of the development between Tutt Boulevard and Woodmen Road. The historic flow generated is Q(5) = 7.11 cfs and Q(100) = 19.30 cfs, which is conveyed to the west via the grassy swale along Woodmen Road. A detention facility releasing at historic rates will require approximately 21,000 cubic-feet of detention. An easement containing overhead electric transmission lines and poles encumber the southern end of this basin, and CSU will not allow detention facilities within their easement. Due to the site constraints from the easement, underground detention will be necessary for this basin. The City does not currently allow underground detention, however they recognize that there may not be another option and are willing to consider it for this location. A recommended detention system consisting of four barrels of 72-inch pipe, 187 feet long each with a bulkhead welded to the outlet to control the release rate. Porous landscaped detention (PLD) will allow multiple water quality treatment locations and serves as a viable option for water quality treatment. Preliminary analysis revealed that a significant amount of the landscaped area will be required for treatment. Therefore to meet water quality requirements, the installation of some form of water quality inlets may be coupled with the PLD islands as necessary. A 30-inch RCP trunk system is recommended for routing the flows into the detention facility, and a 24-inch RCP is recommended for the flows out of the detention facility to the swale.

B. Sand Creek Analysis

The remaining portion of Woodmen Towne Center will flow to the west and eventually into Sand Creek. The Woodmen Heights MDDP identified 54.9 acres of drainage area from the Woodmen Towne Center releasing historic flows across their property (Q(5) = 20.5 cfs and Q(100) = 52.5 cfs). Three detention and water quality facilities will be required; Pond #1, Pond #2, and Pond #2A.

1. Public Road

There is a collector roadway that runs east-west from the roundabout to Black Forest Road. The land will be dedicated to the City through means of right of way. The storm sewer system within this roadway will also be dedicated to the City and will be separate from the private systems in Woodmen Towne Center. The road is composed of four drainage basins RD01 (1.72 acres, Q(5) = 6.11 cfs, Q(100) = 11.60 cfs), RD02 (1.40 acres, Q(5) = 4.87 cfs, Q(100) = 8.66 cfs), RD03 (1.51 acres, Q(5) = 5.89 cfs, Q(100) = 10.50 cfs), and RD04 (1.38 acres, Q(5) = 5.27 cfs, Q(100) = 10.20 cfs). Runoff generated within the roadway will not be detained or undergo any water quality treatment. Design point 1 (Q(5) = 10.39 cfs, Q(100) = 19.15 cfs), design point 2 (Q(5) = 15.19 cfs, Q(100) = 27.68 cfs), and design point 3 (Q(5) = 19.53 cfs, Q(100) = 36.04 cfs) reflect the peak flowrates generated within the road. The peak flowrate that the Woodmen Towne Center can release is the difference between the historic (52.5 cfs) and Design Point 3 (36.04 cfs); Q(100) = 16.46 cfs. This report will assume a design release of 16 cfs. A 30-inch RCP trunk storm system is recommended for routing the flows to the east.

2. Pond #1

Located southeast of Tutt Boulevard roundabout is sub-basin SC01 (20.10 acres, Q(5) = 68.10 cfs, Q(100) = 121.00 cfs). This basin is entirely commercial development, and runoff generated will be routed to the northeast to Pond #1. There is a 24-inch pipe that crosses under the high point in Woodmen Road, this report makes the assumption that this outlet will not be utilized for runoff. A 48-inch RCP trunk system is recommended for routing the flows to the northeast.

Northeast of sub-basin SC01 is sub-basin SC02 (15.00 acres, Q(5) = 55.00 cfs, Q(100) = 97.80 cfs). Runoff from basin SC01 is combined with flows from SC02 at design point 4 (Q(5) = 109.59 cfs, Q(100) = 195.07 cfs) and routed to Pond #1. The volume of Pond #1 was designed to maximize the available detention area while still providing water quality for basins SC01 and SC02. The approximate detention volume required for releasing flow from Pond #1 at 16.5 cfs is 212,000 cubic-feet. A sand filter basin is recommended for providing water quality within Pond #1. It was assumed that the sand filter basin would be 3-foot in depth and constructed with retaining walls to maximize the available volume. Refer to Appendix B for a conceptual cross-section of Pond #1.

3. Ponds #2 and #2A

Sub-basins SC03 (13.20 acres, Q(5) = 37.50 cfs, Q(100) = 66.70 cfs) and SC05 (3.95 acres, Q(5) = 18.40 cfs, Q(100) = 32.70 cfs) drain to Pond #2. The land use of basin SC03 is entirely commercial development. The land use of basin SC05 is unknown at this time (at one point it was slated to be a Park-N-Ride location), so it was assumed to be commercial development as

well. Runoff within each basin is routed to the northeast at Design Point 5 (Q(5) = 48.69 cfs, Q(100) = 86.68 cfs). A sand filter basin is recommended for providing water quality within Pond #2. It was assumed that the sand filter basin would be approximately 3-foot in depth and constructed with retaining walls to maximize the available volume. Refer to Appendix B for a conceptual cross-section of Pond #2. Pond #2 and Pond #2A will act as one detention basin; they will be connected to maximize the available detention volume on the east side of the property.

Basin SC04 (2.80 acres, Q(5) = 12.80 cfs, Q(100) = 22.70 cfs) is located in the northeastern portion of the site and drains to Pond #2A. A sand filter basin at the bottom of Pond #2A is recommended for treatment of water quality, however the use of PLD or other water quality structures could be easily employed in this location. Pond #2 will contain the outlet structure, such that Pond #2A will need to drain to Pond #2. The outlet from Pond #1 will also drain to Pond #2 (16.5 cfs at a time of concentration of 44 minutes). As previously mentioned, the release of Pond #2 was determined by finding the difference between the Woodmen Heights MDDP and the routed peak flow from the proposed public roadway. The approximate required detention for a 16 cfs release rate is 146,000 cubic-feet. The approximate available detention of Ponds #2 and #2A is 179,000 cubic–feet, so the development will detain the runoff to historic flowrates while treating the basins for water quality within the ponds.

C. Timing of Improvements

Several drainage facilities need to be installed with the development of the Woodmen Towne Center. These improvements are summarized in *Table 3* below.

Table 3: Summary of Necessary Improvements

BASIN	LOCATION OF WATER QUALITY FACILITY	LOCATION OF DETENTION FACILITY
D21	ON-SITE	NOT REQ'D
D22	ON-SITE	NOT REQ'D
D23	ON-SITE	NOT REQ'D
WV01	POND #3	POND #3
WW01	POND #4	POND #4
SC01	POND #1	POND #1
SC02	POND #1	POND #1
SC03	POND #2	POND #2
SC04	POND #2A	POND #2A
SC05	POND #2	POND #2

The basins which outfall to Cottonwood Creek may be developed independently of each other due to the fact that the downstream storm sewer infrastructure of each basin is completed. Ponds #3 and #4 will need to be developed with their corresponding basins. It was assumed that Ponds #2 and #2A will be constructed with the initial development of the basins draining east to Sand Creek. The installation of these ponds would limit the runoff to historic levels. There is a potential to develop Pond #1 prior to Ponds #2 and #2A, however more drainage analysis will be

needed than what is presented within this report. All ponds will be privately owned and maintained.

D. Drainage, Bridge, and Pond Fees

The Woodmen Towne Center has not been previously platted. The 2008 bridge and drainage fees as published by the City of Colorado Springs has been assessed to this site. The Woodmen Towne Center straddles the basin line between the Sand Creek and Cottonwood Creek drainage basins. The fees are based upon platted acreage and have been calculated in Table 4.0 below.

Table 4.0 Drainage, Bridge and Pond Fees

BASIN	AREA	DRAINAGE	BRIDGE	POND		TOTAL
	ACRE	FEE/ACRE	FEE/ACRE	LAND	FACILITIES	
COTTONWOOD CREEK	31.9	$ 11,043	$ 844	$ -	$ -	**$ 379,195**
SAND CREEK	58.1	$ 9,041	$ 568	$ 1,070	$ 2,744	**$ 779,876**

TOTAL FEES OWED TO THE CITY OF COLORADO SPRINGS $ 1,159,071

There are no proposed drainage infrastructure improvements to be completed with this project that have been outlined in the Drainage Basin Planning Study (DBPS) for Cottonwood Creek or Sand Creek. The drainage and bridge fees in the amount of $ 1,159,071 will be due at the time of plat recording.

The development is expected to occur in phases, which have been delineated in a phasing map located within Appendix A. The drainage and bridge fees per phase are outlined in Table 4.1 below.

Table 4.1 Drainage, Bridge and Pond Fees Per Phase

Cottonwood Creek Fees						
Phase	**Area**	**Drainage**	**Bridge**	**Pond**		
	ACRE	FEE/ACRE	FEE/ACRE	LAND	FACILITIES	**Sub-Total**
I	18.6	$ 11,043	$ 844	$ -	$ -	$ 221,098
II	11.5	$ 11,043	$ 844	$ -	$ -	$ 136,701
III	17.1	$ 11,043	$ 844	$ -	$ -	$ -
IV	39.5	$ 11,043	$ 844	$ -	$ -	$ -
V	1.8	$ 11,043	$ 844	$ -	$ -	$ 21,397

Total Cottonwood Creek Drainage Basin Fees $ 379,195

Sand Creek Fees						
Phase	**Area**	**Drainage**	**Bridge**	**Pond**		
	ACRE	FEE/ACRE	FEE/ACRE	LAND	FACILITIES	**Sub-Total**
I	1.5	$ 9,041	$ 568	$ 1,070	$ 2,744	$ 20,135
II	11.5	$ 9,041	$ 568	$ 1,070	$ 2,744	$ -
III	17.1	$ 9,041	$ 568	$ 1,070	$ 2,744	$ 229,533
IV	39.5	$ 9,041	$ 568	$ 1,070	$ 2,744	$ 530,209
V	1.8	$ 9,041	$ 568	$ 1,070	$ 2,744	$ -

Total Sand Creek Drainage Basin Fees $ 779,876

V. Conclusion

The proposed Woodmen Towne Center is in compliance with Volume I and II of the City Drainage Criteria Manual, dated November 1991, and the DBPS for Cottonwood Creek and Sand Creek. The overall design concept does not negatively impact downstream storm sewer infrastructure, and coincides with the previously approved drainage reports from the surrounding properties. As previously stated under developed conditions, no offsite flow draining to this property will be accepted and peak runoff rates leaving this development will be detained to historic levels.

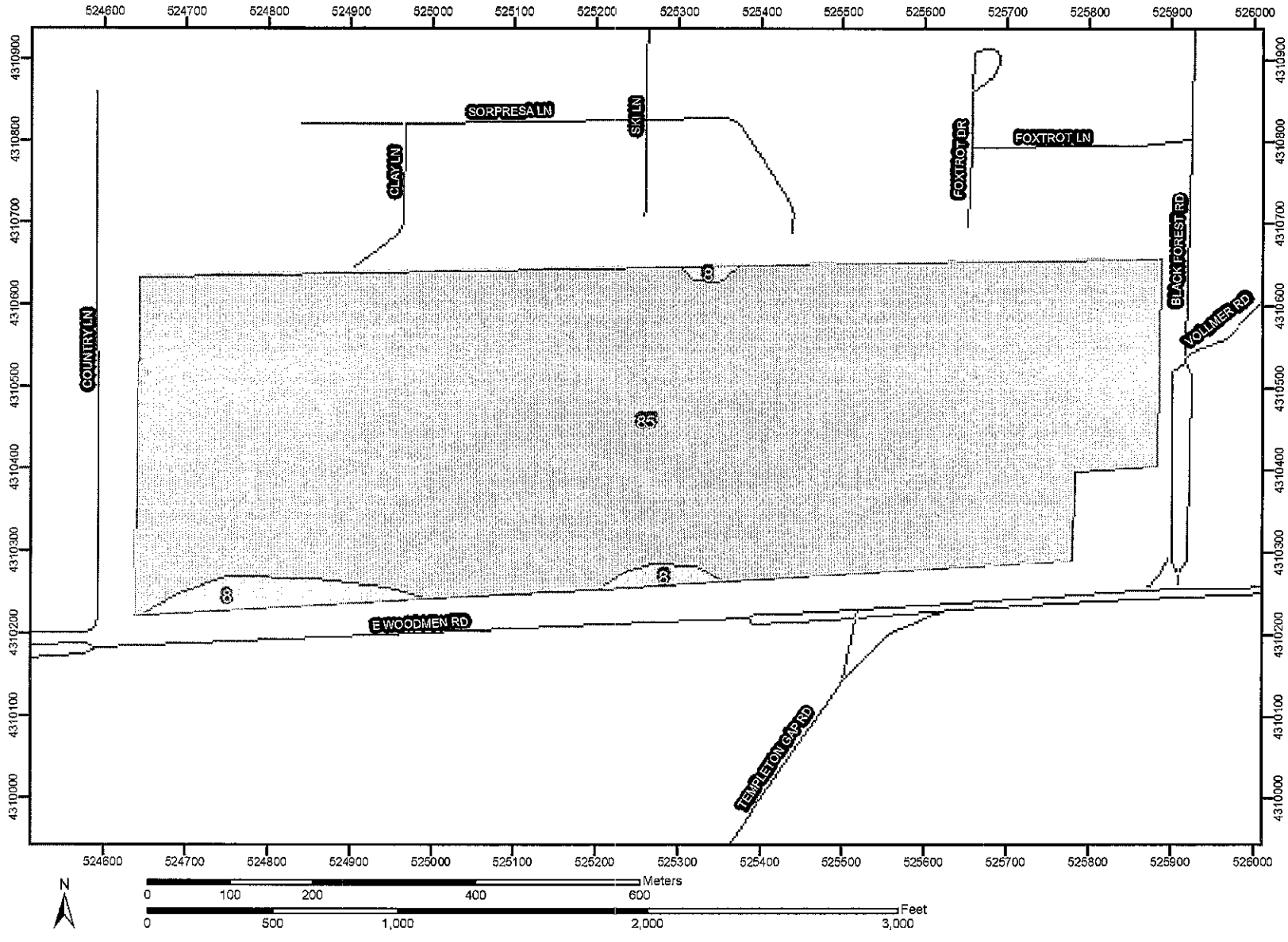
VI. REFERENCES

1. ***Drainage Basin Planning Study for Sand Creek***, Kiowa Engineering, revised March 1996.
2. ***City of Colorado Springs & El Paso County Drainage Criteria Manual***, dated November 1991.
3. ***FEMA Flood Insurance Rate Map***, El Paso County Colorado and Incorporated Areas, Panels 751 and 753 of 1300. March 17, 1997.
4. ***Soil Survey of El Paso County Area, Colorado***. United States Department of Agriculture Soil Conservation Service. Issued June 1981.
5. ***Urban Storm Drainage Criteria Manual, Volumes 1-3***, Urban Drainage and Flood Control District, June 2001 and subsequent updates.
6. ***Master Development Drainage Plan for Woodmen Heights Master Plan***, Classic Consulting Engineers and Surveyors, dated June 2004.
7. ***Master Development Drainage Plan for The Ridge at Woodmen,*** by Law and Mariotti Consulting, dated March 2004.
8. ***Final Drainage Report Powers Boulevard and Woodmen Road Interchange***, CDOT Project STU R200-097, by URS, dated March 14, 2003.
9. ***Preliminary/Final Drainage Report for Tutt Boulevard Filing No. 4, Woodmen Road to Cowpoke Road***, by Matrix Design Group, Inc., dated April 2005.

APPENDIX A

MAPS

Hydrologic Soil Group--El Paso County Area, Colorado
(Woodmen Towne Center)



MAP LEGEND

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

Soils
- Soil Map Units

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

Political Features

Municipalities
- Cities
- Urban Areas

Water Features
- Oceans
- Streams and Canals

Transportation
- Rails

Roads
- Interstate Highways
- US Routes
- State Highways
- Local Roads
- Other Roads

MAP INFORMATION

Original soil survey map sheets were prepared at publication scale. Viewing scale and printing scale, however, may vary from the original. Please rely on the bar scale on each map sheet for proper map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 13N

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

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 4, Dec 20, 2006

Date(s) aerial images were photographed: 1999

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

Hydrologic Soil Group

Hydrologic Soil Group— Summary by Map Unit — El Paso County Area, Colorado				
Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
8	Blakeland loamy sand, 1 to 9 percent slopes	A	3.1	2.7%
85	Stapleton-Bernal sandy loams, 3 to 20 percent slopes	B	112.9	97.3%
Totals for Area of Interest (AOI)			116.1	100.0%

Description

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

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

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

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

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

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

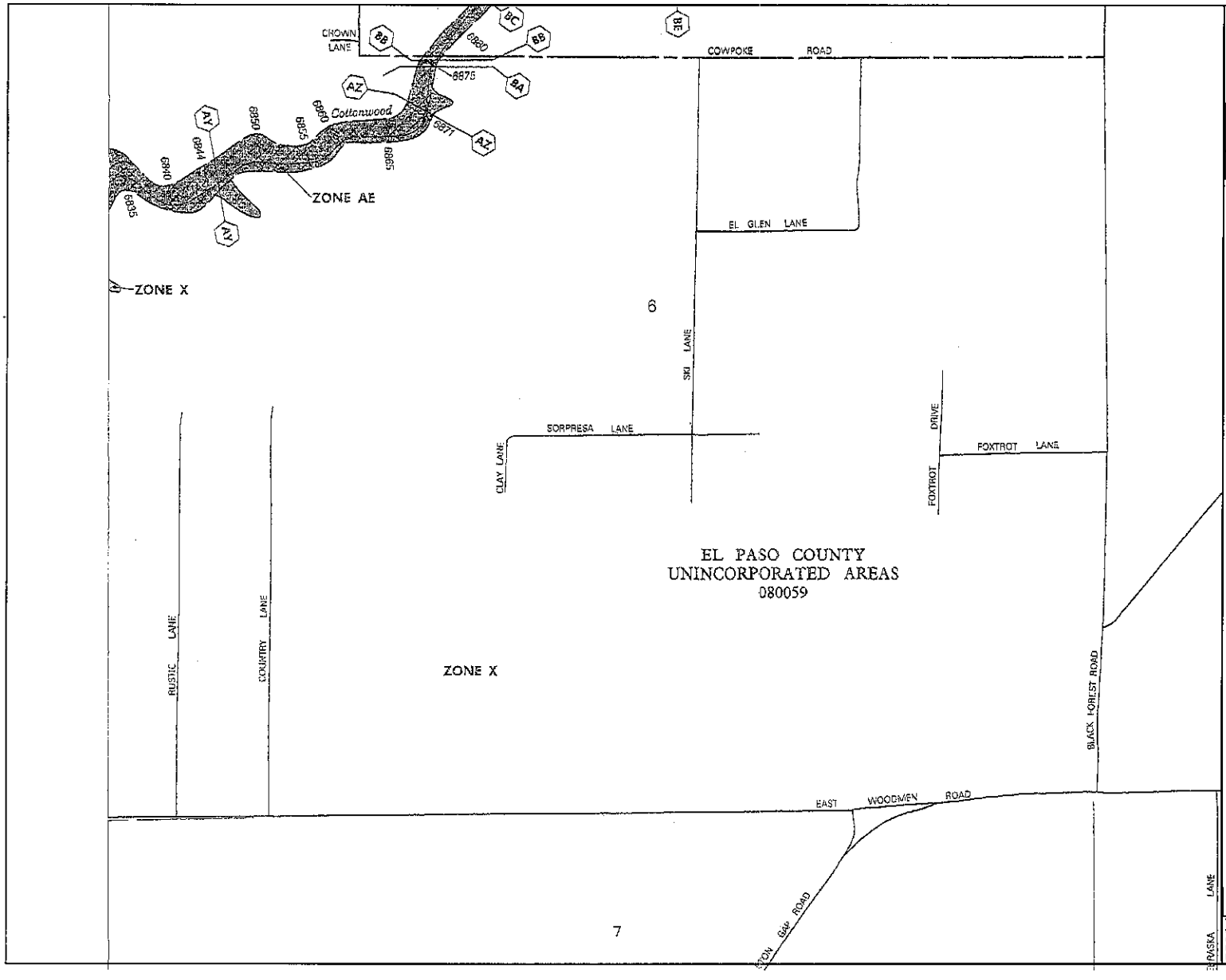
If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: *None Specified*

Tie-break Rule: Lower



APPROXIMATE SCALE IN FEET

500 0 500

NATIONAL FLOOD INSURANCE PROGRAM

FIRM

FLOOD INSURANCE RATE MAP

EL PASO COUNTY, COLORADO AND INCORPORATED AREAS

PANEL 529 OF 1300

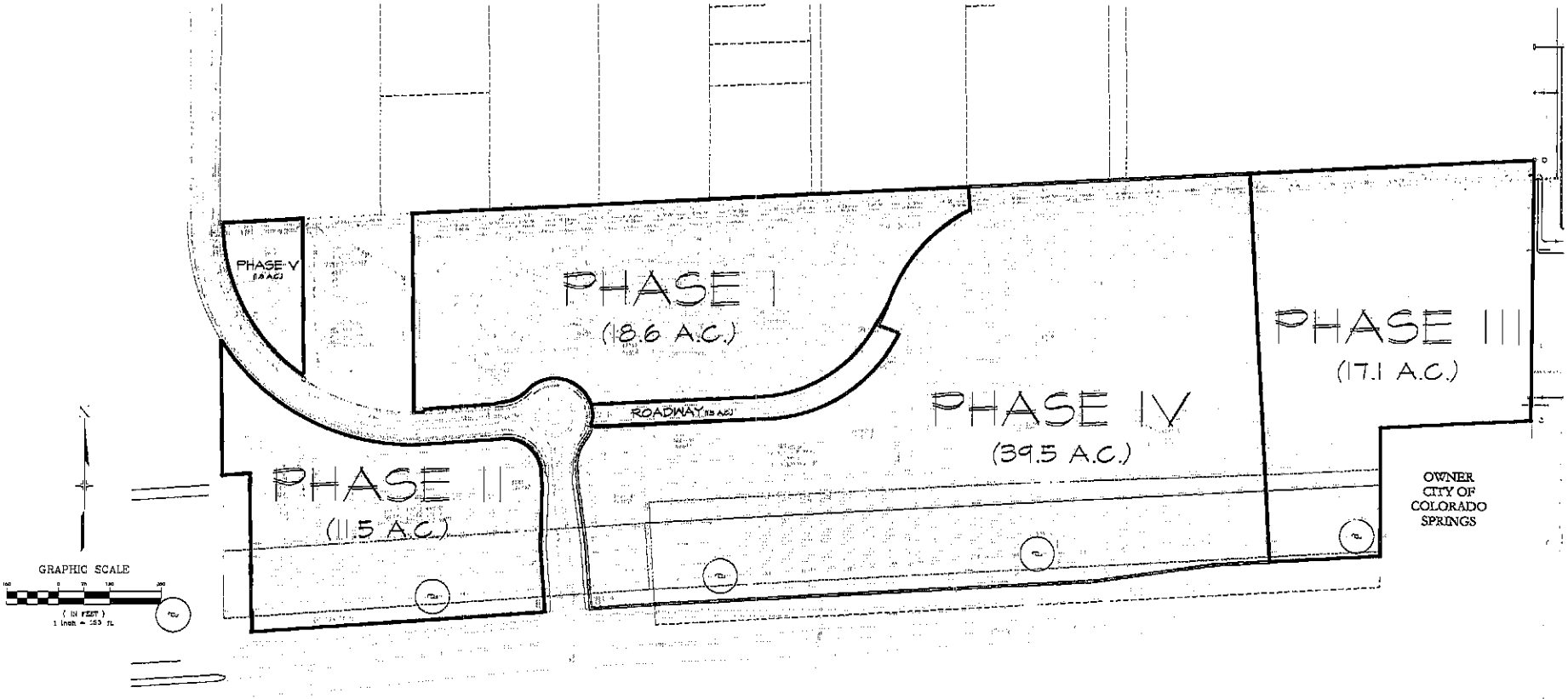
(SEE MAP INDEX FOR PANELS NOT PRINTED)

CONTAINS: COMMUNITY	NUMBER	PANEL	SUFFIX
COLORADO SPRINGS, CITY OF	080060	0529	F
EL PASO COUNTY, UNINCORPORATED AREAS	080059	0529	F

MAP NUMBER
08041C0529 F

EFFECTIVE DATE:
MARCH 17, 1997

Federal Emergency Management Agency



PHASING PLAN

City Planning File Number:
CPC PUZ 07-344
CPC PUP 07-345

Matrix Design Group, Inc.
Integrated Design Solutions
2435 Research Parkway, Suite 300
Colorado Springs, CO 80920
Phone 719-575-0100
Fax 719-575-0208

APPENDIX B

HYDROLOGIC AND HYDRAULIC CALCULATIONS

Matrix Design Group, Inc.
Integrated Design Solutions
Infrastructure Engineering
Community Development
Program Management

Individual Basin Hydrology

Sub-Basin Data			Runoff Coefficients		CA		Initial/Overland Time (T_i)			Pavement Travel Time (T_t)				Pipe Travel Time (T_t)				Tc Check			Final T_c	*4 Intensity		Peak Runoff		Remarks
Basin	Area (sqft,ac)		C(5)	C(100)	CA(5)	CA(100)	Length (ft)	Slope (%)	* T_i (min)	Length (ft)	Slope (%)	*3 Vel. (fps)	*2 T_t (min)	Length (ft)	Slope (%)	*7 Vel. (fps)	Tt (min)	Total Tt (min)	*8 Tc = (L/180)+10 (min)		(min)	I(5) in/hr	I(100) in/hr	Q(5)	Q(100)	
D21	74553	1.71	0.75	0.80	1.30	1.40														*6	5.00	5.10	9.09	6.64	12.70	Neighborhood Commercial
D22	172282	3.96	0.75	0.80	3.00	3.20														*6	5.00	5.10	9.09	15.30	29.10	Water Tanks (Light Industrial)
D23	116951	2.68	0.75	0.80	2.00	2.10														*6	5.00	5.10	9.09	10.20	19.10	Neighborhood Commercial
D30	108128	2.48	0.90	0.95	2.20	2.40														*5	16.70	3.29	5.86	7.25	14.10	Public Roadway
D31	117271	2.69	0.90	0.95	2.40	2.60														*5	16.70	3.29	5.86	7.90	15.20	Public Roadway
D50	22855	0.53	0.90	0.95	0.47	0.50														*6	5.00	5.10	9.09	2.40	4.54	Public Roadway
WW01	594790	13.70	0.60	0.70	8.20	9.60	150	5.3%	11.87	530	2.0%	3.0	2.94	825.00		5.00	2.75	17.56	18.36		17.56	3.21	5.72	26.40	54.90	Multi-family
EX-WW01	416802	9.57	0.20	0.30	1.90	2.90	100	7.0%	8.86	400	6.3%	1.8	3.70					12.56	12.78	*5	12.56	3.74	6.66	7.11	19.30	Historical
WW01	416802	9.57	0.75	0.80	7.20	7.70	81	12.50	1.44	600	1.3%	2.20	4.55					5.99	13.78	*8	5.99	4.86	8.66	35.00	66.70	Neighborhood Commercial
RD01	75091	1.72	0.90	0.95	1.50	1.60	25.00	2.0%	6.69	625.00	2.0%	3.00	3.47					10.17	13.61		10.17	4.08	7.26	6.11	11.60	Public Roadway
RD02	61132	1.40	0.90	0.95	1.30	1.30	25.00	2.0%	6.69	775.00	1.5%	2.20	5.87					12.57	14.44		12.57	3.74	6.66	4.87	8.66	Public Roadway
RD03	65758	1.51	0.90	0.95	1.40	1.40	25.00	2.0%	6.69	800.00	5.0%	5.00	2.67					9.36	14.58		9.36	4.20	7.48	5.89	10.50	Public Roadway
RD04	59981	1.38	0.90	0.95	1.20	1.30	25.00	2.0%	6.69	475.00	5.0%	5.00	1.58					8.28	12.78		8.28	4.39	7.82	5.27	10.20	Public Roadway
SC01	875040	20.10	0.90	0.90	18.00	18.00	25.00	2.0%	6.69	285.00	2.0%	3.00	1.58	1188.00		5.00	3.96	12.24	18.32		12.24	3.78	6.74	68.10	121.00	Commerical
SC02	654193	15.00	0.90	0.90	14.00	14.00	25.00	2.0%	6.69	525.00	3.0%	3.50	2.50	600.00		5.00	2.00	11.19	16.39		11.19	3.93	6.99	55.00	97.80	Commerical
SC03	573627	13.20	0.90	0.90	12.00	12.00	75.00	2.0%	11.60	435.00	2.0%	3.00	2.42	1392.00		5.00	4.64	18.65	20.57		18.65	3.12	5.56	37.50	66.70	Commerical
SC04	121769	2.80	0.90	0.90	2.50	2.50														*	5.00	5.10	9.09	12.80	22.70	Commerical
SC05	172072	3.95	0.90	0.90	3.60	3.60															5.00	5.10	9.09	18.40	32.70	Commerical

Location S:\07.187.003 (Woodmen Town Center)\300-Water Resources\303 MDDP\ray\[RAY-HYDRO.xls]Hydro
By Rich Eastland
Project: Woodmen Towne Center
Printed 11/24/2008 8:26

* - Colorado Springs Drainage Criteria Manual $Tc = 1.87(1.1-C)L^{0.5}S^{-0.33}$, where C = 0.2

*2 - Tt = Length/Velocity

*3 - Urban Drainage Figure RO-1

*4 - Colorado Springs Drianage Criteria Manual

$I(5) = (26.65*1.5)/(10+T_c)^{0.76}$

$I(100) = (26.65*2.67)/(10+T_c)^{0.76}$

*5 - FDR Tutt Blvd., time of conc = 16.7 minutes

*6 - Assumed a 5 minute time of concentration

*7 - Assumed a velocity of 5 feet per second

*8 - Urban Drainage (for urbanized basins only)

Matrix Design Group, Inc.
Integrated Design Solutions
Infrastructure Engineering
Community Development
Program Management

Routed Hydraulic Calculations

Routed			*CA*		*Initial/Overland Time (T_i)*			*Pavement Travel Time (T_t)*				*Pipe Travel Time (T_t)*			*Tc Check*		*Final Tc*	**4 Intensity*		*Peak Runoff*	
Sub-Basin	Design Point	Area (ac)	CA(5)	CA(100)	Length (ft)	Slope (%)	* T_i (min)	Length (ft)	Slope (%)	*3 Vel. (fps)	*2 T_t (min)	Length (ft)	*7 Vel. (fps)	Tt (min)	Total Tt (min)	*8 Tc = (L/180)+10 (min)				Q(5)	Q(100)
RD01, RD02	1	3.12	2.80	2.90	25	2.0%	6.69	625	2.0%	3.0	3.47	800	5.0	2.67	12.83	13.61	12.83	3.71	6.60	10.39	19.15
RD01, RD02, RD03	2	4.63	4.20	4.30	25	2.0%	6.69	625	2.0%	3.0	3.47	1625	5.0	5.42	15.58	13.61	13.61	3.62	6.44	15.19	27.68
RD01, RD02, RD03, RD04	3	6.01	5.40	5.60	25	2.0%	6.69	625	2.0%	3.0	3.47	2515	5.0	8.38	18.55	13.61	13.61	3.62	6.44	19.53	36.04
SC01 & SC02	4	35.10	32.00	32.00	25	2.0%	6.69	285	2.0%	3.0	1.58	2125	5.0	7.08	15.36	23.53	15.36	3.42	6.10	109.59	195.07
SC03 & SC05	5	17.15	15.60	15.60	75	2.0%	11.60	435	2.0%	3.0	2.42	1392	5.0	4.64	18.65	20.57	18.65	3.12	5.56	48.69	86.68
D22, D23	11	6.64	5.00	5.30											5.00			5.10	9.09	25.52	48.16
DP11, D21	12	8.35	6.30	6.70											5.00			5.10	9.09	32.16	60.88
Woodmen Vista FDR (DP15 ultimate)		*37.72*	*4.17*	*8.29*											*35.20*			*2.21*	*3.93*	*9.2*	*32.8*
Prarie Vista (D20)		*13.58*	*8.15*	*9.03*											*20.18*			*3.00*	*5.34*	*24.4*	*48.2*
Woodmen Vista FDR, Prarie Vista FDR	13	51.30	12.32	17.32											35.20			2.21	3.93	27.19	68.06
DP12, DP13, D30, D31, D50	14	65.35	23.69	29.52											35.20			2.21	3.93	52.29	115.99

Location S:\07.187.003 (Woodmen Town Center)\300-Water Resources\303 MDDP\ray\[RAY-HYDRO.xls]Hydro
By Rich Eastland
Project: Woodmen Towne Center
Printed 11/24/2008 8:26

* - Colorado Springs Drainage Criteria Manual $Tc = 1.87(1.1-C)L^{0.5}S^{-0.33}$, where C = 0.2

*2 - Tt = Length/Velocity

*3 - Urban Drainage Figure RO-1

*4 - Colorado Springs Drianage Criteria Manual

*5 - FDR Tutt Blvd., time of conc = 16.7 minutes

*6 - Assumed a 5 minute time of concentration

*7 - Assumed a velocity of 5 feet per second

*8 - Urban Drainage (for urbanized basins only)

Available Volume
(Based upon CAD layout and available pond volume for alloted area)

Pond #1

	Elevation	*Area*	*Avg Area*
0	6911	22179	
1	6912	23951	23065
2	6913	25781	26724
3	6914	27667	28638
4	6915	29609	30608.5
5	6916	31608	32635.5
6	6917	33663	34719
7	6918	35775	35775

Pond #1 Volume ***212,165***

Pond #2

	Elevation	*Area*	*Avg Area*
0	6911	11062	
1	6912	13121	12091.5
2	6913	15240	14180.5
3	6914	17417	16328.5
4	6915	19653	18535
5	6916	21947	20800
6	6917	24301	23124
7	6918	26713	25507

Pond #2 Volume ***130,567***

Pond #2A

	Elevation	*Area*	*Avg Area*
0	6911	3585	
1	6912	4350	3968
2	6913	5173	5173
3	6914	6052	5613
4	6915	6988	6520
5	6916	7982	7485
6	6917	10138	9060
7	6918	11302	10720

Pond #2A Volume ***48,538***

Pond #2	130,567
Pond #2A	48,538

179,105 Total Volume For Ponds #2 and #2A

Design Procedure Form: Sand Filter Basin (SFB)

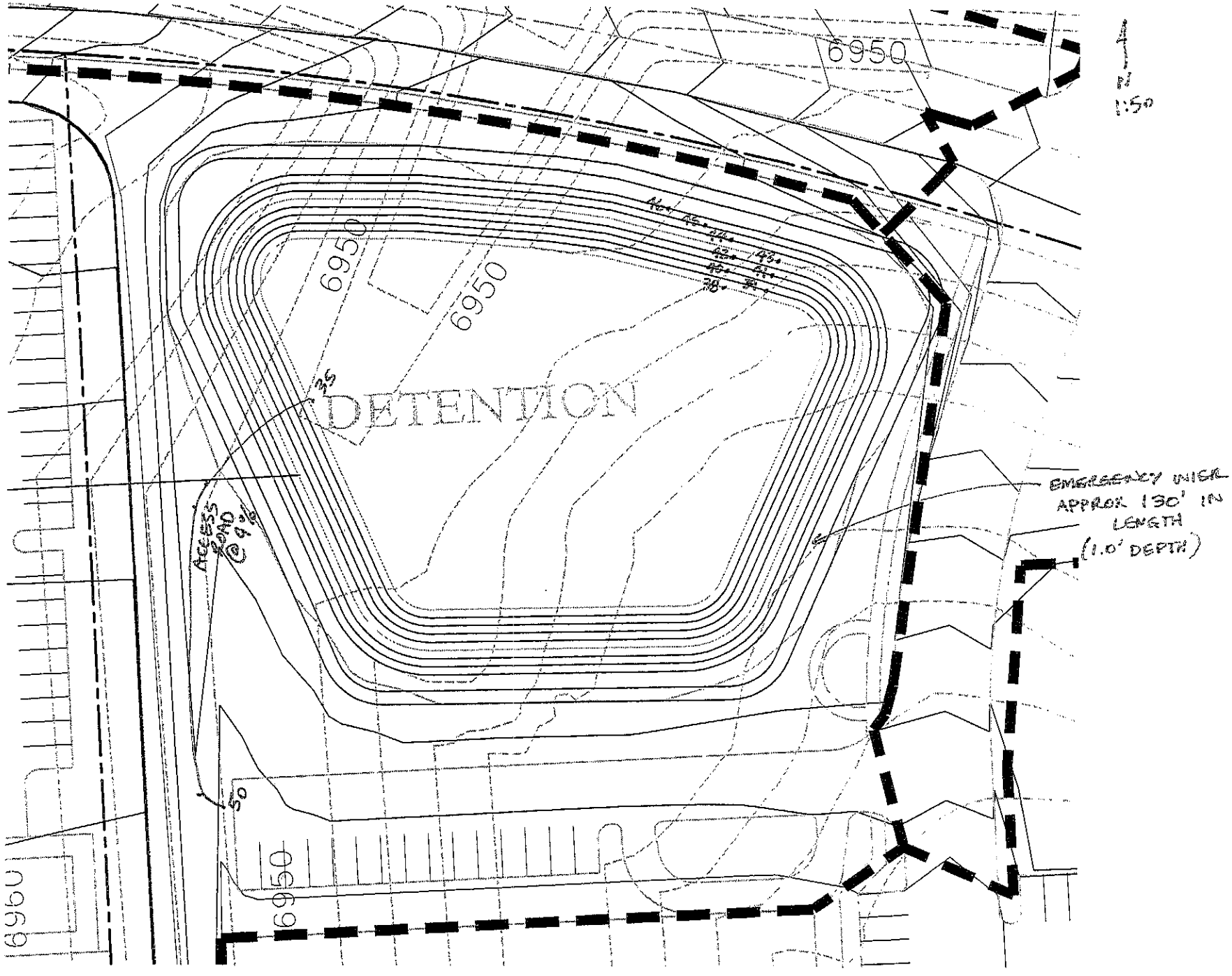
Designer:	Rich Eastland
Company:	Matrix Design Group
Date:	April 23, 2008
Project:	Woodmen Towne Center
Location:	Pond #1, basins SC01, SC02

1. Basin Storage Volume	
A) Tributary Area's Imperviousness Ratio ($i = I_a / 100$)	I_a = 100.00 % i = 1.00
B) Contributing Watershed Area (Area)	Area = 35.1000 acres
C) Water Quality Capture Volume (WQCV) $(WQCV = 1.0 * (0.91 * I^3 - 1.19 * I^2 + 0.78 * I))$	WQCV = 0.50 watershed inches
D) Design Volume: Vol = (WQCV / 12) * Area	Vol = 1.4625 acre-feet
2. Minimum Filter Surface Area: $A_s = (Vol / 3) * 43{,}560$	A_s = 21,236 square feet, Minimum
Actual Filter Surface Area Used (Should not be less than minimum):	A_s = 21,236 square feet,
Filter Surface Elevation	0.00 feet
Average Side Slope of the Filter Basin (4:1 or flatter, zero for vertical walls)	Z = 0.0 Using Vertical Walls
3. Estimate of Basin Depth (D), based on filter area A_s	D = 3.0 feet
* 4. Outlet Works	
A) Sand (ASTM C-33) Layer Thickness (18" min.)	_____ inches
B) Non-Woven Geotextile Fabric Between Sand & Gravel - meeting ASTM D4751 - AOS U.S. Std. Seive #50 to #70. Min. Grab Strength of 100 lbs., min. permitivity of 1.8 / sec.	_____ Non-Woven Geotextile Per USDCM Figure SFB-1 _____ Other: _____
C) Gravel (AASHTO or CDOT Section 703; #4, #57, or #67) Thickness (8" min.)	_____ inches, No. _____
D) Overflow Elevation At Top of Design Volume (Filter Surface Elev. + Estimate of Basin Depth (D))	3.00 feet
4. Basin Inlet	
A) Inlet Pipe with Impact Basin; OR Inlet Channel with Grouted Sloping Boulder Drop; OR Inlet Channel with Concrete Baffle Chute Drop	[ ] Inlet Pipe with Impact Basin; OR [ ] Inlet Channel with GSB Drop; OR [ ] Inlet Channel with Baffle Chute Drop
B) Riprap Outlet Protection For Pipe or Channel Over Non-Woven Geotextile Fabric Wrapped to the Top of the Sand Layer	_____ Riprap Outlet Protection _____ Other: _____
5. Draining of Sand Filter Basin (Check A, or B, or C, answer D) Based on answers to 5A through 5D, check the appropriate method	[X] Infiltration to Subgrade with Permeable Membrane: 5(C) checked **and** 5(D) = no
A) Check box if subgrade is heavy or expansive clay [ ] B) Check box if subgrade is silty or clayey sands [ ] C) Check box if subgrade is well-draining soils [X]	_____ Underdrain with Impermeable Membrane: 5(A) checked **or** 5(D) = yes
D) Does tributary catchment contain land uses that may have petroleum products, greases, or other chemicals present, such as gas station, hardware store, restaurant, etc.? yes [ ] no [X]	_____ Underdrain with Non-Woven Geotextile Fabric: 5(B) checked **and** 5(D) = no _____ Other: _____
6. Describe Provisions for Maintenance	

Notes: * - Exact dimensions for SFB to be designed at the FDR level.

RELEASE LIMITED TO 16.5 CFS PER DETENTION REQUIREMENTS

POND #1


6950
6950
6950
6950
6960
DETENTION
ACCESS ROAD @ 4%
50'
EMERGENCY WIER
APPROX 130' IN LENGTH
(1.0' DEPTH)
N
1:50

Matrix Design Group, Inc.
Integrated Design Solutions
Infrastructure Engineering
Community Development
Program Management

Job. No. _____

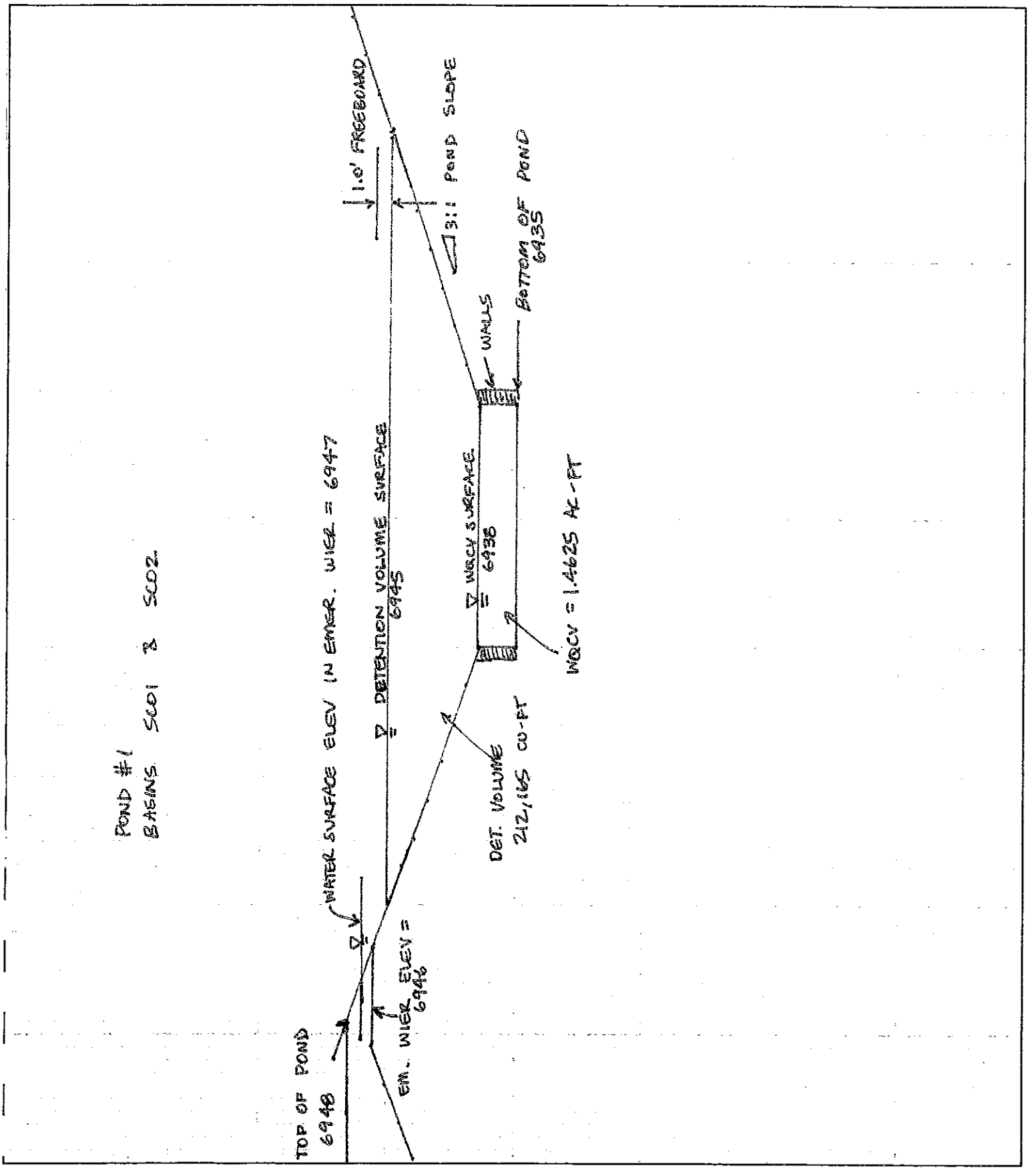
Date _____ / _____ / _____

Sheet _____ of _____

By _____

Project _____

Subject _____



Pond #1
Detention Volume

Estimated Detention for Storm 3
100-Year Storm

16.5 Target Flow (cfs)

212069.916 Estimated Storage (cf)

0
44

Time (min)	Total (cfs)	Volume (cf)	Decreasing	Match Value	Estimated Volume out (cf)	Estimated Storage Necessary (cf)	Ouflow
0	0						0
1	1.9507	58.521	NO	NO	0	0	
2	9.7535	409.647	NO	NO	0	0	
3	17.5563	1228.941	NO	NO	0	0	
4	29.2605	2633.445	NO	NO	0	0	
5	40.9647	4740.201	NO	NO	0	0	
6	58.521	7724.772	NO	NO	0	0	
7	76.0773	11762.72	NO	NO	0	0	
8	99.4857	17029.61	NO	NO	0	0	
9	120.9434	23642.48	NO	NO	0	0	
10	144.3518	31601.34	NO	NO	0	0	
11	161.9081	40789.14	NO	NO	0	0	
12	177.5137	50971.79	NO	NO	0	0	
13	185.3165	61856.7	NO	NO	0	0	
14	193.1193	73209.77	NO	NO	0	0	
15	193.1193	84796.93	NO	NO	0	0	
16	195.07	96442.61	NO	NO	0	0	
17	193.1193	108088.3	YES	NO	0	0	
18	185.3165	119441.4	YES	NO	0	0	
19	177.5137	130326.3	YES	NO	0	0	
20	167.7602	140684.5	YES	NO	0	0	
21	158.0067	150457.5	YES	NO	0	0	
22	146.3025	159586.8	YES	NO	0	0	
23	134.5983	168013.8	YES	NO	0	0	
24	118.9927	175621.5	YES	NO	0	0	
25	105.3378	182351.4	YES	NO	0	0	
26	91.6829	188262.1	YES	NO	0	0	
27	83.8801	193528.9	YES	NO	0	0	
28	74.1266	198269.1	YES	NO	0	0	
29	66.3238	202482.7	YES	NO	0	0	

PAGE 8A

Detention
100-Year
Basin SC01, SC02
POND #1

Inflow Hydrograph Storm 3
100-Year Storm

Hydrograph #1
x SCS Unit Hydrograph 15.36 Time to peak (min)
User Input Hydrograph 195.07 Peak flow (cfs) DP4

Hydrograph #2
SCS Unit Hydrograph Time to peak (min)
x User Input Hydrograph Peak flow (cfs)
Input Hydrograph Manually

Hydrograph #3
SCS Unit Hydrograph Time to peak (min)
x User Input Hydrograph Peak flow (cfs)
Input Hydrograph Manually

Time	Hydrograph #1			Hydrograph #2			Hydrograph #	
(min)	SCS	User	Actual	SCS	User	Actual	SCS	User
0	0		0	0		0	0	
1	1.9507		1.9507	0		0	0	
2	9.7535		9.7535	0		0	0	
3	17.5563		17.5563	0		0	0	
4	29.2605		29.2605	0		0	0	
5	40.9647		40.9647	0		0	0	
6	58.521		58.521	0		0	0	
7	76.0773		76.0773	0		0	0	
8	99.4857		99.4857	0		0	0	
9	120.9434		120.9434	0		0	0	
10	144.3518		144.3518	0		0	0	
11	161.9081		161.9081	0		0	0	
12	177.5137		177.5137	0		0	0	
13	185.3165		185.3165	0		0	0	
14	193.1193		193.1193	0		0	0	
15	193.1193		193.1193	0		0	0	
16	195.07		195.07	0		0	0	
17	193.1193		193.1193	0		0	0	
18	185.3165		185.3165	0		0	0	
19	177.5137		177.5137	0		0	0	
20	167.7602		167.7602	0		0	0	
21	158.0067		158.0067	0		0	0	
22	146.3025		146.3025	0		0	0	
23	134.5983		134.5983	0		0	0	
24	118.9927		118.9927	0		0	0	
25	105.3378		105.3378	0		0	0	
26	91.6829		91.6829	0		0	0	
27	83.8801		83.8801	0		0	0	
28	74.1266		74.1266	0		0	0	
29	66.3238		66.3238	0		0	0	
30	60.4717		60.4717	0		0	0	
31	54.6196		54.6196	0		0	0	
32	50.7182		50.7182	0		0	0	
33	44.8661		44.8661	0		0	0	
34	40.9647		40.9647	0		0	0	

Detention
100-Year
Basin SC03, SC04, SC05

Inflow Hydrograph Storm 3
100-Year Storm

Pond #1 Release / INFLOW PONDS #2 #2A

Hydrograph #1
x SCS Unit Hydrograph 18.65 Time to peak (min) DP 5
User Input Hydrograph 86.68 Peak flow (cfs)

Hydrograph #2
x SCS Unit Hydrograph 44 Time to peak (min) POND #1
User Input Hydrograph 16.5 Peak flow (cfs)

Hydrograph #3
x SCS Unit Hydrograph 5 Time to peak (min) SC04
User Input Hydrograph 22.7 Peak flow (cfs)

Time	Hydrograph #1			Hydrograph #2			Hydrograph #	
(min)	SCS	User	Actual	SCS	User	Actual	SCS	User
0	0		0	0		0	0	
1	0.8668		0.8668	0		0	2.27	
2	2.6004		2.6004	0.165		0.165	7.037	
3	6.0676		6.0676	0.165		0.165	14.982	
4	9.5348		9.5348	0.33		0.33	21.111	
5	13.002		13.002	0.66		0.66	22.7	
6	18.2028		18.2028	0.825		0.825	21.111	
7	23.4036		23.4036	0.99		0.99	17.706	
8	29.4712		29.4712	1.32		1.32	12.712	
9	38.1392		38.1392	1.65		1.65	8.853	
10	45.9404		45.9404	1.98		1.98	6.356	
11	53.7416		53.7416	2.31		2.31	4.767	
12	62.4096		62.4096	2.64		2.64	3.405	
13	69.344		69.344	2.97		2.97	2.497	
14	76.2784		76.2784	3.3		3.3	1.816	
15	80.6124		80.6124	3.96		3.96	1.362	
16	83.2128		83.2128	4.29		4.29	0.908	
17	85.8132		85.8132	4.785		4.785	0.681	
18	85.8132		85.8132	5.115		5.115	0.454	
19	86.68		86.68	5.94		5.94	0.454	
20	86.68		86.68	6.435		6.435	0.227	
21	84.9464		84.9464	6.93		6.93	0.227	
22	82.346		82.346	7.755		7.755	0.227	
23	78.8788		78.8788	8.415		8.415	0.227	
24	76.2784		76.2784	9.075		9.075	0.227	
25	71.9444		71.9444	9.57		9.57	0	
26	68.4772		68.4772	10.56		10.56	0	
27	64.1432		64.1432	11.22		11.22	0	
28	58.9424		58.9424	11.715		11.715	0	
29	53.7416		53.7416	12.21		12.21	0	
30	48.5408		48.5408	13.035		13.035	0	
31	43.34		43.34	13.53		13.53	0	
32	39.006		39.006	13.86		13.86	0	
33	36.4056		36.4056	14.52		14.52	0	
34	32.9384		32.9384	14.85		14.85	0	

Design Procedure Form: Sand Filter Basin (SFB)

Designer:	Rich Eastland
Company:	Matrix Design Group
Date:	April 23, 2008
Project:	Woodmen Towne Center
Location:	Pond #2, basins SC03, SC05

1. Basin Storage Volume	
A) Tributary Area's Imperviousness Ratio (i = i_a / 100)	i_a = 100.00 % i = 1.00
B) Contributing Watershed Area (Area)	Area = 17.1500 acres
C) Water Quality Capture Volume (WQCV) (WQCV =1.0 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i))	WQCV = 0.50 watershed inches
D) Design Volume: Vol = (WQCV / 12) * Area	Vol = 0.7146 acre-feet
2. Minimum Filter Surface Area: A_s = (Vol / 3) * 43,560	A_s = 10,376 square feet, Minimum
Actual Filter Surface Area Used (Should not be less than minimum):	A_s = 11,025 square feet,
Filter Surface Elevation	0.00 feet
Average Side Slope of the Filter Basin (4:1 or flatter, zero for vertical walls)	Z = 0.0 Using Vertical Walls
3. Estimate of Basin Depth (D), based on filter area A_s	D = 2.9 feet
* 4. Outlet Works	
A) Sand (ASTM C-33) Layer Thickness (18" min.)	_____ inches
B) Non-Woven Geotextile Fabric Between Sand & Gravel - meeting ASTM D4751 - AOS U.S. Std. Seive #50 to #70. Min. Grab Strength of 100 lbs., min. permitivity of 1.8 / sec.	_____ Non-Woven Geotextile Per USDCM Figure SFB-1 _____ Other: _____
C) Gravel (AASHTO or CDOT Section 703; #4, #57, or #67) Thickness (8" min.)	_____ inches, No. _____
D) Overflow Elevation At Top of Design Volume (Filter Surface Elev. + Estimate of Basin Depth (D))	2.90 feet
4. Basin Inlet	
A) Inlet Pipe with Impact Basin; **OR** Inlet Channel with Grouted Sloping Boulder Drop; **OR** Inlet Channel with Concrete Baffle Chute Drop	[ ] Inlet Pipe with Impact Basin; **OR** [ ] Inlet Channel with GSB Drop; **OR** [ ] Inlet Channel with Baffle Chute Drop
B) Riprap Outlet Protection For Pipe or Channel Over Non-Woven Geotextile Fabric Wrapped to the Top of the Sand Layer	_____ Riprap Outlet Protection _____ Other: _____
5. Draining of Sand Filter Basin (Check A, **or** B, **or** C, **answer** D) Based on answers to 5A **through** 5D, check the appropriate method	[X] Infiltration to Subgrade with Permeable Membrane: 5(C) checked **and** 5(D) = no
A) Check box if subgrade is heavy or expansive clay [ ] B) Check box if subgrade is silty or clayey sands [ ] C) Check box if subgrade is well-draining soils [X]	[ ] Underdrain with Impermeable Membrane: 5(A) checked **or** 5(D) = yes
D) Does tributary catchment contain land uses that may have petroleum products, greases, or other chemicals present, such as gas station, hardware store, restaurant, etc.? yes [ ] no [X]	[ ] Underdrain with Non-Woven Geotextile Fabric: 5(B) checked **and** 5(D) = no _____ Other: _____
6. Describe Provisions for Maintenance	

Notes: * – Exact dimensions for SFB to be designed at the FDR level.

RELEASE LIMITED TO 16.0 CFS PER DETENTION REQUIREMENTS.

Pond #2 2A
Detention Volume

Estimated Detention for Storm 3
100-Year Storm

16 Target Flow (cfs) **146231.262 Estimated Storage (cf)**

0
63

Time (min)	Total (cfs)	Volume (cf)	Decreasing	Match Value	Estimated Volume out (cf)	Estimated Storage Necessary (cf)	Ouflow
0	0						0
1	3.1368	94.104	NO	NO	0	0	
2	9.8024	482.28	NO	NO	0	0	
3	21.2146	1412.79	NO	NO	0	0	
4	30.9758	2978.502	NO	NO	0	0	
5	36.362	4998.636	NO	NO	0	0	
6	40.1388	7293.66	NO	NO	0	0	
7	42.0996	9760.812	NO	NO	0	0	
8	43.5032	12328.9	NO	NO	0	0	
9	48.6422	15093.26	NO	NO	0	0	
10	54.2764	18180.82	NO	NO	0	0	
11	60.8186	21633.67	NO	NO	0	0	
12	68.4546	25511.86	NO	NO	0	0	
13	74.811	29809.83	NO	NO	0	0	
14	81.3944	34495.99	NO	NO	0	0	
15	85.9344	39515.86	NO	NO	0	0	
16	88.4108	44746.21	NO	NO	0	0	
17	91.2792	50136.91	NO	NO	0	0	
18	91.3822	55616.75	NO	NO	0	0	
19	93.074	61150.44	NO	NO	0	0	
20	93.342	66742.92	NO	NO	0	0	
21	92.1034	72306.28	YES	NO	0	0	
22	90.328	77779.22	YES	NO	0	0	
23	87.5208	83114.69	YES	NO	0	0	
24	85.5804	88307.72	YES	NO	0	0	
25	81.5144	93320.57	YES	NO	0	0	
26	79.0372	98137.12	YES	NO	0	0	
27	75.3632	102769.1	YES	NO	0	0	
28	70.6574	107149.7	YES	NO	0	0	
29	65.9516	111248	YES	NO	0	0	

4A

CLEAR ROAD
2% GRADE
TO 6907
POND
#2
ROAD
6914
UGE
G
P-SS-8

Matrix Design Group, Inc.
Integrated Design Solutions
Infrastructure Engineering
Community Development
Program Management

Project _____

Subject _____

Job No. _____

Date _____ / _____ / _____

Sheet _____ of _____

By _____

POND # 2
BASINS SC03 & SC05

TOP OF POND = 6920
EM. WIER WATER SURFACE = 6919
EM. WIER ELEV = 6918
100-YR WATER SURFACE = 6917
WQCV SURFACE = 6910
BOTTOM OF POND = 6907

12 C

Design Procedure Form: Sand Filter Basin (SFB)

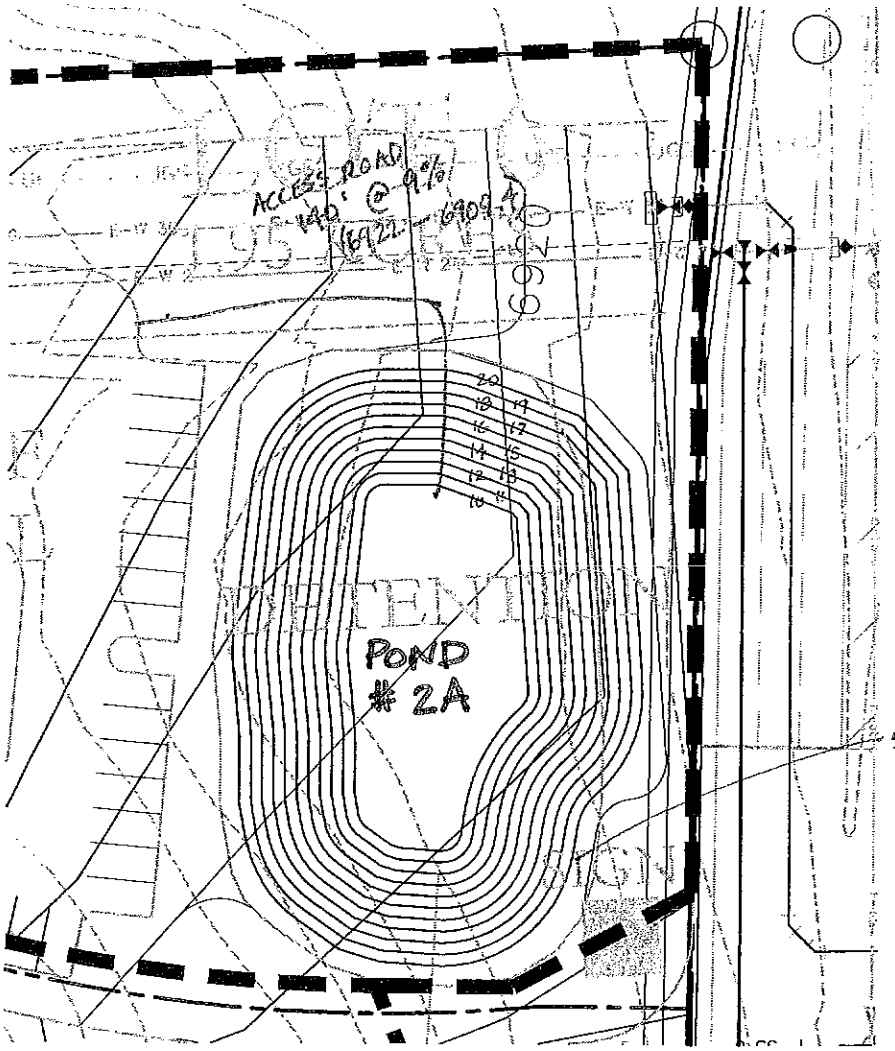
Designer: Rich Eastland
Company: Matrix Design Group
Date: April 23, 2008
Project: Woodmen Towne Center
Location: Pond #2A, basins SC04

1. Basin Storage Volume	
A) Tributary Area's Imperviousness Ratio ($i = I_a / 100$)	I_a = 100.00 % i = 1.00
B) Contributing Watershed Area (Area)	Area = 2.8000 acres
C) Water Quality Capture Volume (WQCV) ($WQCV = 1.0 * (0.91 * I^3 - 1.19 * I^2 + 0.78 * I)$)	WQCV = 0.50 watershed inches
D) Design Volume: Vol = (WQCV / 12) * Area	Vol = 0.1167 acre-feet → 5083.45 cu-FT
2. Minimum Filter Surface Area: A_s = (Vol / 3) * 43,560	A_s = 1,694 square feet, Minimum
Actual Filter Surface Area Used (Should not be less than minimum):	A_s = 3,585 square feet,
Filter Surface Elevation	0.00 feet
Average Side Slope of the Filter Basin (4:1 or flatter, zero for vertical walls) **NOTE: Basin side slope steeper than recommended limit.**	Z = 3.0
3. Estimate of Basin Depth (D), based on filter area A_s	D = 1.3 feet
*4. Outlet Works	
A) Sand (ASTM C-33) Layer Thickness (18" min.)	_____ inches
B) Non-Woven Geotextile Fabric Between Sand & Gravel - meeting ASTM D4751 - AOS U.S. Std. Seive #50 to #70. Min. Grab Strength of 100 lbs., min. permitivity of 1.8 / sec.	_____ Non-Woven Geotextile Per USDCM Figure SFB-1 _____ Other: _____
C) Gravel (AASHTO or CDOT Section 703; #4, #57, or #67) Thickness (8" min.)	_____ inches, No. _____
D) Overflow Elevation At Top of Design Volume (Filter Surface Elev. + Estimate of Basin Depth (D))	1.30 feet
4. Basin Inlet	
A) Inlet Pipe with Impact Basin; **OR** Inlet Channel with Grouted Sloping Boulder Drop; **OR** Inlet Channel with Concrete Baffle Chute Drop	_____ Inlet Pipe with Impact Basin; **OR** _____ Inlet Channel with GSB Drop; **OR** _____ Inlet Channel with Baffle Chute Drop
B) Riprap Outlet Protection For Pipe or Channel Over Non-Woven Geotextile Fabric Wrapped to the Top of the Sand Layer	_____ Riprap Outlet Protection _____ Other: _____
5. Draining of Sand Filter Basin (Check A, **or** B, **or** C, **answer** D) Based on answers to 5A through 5D, check the appropriate method	X Infiltration to Subgrade with Permeable Membrane: 5(C) checked **and** 5(D) = no
A) Check box if subgrade is heavy or expansive clay B) Check box if subgrade is silty or clayey sands C) Check box if subgrade is well-draining soils: X	_____ Underdrain with Impermeable Membrane: 5(A) checked **or** 5(D) = yes
D) Does tributary catchment contain land uses that may have petroleum products, greases, or other chemicals present, such as gas station, hardware store, restaurant, etc.? (yes: ____ no: X)	_____ Underdrain with Non-Woven Geotextile Fabric: 5(B) checked **and** 5(D) = no _____ Other: _____
6. Describe Provisions for Maintenance	

Notes: *Exact dimensions for SFB to be designed at the FDR level.

N

1:50



APPROX LOCATION FOR
50' WEIR FOR 22.70 CFS
0.48' DEPTH

Matrix Design Group, Inc.
Integrated Design Solutions
Infrastructure Engineering
Community Development
Program Management

Project _____

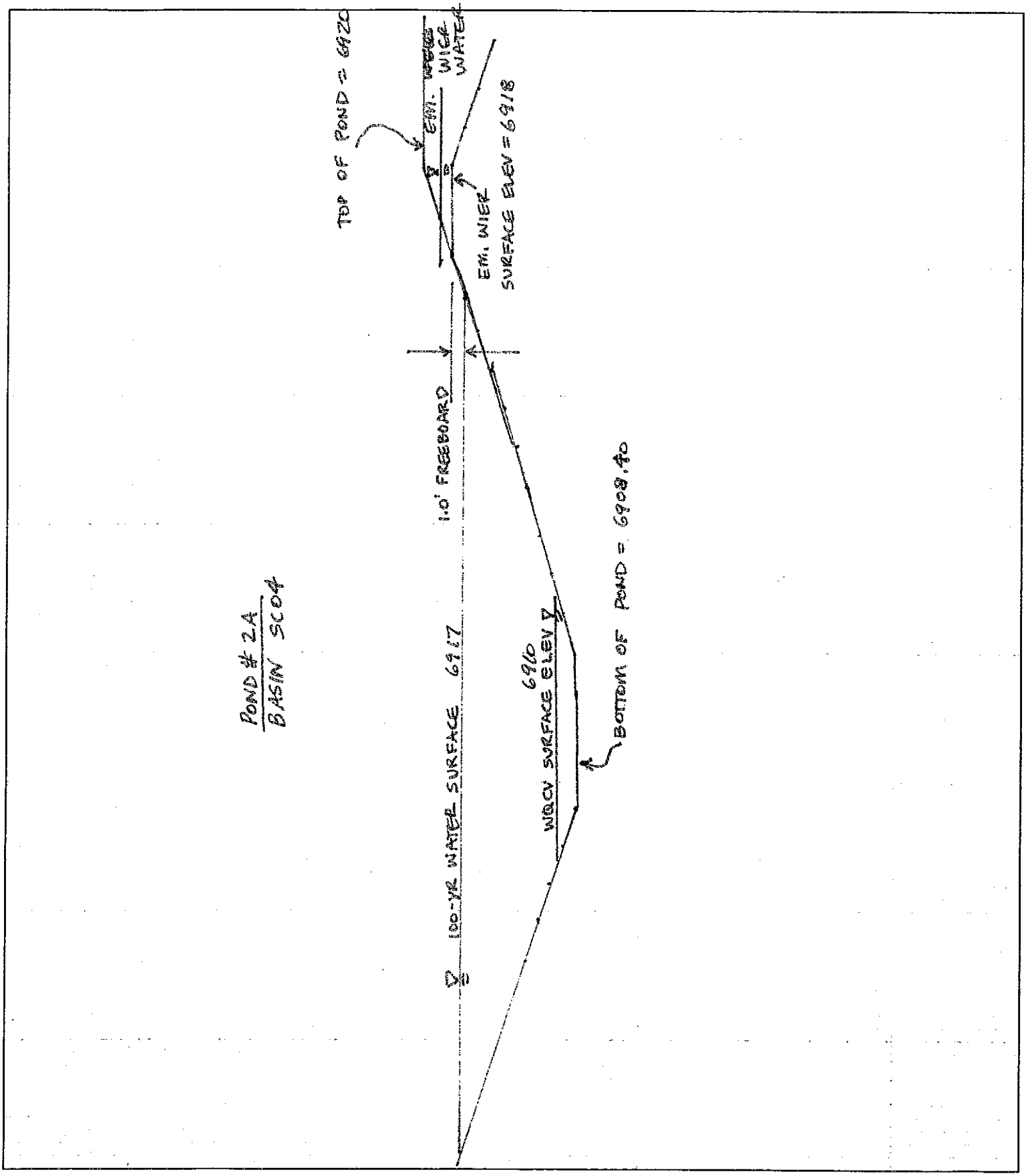
Subject _____

Job. No. _____

Date _____ / _____ / _____

Sheet _____ of _____

By _____



Design Procedure Form: Porous Landscape Detention (PLD)

Designer: Rich Eastland
Company: Matrix Design Group, Inc.
Date: July 28, 2008
Project: Woodmen Towne Center
Location: Basin D21

1. Basin Storage Volume
   (I_a = 100% if all paved and roofed areas u/s of PLD)
   A) Tributary Area's Imperviousness Ratio (i = I_a / 100)
   B) Contributing Watershed Area Including the PLD (Area)
   C) Water Quality Capture Volume (WQCV)
   (WQCV = 0.8 * (0.91 * I^3 - 1.19 * I^2 + 0.78 * I))
   D) Design Volume: Vol_{PLD} = (WQCV / 12) * Area

   I_a = 90.00 %
   i = 0.90
   Area = 74,553 square feet
   WQCV = 0.32 watershed inches
   Vol = 1,995 cubic feet

2. PLD Surface Area (A_{PLD}) and Average Depth (d_{av})
   (from 1995.49 square feet to 3990.97 square feet)
   (d_{av}: = (Vol / A_{PLD}), Min=0.5', Max=1.0')

   A_{PLD} = 2,000 square feet
   d_{av} = 1.00 feet

3. Draining of PLD (Check A, **or** B, **or** C, **answer** D)
   Based on answers to 3A through 3D, check the appropriate method

   A) Check box if subgrade is heavy or expansive clay [ ]
   B) Check box if subgrade is silty or clayey sand [ ]
   C) Check box if subgrade is well-draining soil [X]
   D) Check box if underdrains are not desirable or if underdrains are not feasible at this site. [ ]
   E) Does tributary catchment contain land uses that may have petroleum products, greases, or other chemicals present, such as gas station, hardware store, restaurant, etc.? yes [ ] no [X]

   [X] Infiltration to Subgrade with Permeable Membrane: 3(C) checked and 3(E) = no
   [ ] Underdrain with Impermeable Liner: 3(A) checked or 3(E) = yes
   [ ] Underdrain with Non-Woven Geotextile Fabric: 3(B) checked and 3(E) = no
   [ ] 16-Mil. Impermeable Membrane with No Underdrain: 3(D) checked - Evapotranspiration only
   [ ] Other:

4. Sand/Peat Mix and Gravel Subbase (See Figure PLD-1)

   A) Heavy or Expansive Clay (NRCS Group D Soils) Present; Perforated HDPE Underdrain Used.
   [ ] 18" Minimum Depth Sand-Peat Mix with 8" Gravel Layer. 16-Mil. Impermeable Liner and a 3" to 4" Perforated HDPE Underdrain.

   B) Silty or Clayey Sand (NRCS Group C Soils) Present; Perforated HDPE Underdrain Used.
   [ ] 18" Minimum Depth Sand-Peat Mix with 8" Gravel Layer and a 3" to 4" Perforated HDPE Underdrain w/ Non-Woven Pemeable Membrane.

   C) No Potential For Contamination And Well-Draining (NRCS Group A or B Soils) Are Present; Underdrains Elliminated.
   [X] 18" Minimum Depth Sand-Peat Mix with Non-Woven Permeable Membrane and No Underdrain (Direct Infiltration).

   D) Underdrains Are Not Desirable Or Are Not Feasible At This Site.
   [ ] 18" Minimum Depth Sand-Peat Mix with An Additional 18" Minimum Layer Sand-Peat Mix or Sand-Class 'A' Compost Bottom Layer (Total Sand-Peat Depth of 36"). 16-Mil. Impermeable Liner Used.

   E) Other:
   [ ] Other:

Notes: Final Design to be submitted in the FDR.

Design Procedure Form: Sand Filter Basin (SFB)

Designer:	Rich Eastland
Company:	Matrix Design Group
Date:	April 18, 2008
Project:	Woodmen Towne Center
Location:	WV01

1. Basin Storage Volume

A) Tributary Area's Imperviousness Ratio (i = I_a / 100)
I_a = 80.00 %
i = 0.80

B) Contributing Watershed Area (Area)
Area = 13.7000 acres

C) Water Quality Capture Volume (WQCV)
(WQCV =1.0 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i))
WQCV = 0.33 watershed inches

D) Design Volume: Vol = (WQCV / 12) * Area
Vol = 0.3748 acre-feet

2. Minimum Filter Surface Area: A_s = (Vol / 3) * 43,560
A_s = 5,443 square feet, Minimum

Actual Filter Surface Area Used (Should not be less than minimum):
A_s = 10,885 square feet,

Filter Surface Elevation
0.00 feet BOTTOM OF POND

Average Side Slope of the Filter Basin (4:1 or flatter, zero for vertical walls)
NOTE: Basin side slope steeper than recommended limit.
Z = 3.0

3. Estimate of Basin Depth (D), based on filter area A_s
D = 1.4 feet

4. Outlet Works

A) Sand (ASTM C-33) Layer Thickness (18" min.)
18 inches

B) Non-Woven Geotextile Fabric Between Sand & Gravel - meeting ASTM D4751 - AOS U.S. Std. Seive #50 to #70. Min. Grab Strength of 100 lbs., min. permitivity of 1.8 / sec.
x Non-Woven Geotextile Per USDCM Figure SFB-1
___ Other: ___

C) Gravel (AASHTO or CDOT Section 703; #4, #57, or #67) Thickness (8" min.)
9 inches, No. ___

D) Overflow Elevation At Top of Design Volume (Filter Surface Elev. + Estimate of Basin Depth (D))
1.40 feet

4. Basin Inlet

A) Inlet Pipe with Impact Basin; OR Inlet Channel with Grouted Sloping Boulder Drop; OR Inlet Channel with Concrete Baffle Chute Drop

TO BE DESIGNED @ FDR

[ ] Inlet Pipe with Impact Basin; OR
[ ] Inlet Channel with GSB Drop; OR
[ ] Inlet Channel with Baffle Chute Drop

B) Riprap Outlet Protection For Pipe or Channel Over Non-Woven Geotextile Fabric Wrapped to the Top of the Sand Layer
x Riprap Outlet Protection
___ Other: ___

5. Draining of Sand Filter Basin (Check A, or B, or C, answer D)
Based on answers to 5A through 5D, check the appropriate method

A) Check box if subgrade is heavy or expansive clay	
B) Check box if subgrade is silty or clayey sands	
C) Check box if subgrade is well-draining soils	X

D) Does tributary catchment contain land uses that may have petroleum products, greases, or other chemicals present, such as gas station, hardware store, restaurant, etc.?

yes	no
	X

X Infiltration to Subgrade with Permeable Membrane: 5(C) checked **and** 5(D) = no

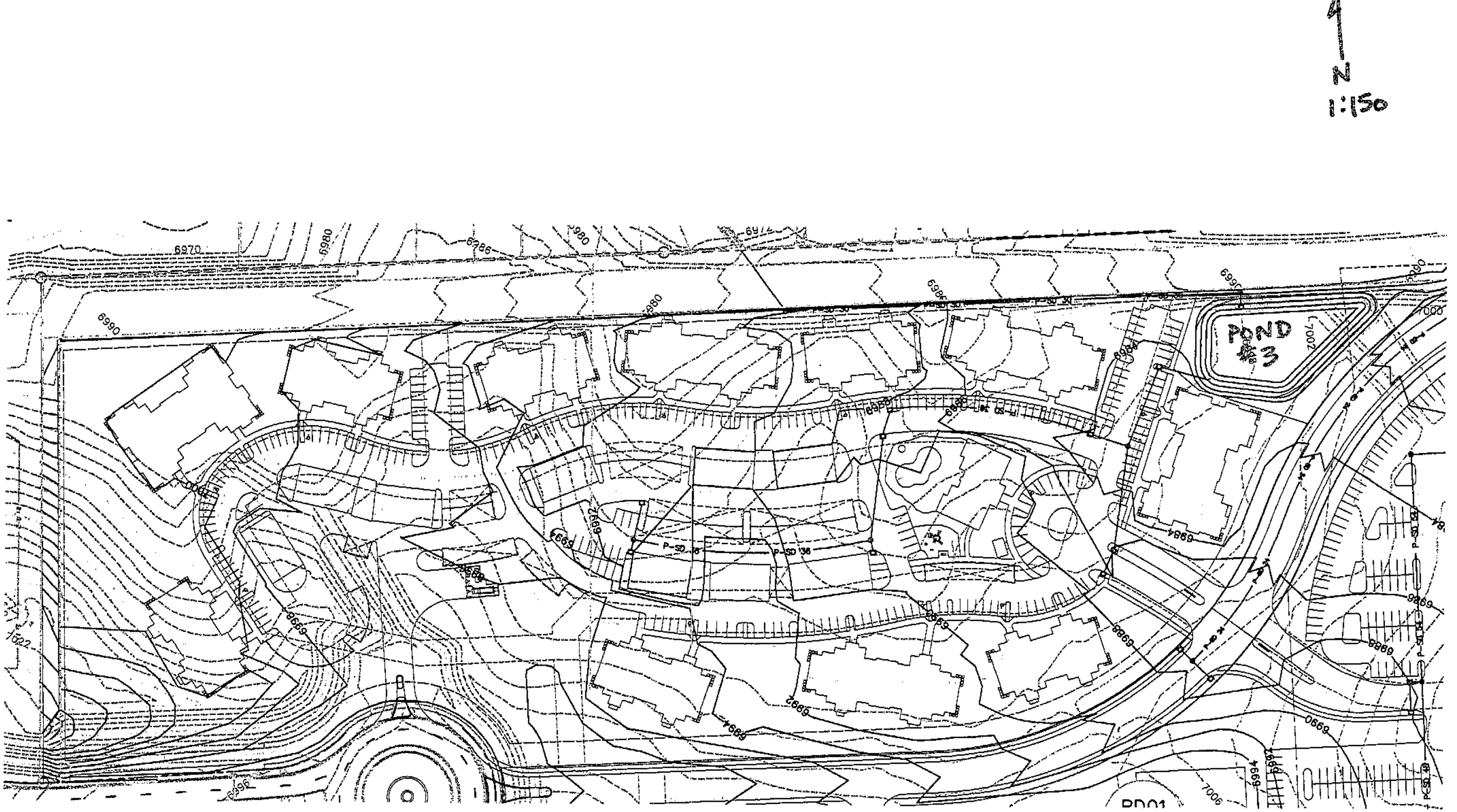
___ Underdrain with Impermeable Membrane: 5(A) checked **or** 5(D) = yes

___ Underdrain with Non-Woven Geotextile Fabric: 5(B) checked **and** 5(D) = no

___ Other: ___

6. Describe Provisions for Maintenance

Notes:


N
1:150
POND #3
6970
6980
6990
6986
7000
7002
6984
P-SD 36
7006
6994
6990
6996
RD01

Basin WV01
Detention Volume
POND #3

Estimated Detention for Storm 3
100-Year Storm

HISTORICAL RELEASE ACCEPTED PER WOODMEN VISTA FILING NO. 1 & 2 FDR
Q(100) = 24.7 CFS
USE → 24.5 CFS ✓

24.5 Target Flow (cfs)

43662.3 Estimated Storage (cf)

AREA @ 2.0' ELEV = 13,685 SQ FT
43,662 CUFT / 13,685 SQ FT = 3.14 FT DEPTH
3.19' + 1.4' + 1.0' ≅ 5.6' DEPTH OF POND
(WQ DEPTH) ↑ FREEBOARD

0
31

Time (min)	Total (cfs)	Volume (cf)	Decreasing	Match Value	Estimated Volume out (cf)	Estimated Storage Necessary (cf)	Ouflow
0	0						0
1	1.549	46.47	NO	NO	0	0	
2	5.296	251.82	NO	NO	0	0	
3	10.992	740.46	NO	NO	0	0	
4	15.888	1546.86	NO	NO	0	0	
5	19.333	2603.49	NO	NO	0	0	
6	22.476	3857.76	NO	NO	0	0	
7	24.27	5260.14	NO	NO	0	0	
8	27.011	6798.57	NO	NO	0	0	
9	30.801	8532.93	NO	NO	0	0	
10	34.642	10496.22	NO	NO	0	0	
11	39.981	12734.91	NO	NO	0	0	
12	44.871	15280.47	NO	NO	0	0	
13	48.314	18076.02	NO	NO	0	0	
14	51.308	21064.68	NO	NO	0	0	
15	53.304	24203.04	NO	NO	0	0	
16	54.751	27444.69	NO	NO	0	0	
17	54.651	30726.75	NO	NO	0	0	
18	55.1	34019.28	NO	NO	0	0	
19	55.1	37325.28	YES	NO	0	0	
20	53.353	40578.87	YES	NO	0	0	
21	51.706	43730.64	YES	NO	0	0	
22	49.51	46767.12	YES	NO	0	0	
23	47.314	49671.84	YES	NO	0	0	
24	44.569	52428.33	YES	NO	0	0	
25	41.724	55017.12	YES	NO	0	0	
26	38.43	57421.74	YES	NO	0	0	
27	35.136	59628.72	YES	NO	0	0	
28	31.293	61621.59	YES	NO	0	0	
29	27.999	63400.35	YES	NO	0	0	

Detention
5-Year
Basin WV01

Inflow Hydrograph Storm 2
5-Year Storm

POND #3

Hydrograph #1
x SCS Unit Hydrograph 17.56 Time to peak (min)
User Input Hydrograph 26.4 Peak flow (cfs)

Hydrograph #2
SCS Unit Hydrograph Time to peak (min)
x User Input Hydrograph Peak flow (cfs)
Input Hydrograph Manually

Hydrograph #3
SCS Unit Hydrograph Time to peak (min)
x User Input Hydrograph Peak flow (cfs)
Input Hydrograph Manually

Time	Hydrograph #1			Hydrograph #2			Hydrograph #	
(min)	SCS	User	Actual	SCS	User	Actual	SCS	User
0	0		0	0		0	0	
1	0.264		0.264	0		0	0	
2	1.056		1.056	0		0	0	
3	2.112		2.112	0		0	0	
4	3.168		3.168	0		0	0	
5	4.488		4.488	0		0	0	
6	6.336		6.336	0		0	0	
7	7.92		7.92	0		0	0	
8	10.296		10.296	0		0	0	
9	12.936		12.936	0		0	0	
10	15.312		15.312	0		0	0	
11	18.216		18.216	0		0	0	
12	20.856		20.856	0		0	0	
13	22.704		22.704	0		0	0	
14	24.288		24.288	0		0	0	
15	25.344		25.344	0		0	0	
16	26.136		26.136	0		0	0	
17	26.136		26.136	0		0	0	
18	26.4		26.4	0		0	0	
19	26.4		26.4	0		0	0	
20	25.608		25.608	0		0	0	
21	24.816		24.816	0		0	0	
22	23.76		23.76	0		0	0	
23	22.704		22.704	0		0	0	
24	21.384		21.384	0		0	0	
25	20.064		20.064	0		0	0	
26	18.48		18.48	0		0	0	
27	16.896		16.896	0		0	0	
28	15.048		15.048	0		0	0	
29	13.464		13.464	0		0	0	
30	12.144		12.144	0		0	0	
31	11.088		11.088	0		0	0	
32	10.032		10.032	0		0	0	
33	9.24		9.24	0		0	0	
34	8.448		8.448	0		0	0	

Detention
100-Year
Basin WV01

Inflow Hydrograph Storm 3
100-Year Storm

POND #3

Hydrograph #1
x SCS Unit Hydrograph 17.56 Time to peak (min) ✓
User Input Hydrograph 54.9 Peak flow (cfs) ✓

Hydrograph #2
SCS Unit Hydrograph Time to peak (min)
x User Input Hydrograph Peak flow (cfs)

Input Hydrograph Manually

Hydrograph #3
x SCS Unit Hydrograph 5 Time to peak (min)
User Input Hydrograph 10 Peak flow (cfs)

Time	Hydrograph #1			Hydrograph #2			Hydrograph #	
(min)	SCS	User	Actual	SCS	User	Actual	SCS	User
0	0		0	0		0	0	0
1	0.549		0.549	0		0	0	1
2	2.196		2.196	0		0	0	3.1
3	4.392		4.392	0		0	0	6.6
4	6.588		6.588	0		0	0	9.3
5	9.333		9.333	0		0	0	10
6	13.176		13.176	0		0	0	9.3
7	16.47		16.47	0		0	0	7.8
8	21.411		21.411	0		0	0	5.6
9	26.901		26.901	0		0	0	3.9
10	31.842		31.842	0		0	0	2.8
11	37.881		37.881	0		0	0	2.1
12	43.371		43.371	0		0	0	1.5
13	47.214		47.214	0		0	0	1.1
14	50.508		50.508	0		0	0	0.8
15	52.704		52.704	0		0	0	0.6
16	54.351		54.351	0		0	0	0.4
17	54.351		54.351	0		0	0	0.3
18	54.9		54.9	0		0	0	0.2
19	54.9		54.9	0		0	0	0.2
20	53.253		53.253	0		0	0	0.1
21	51.606		51.606	0		0	0	0.1
22	49.41		49.41	0		0	0	0.1
23	47.214		47.214	0		0	0	0.1
24	44.469		44.469	0		0	0	0.1
25	41.724		41.724	0		0	0	0
26	38.43		38.43	0		0	0	0
27	35.136		35.136	0		0	0	0
28	31.293		31.293	0		0	0	0
29	27.999		27.999	0		0	0	0
30	25.254		25.254	0		0	0	0
31	23.058		23.058	0		0	0	0
32	20.862		20.862	0		0	0	0
33	19.215		19.215	0		0	0	0
34	17.568		17.568	0		0	0	0

Design Procedure Form: Porous Landscape Detention (PLD)

Designer: Rich Eastland
Company: Matrix Design Group, Inc.
Date: July 28, 2008
Project: Woodmen Towne Center
Location: Basin WW01

1. Basin Storage Volume (I_a = 100% if all paved and roofed areas u/s of PLD) A) Tributary Area's Imperviousness Ratio (i = I_a / 100)	I_a = 100.00 % i = 1.00
B) Contributing Watershed Area Including the PLD (Area)	Area = 416,802 square feet
C) Water Quality Capture Volume (WQCV) (WQCV = 0.8 * (0.91 * I^3 - 1.19 * I^2 + 0.78 * I)) D) Design Volume: Vol_{PLD} = (WQCV / 12) * Area	WQCV = 0.40 watershed inches Vol = 13,893 cubic feet
2. PLD Surface Area (A_{PLD}) and Average Depth (d_{av}) (from 13893.4 square feet to 27786.8 square feet) (d_{av}: = (Vol / A_{PLD}), Min=0.5', Max=1.0')	A_{PLD} = 14,000 square feet d_{av} = 0.99 feet
3. Draining of PLD (Check A, **or** B, **or** C, **answer** D) Based on answers to 3A through 3D, check the appropriate method A) Check box if subgrade is heavy or expansive clay B) Check box if subgrade is silty or clayey sand C) Check box if subgrade is well-draining soil [X] D) Check box if underdrains are not desirable or if underdrains are not feasible at this site. E) Does tributary catchment contain land uses that may have petroleum products, greases, or other chemicals present, such as gas station, hardware store, restaurant, etc.? yes [ ] no [X]	[X] Infiltration to Subgrade with Permeable Membrane: 3(C) checked and 3(E) = no [ ] Underdrain with Impermeable Liner: 3(A) checked or 3(E) = yes [ ] Underdrain with Non-Woven Geotextile Fabric: 3(B) checked and 3(E) = no [ ] 16-Mil. Impermeable Membrane with No Underdrain: 3(D) checked - Evapotranspiration only [ ] Other:
4. Sand/Peat Mix and Gravel Subbase (See Figure PLD-1) A) Heavy or Expansive Clay (NRCS Group D Soils) Present; Perforated HDPE Underdrain Used. B) Silty or Clayey Sand (NRCS Group C Soils) Present; Perforated HDPE Underdrain Used. C) No Potential For Contamination And Well-Draining (NRCS Group A or B Soils) Are Present; Underdrains Elliminated. D) Underdrains Are Not Desirable Or Are Not Feasible At This Site. E) Other:	[ ] 18" Minimum Depth Sand-Peat Mix with 8" Gravel Layer. 16-Mil. Impermeable Liner and a 3" to 4" Perforated HDPE Underdrain. [ ] 18" Minimum Depth Sand-Peat Mix with 8" Gravel Layer and a 3" to 4" Perforated HDPE Underdrain w/ Non-Woven Permeable Membrane. [X] 18" Minimum Depth Sand-Peat Mix with Non-Woven Permeable Membrane and No Underdrain (Direct Infiltration). [ ] 18" Minimum Depth Sand-Peat Mix with An Additional 18" Minimum Layer Sand-Peat Mix or Sand-Class 'A' Compost Bottom Layer (Total Sand-Peat Depth of 36"). 16-Mil. Impermeable Liner Used. [ ] Other:

Notes: Final Design to be submitted in the FDR.

Basin WW01 Detention Volume
Pond #4

Estimated Detention for Storm 3
100-Year Storm

19 Target Flow (cfs) **21053.94 Estimated Storage (cf)** 0 12

Time (min)	Total (cfs)	Volume (cf)	Decreasing	Match Value	Estimated Volume out (cf)	Estimated Storage Necessary (cf)	Ouflow
0	0						0
1	4.669	140.07	NO	NO	0	0	
2	15.341	740.37	NO	NO	0	0	
3	31.349	2141.07	NO	NO	0	0	
4	50.692	4602.3	NO	NO	0	0	
5	63.365	8024.01	NO	NO	0	0	
6	66.7	11925.96	NO	NO	0	0	
7	64.032	15847.92	YES	NO	0	0	
8	56.028	19449.72	YES	NO	0	0	
9	45.356	22491.24	YES	NO	0	0	
10	33.35	24852.42	YES	NO	0	0	
11	24.679	26593.29	YES	NO	0	0	
12	18.676	27893.94	YES	YES	6840	21053.94	12
13	14.674	28894.44	YES	NO	0	0	
14	11.339	29674.83	YES	NO	0	0	
15	8.671	30275.13	YES	NO	0	0	
16	6.67	30735.36	YES	NO	0	0	
17	5.336	31095.54	YES	NO	0	0	
18	4.002	31375.68	YES	NO	0	0	
19	3.335	31595.79	YES	NO	0	0	
20	2.668	31775.88	YES	NO	0	0	
21	2.001	31915.95	YES	NO	0	0	
22	1.334	32016	YES	NO	0	0	
23	1.334	32096.04	YES	NO	0	0	
24	0.667	32156.07	YES	NO	0	0	
25	0.667	32196.09	YES	NO	0	0	
26	0.667	32236.11	YES	NO	0	0	
27	0.667	32276.13	YES	NO	0	0	
28	0.667	32316.15	YES	NO	0	0	
29	0.667	32356.17	YES	NO	0	0	

SC POND #1
100-Year
Basins WW01
Pond #4

Inflow Hydrograph Storm 3
100-Year Storm

Hydrograph #1
x SCS Unit Hydrograph 5.99 Time to peak (min)
User Input Hydrograph 66.7 Peak flow (cfs)

Hydrograph #2
SCS Unit Hydrograph Time to peak (min)
x User Input Hydrograph Peak flow (cfs)
Input Hydrograph Manually

Hydrograph #3
SCS Unit Hydrograph Time to peak (min)
x User Input Hydrograph Peak flow (cfs)
Input Hydrograph Manually

Time	Hydrograph #1			Hydrograph #2			Hydrograph #	
(min)	SCS	User	Actual	SCS	User	Actual	SCS	User
0	0		0	0		0	0	
1	4.669		4.669	0		0	0	
2	15.341		15.341	0		0	0	
3	31.349		31.349	0		0	0	
4	50.692		50.692	0		0	0	
5	63.365		63.365	0		0	0	
6	66.7		66.7	0		0	0	
7	64.032		64.032	0		0	0	
8	56.028		56.028	0		0	0	
9	45.356		45.356	0		0	0	
10	33.35		33.35	0		0	0	
11	24.679		24.679	0		0	0	
12	18.676		18.676	0		0	0	
13	14.674		14.674	0		0	0	
14	11.339		11.339	0		0	0	
15	8.671		8.671	0		0	0	
16	6.67		6.67	0		0	0	
17	5.336		5.336	0		0	0	
18	4.002		4.002	0		0	0	
19	3.335		3.335	0		0	0	
20	2.668		2.668	0		0	0	
21	2.001		2.001	0		0	0	
22	1.334		1.334	0		0	0	
23	1.334		1.334	0		0	0	
24	0.667		0.667	0		0	0	
25	0.667		0.667	0		0	0	
26	0.667		0.667	0		0	0	
27	0.667		0.667	0		0	0	
28	0.667		0.667	0		0	0	
29	0.667		0.667	0		0	0	
30	0		0	0		0	0	
31	0		0	0		0	0	
32	0		0	0		0	0	
33	0		0	0		0	0	
34	0		0	0		0	0	

Detention
5-Year
Basin WW01

Inflow Hydrograph Storm 2
5-Year Storm

Hydrograph #1
x SCS Unit Hydrograph 5.99 Time to peak (min)
User Input Hydrograph 35 Peak flow (cfs)

Hydrograph #2
SCS Unit Hydrograph Time to peak (min)
x User Input Hydrograph Peak flow (cfs)
Input Hydrograph Manually

Hydrograph #3
SCS Unit Hydrograph Time to peak (min)
x User Input Hydrograph Peak flow (cfs)
Input Hydrograph Manually

Time	Hydrograph #1			Hydrograph #2			Hydrograph #	
(min)	SCS	User	Actual	SCS	User	Actual	SCS	User
0	0		0	0			0	0
1	2.45		2.45	0			0	0
2	8.05		8.05	0			0	0
3	16.45		16.45	0			0	0
4	26.6		26.6	0			0	0
5	33.25		33.25	0			0	0
6	35		35	0			0	0
7	33.6		33.6	0			0	0
8	29.4		29.4	0			0	0
9	23.8		23.8	0			0	0
10	17.5		17.5	0			0	0
11	12.95		12.95	0			0	0
12	9.8		9.8	0			0	0
13	7.7		7.7	0			0	0
14	5.95		5.95	0			0	0
15	4.55		4.55	0			0	0
16	3.5		3.5	0			0	0
17	2.8		2.8	0			0	0
18	2.1		2.1	0			0	0
19	1.75		1.75	0			0	0
20	1.4		1.4	0			0	0
21	1.05		1.05	0			0	0
22	0.7		0.7	0			0	0
23	0.7		0.7	0			0	0
24	0.35		0.35	0			0	0
25	0.35		0.35	0			0	0
26	0.35		0.35	0			0	0
27	0.35		0.35	0			0	0
28	0.35		0.35	0			0	0
29	0.35		0.35	0			0	0
30	0		0	0			0	0
31	0		0	0			0	0
32	0		0	0			0	0
33	0		0	0			0	0
34	0		0	0			0	0

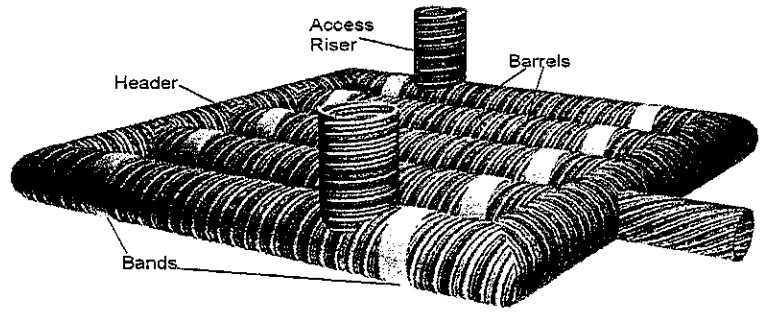
DYODS™

Design Your Own Detention System

CONTECH® CMP DETENTION SYSTEMS

CONTECH® STORMWATER SOLUTIONS INC.

For design assistance, drawings, and pricing send completed worksheet to:
dyods@contech-cpi.com



Project Summary

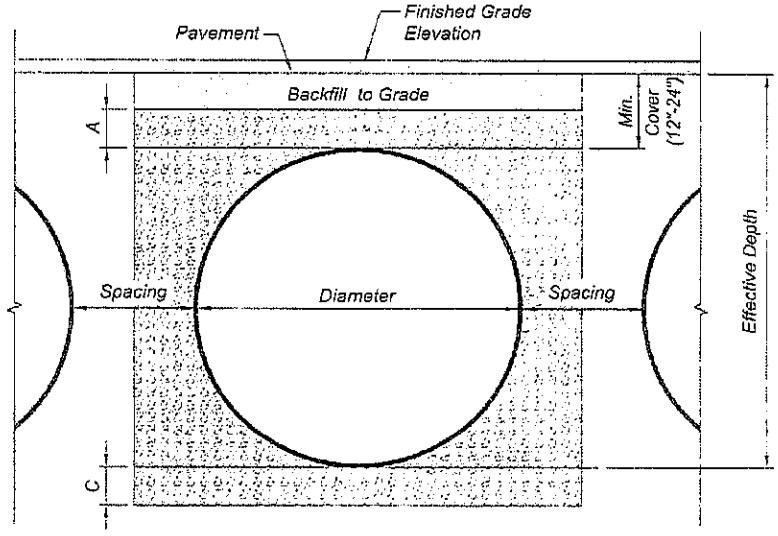
Date:	6/30/2008
Project Name:	Woodmen Towne Center
City / County:	Colorado Springs
State:	Colorado
Designed By:	Eastland
Company:	Matrix Design Group
Telephone:	(719) 575-0100

Enter Information in Blue Cells

Corrugated Metal Pipe Calculator

Storage Volume Required (cf):	21,054
Limiting Width (ft):	35.00
Effective Depth Below Asphalt (ft):	9.00
Solid or Perforated Pipe:	Solid
Shape Or Diameter:	72
Spacing between Barrels (ft):	3.00
Stone Width Around Perimeter of System (ft):	0
Depth A: Porous Stone Above Pipe (in):	12
Depth C: Porous Stone Below Pipe (in):	0
Stone Porosity (0 to 40%):	40

28.27 ft^2 Pipe Area



System Sizing

Use Custom Layout (at right) for layout adjustment

Pipe Storage:	21,149 cf	
Porous Stone Storage:	0 cf	
Total Storage Provided:	21,149 cf	100.5% Of Required Storage
Number of Barrels:	4 barrels	
Length Per Barrel:	187.00 ft	
Rectangular Footprint (W x L):	33. ft x 187. ft	

CONTECH Materials

Total CMP Footage:	748 ft
Approximate Total Pieces:	32 pcs
Approximate Coupling Bands:	28 bands
Approximate Truckloads:	16 trucks

Construction Quantities**

Total Excavation:	2057 cy
Porous Stone Backfill For Storage:	0 cy Stone
Backfill to Grade Excluding Stone:	1274 cy Fill

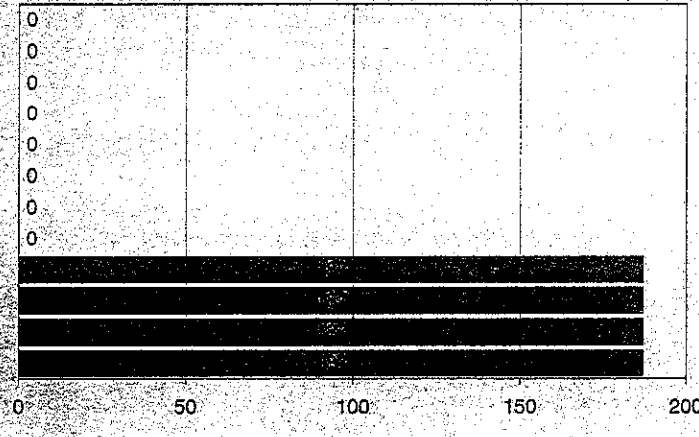
***Construction quantities are approximate and should be verified upon final design*

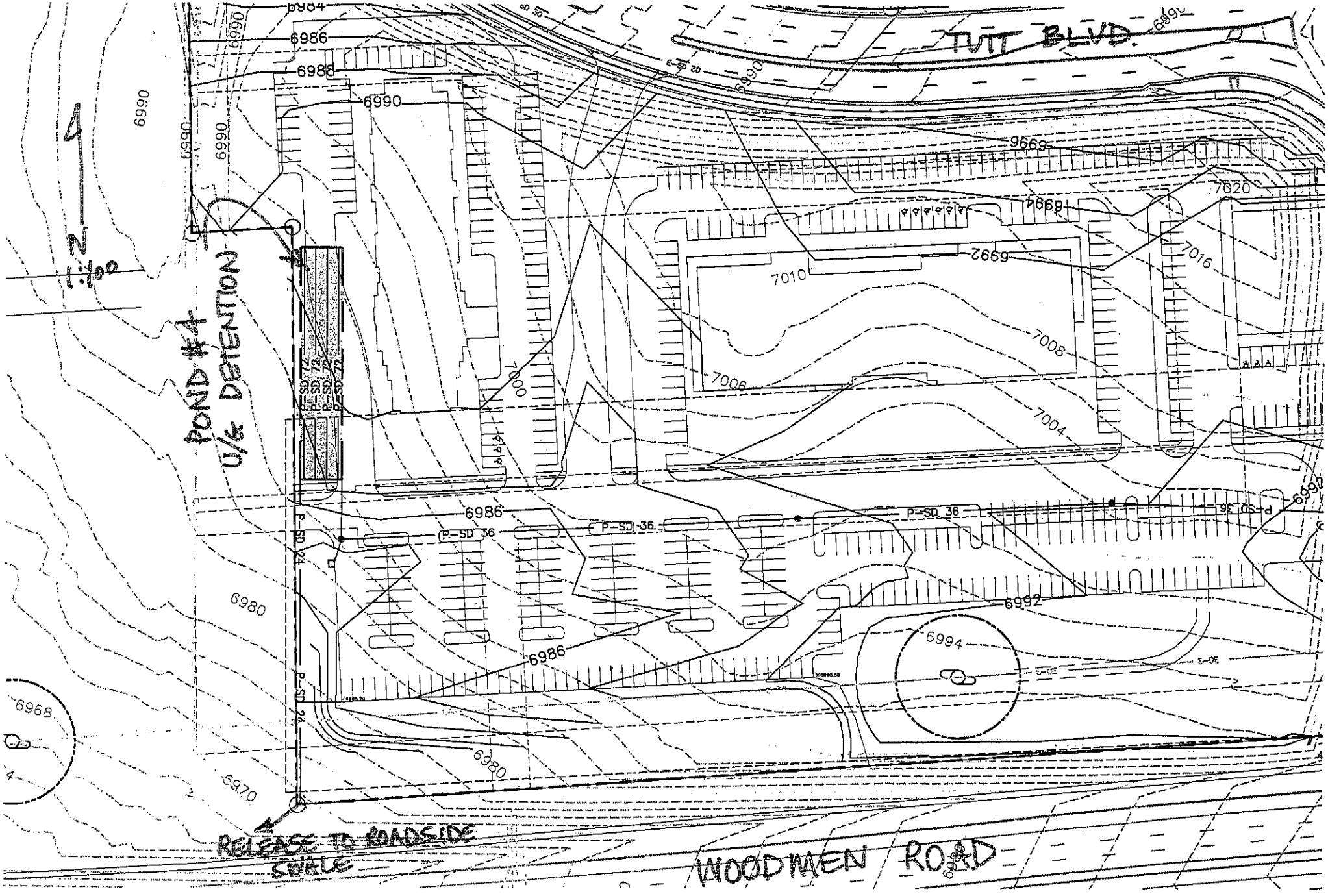
Custom Layout

To adjust layout, enter desired barrel length in the light blue boxes below.

Excess Footage = 0

Barrel 12	0
Barrel 11	0
Barrel 10	0
Barrel 9	0
Barrel 8	0
Barrel 7	0
Barrel 6	0
Barrel 5	0
Barrel 4	187
Barrel 3	187
Barrel 2	187
Barrel 1	187




TUTT BLVD.
POND #4
U/G DETENTION
N
1:100
RELEASE TO ROADSIDE SWALE
WOODMEN ROAD
P-SD 72
P-SD 36
P-SD 24
6984
6986
6988
6990
6992
6994
6996
6998
7000
7004
7006
7008
7010
7016
7020
6980
6970
6968

Worksheet for Pond #3

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.00500	ft/ft
Diameter	2.50	ft
Discharge	25.00	ft^3/s

Results

Normal Depth	1.79	ft
Flow Area	3.76	ft^2
Wetted Perimeter	5.04	ft
Top Width	2.25	ft
Critical Depth	1.70	ft
Percent Full	71.6	%
Critical Slope	0.00569	ft/ft
Velocity	6.65	ft/s
Velocity Head	0.69	ft
Specific Energy	2.48	ft
Froude Number	0.91	
Maximum Discharge	31.20	ft^3/s
Discharge Full	29.00	ft^3/s
Slope Full	0.00372	ft/ft
Flow Type	SubCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	71.61	%
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s

Worksheet for Pond #3

GVF Output Data

Normal Depth	1.79	ft
Critical Depth	1.70	ft
Channel Slope	0.00500	ft/ft
Critical Slope	0.00569	ft/ft

Worksheet for WV Trunk

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.01000	ft/ft
Diameter	3.00	ft
Discharge	55.00	ft^3/s

Results

Normal Depth	2.08	ft
Flow Area	5.22	ft^2
Wetted Perimeter	5.89	ft
Top Width	2.77	ft
Critical Depth	2.41	ft
Percent Full	69.2	%
Critical Slope	0.00708	ft/ft
Velocity	10.54	ft/s
Velocity Head	1.73	ft
Specific Energy	3.80	ft
Froude Number	1.35	
Maximum Discharge	71.74	ft^3/s
Discharge Full	66.69	ft^3/s
Slope Full	0.00680	ft/ft
Flow Type	SuperCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	69.20	%
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s

Worksheet for WV Trunk

GVF Output Data

Normal Depth	2.08	ft
Critical Depth	2.41	ft
Channel Slope	0.01000	ft/ft
Critical Slope	0.00708	ft/ft

Worksheet for Pond #4

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.01000	ft/ft
Diameter	2.00	ft
Discharge	19.00	ft^3/s

Results

Normal Depth	1.40	ft
Flow Area	2.36	ft^2
Wetted Perimeter	3.97	ft
Top Width	1.83	ft
Critical Depth	1.57	ft
Percent Full	70.2	%
Critical Slope	0.00769	ft/ft
Velocity	8.07	ft/s
Velocity Head	1.01	ft
Specific Energy	2.41	ft
Froude Number	1.25	
Maximum Discharge	24.33	ft^3/s
Discharge Full	22.62	ft^3/s
Slope Full	0.00705	ft/ft
Flow Type	SuperCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	70.18	%
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s

Worksheet for Pond #4

GVF Output Data

Normal Depth	1.40	ft
Critical Depth	1.57	ft
Channel Slope	0.01000	ft/ft
Critical Slope	0.00769	ft/ft

Worksheet for WW Trunk

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.01000	ft/ft
Diameter	3.00	ft
Discharge	67.00	ft^3/s

Results

Normal Depth	2.47	ft
Flow Area	6.23	ft^2
Wetted Perimeter	6.83	ft
Top Width	2.29	ft
Critical Depth	2.62	ft
Percent Full	82.4	%
Critical Slope	0.00918	ft/ft
Velocity	10.75	ft/s
Velocity Head	1.80	ft
Specific Energy	4.27	ft
Froude Number	1.15	
Maximum Discharge	71.74	ft^3/s
Discharge Full	66.69	ft^3/s
Slope Full	0.01009	ft/ft
Flow Type	SuperCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	82.38	%
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s

Worksheet for WW Trunk

GVF Output Data

Normal Depth	2.47	ft
Critical Depth	2.62	ft
Channel Slope	0.01000	ft/ft
Critical Slope	0.00918	ft/ft

Worksheet for SC01

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.01000	ft/ft
Diameter	4.00	ft
Discharge	110.00	ft^3/s

Results

Normal Depth	2.62	ft
Flow Area	8.73	ft^2
Wetted Perimeter	7.55	ft
Top Width	3.80	ft
Critical Depth	3.17	ft
Percent Full	65.6	%
Critical Slope	0.00625	ft/ft
Velocity	12.60	ft/s
Velocity Head	2.47	ft
Specific Energy	5.09	ft
Froude Number	1.46	
Maximum Discharge	154.51	ft^3/s
Discharge Full	143.64	ft^3/s
Slope Full	0.00586	ft/ft
Flow Type	SuperCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	65.57	%
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s

Worksheet for SC01

GVF Output Data

Normal Depth	2.62	ft
Critical Depth	3.17	ft
Channel Slope	0.01000	ft/ft
Critical Slope	0.00625	ft/ft

Worksheet for DP4

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.01000	ft/ft
Diameter	4.50	ft
Discharge	195.07	ft^3/s

Results

Normal Depth	3.66	ft
Flow Area	13.84	ft^2
Wetted Perimeter	10.11	ft
Top Width	3.51	ft
Critical Depth	4.00	ft
Percent Full	81.3	%
Critical Slope	0.00876	ft/ft
Velocity	14.09	ft/s
Velocity Head	3.09	ft
Specific Energy	6.74	ft
Froude Number	1.25	
Maximum Discharge	211.53	ft^3/s
Discharge Full	196.64	ft^3/s
Slope Full	0.00984	ft/ft
Flow Type	SuperCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	81.25	%
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s

Worksheet for DP4

GVF Output Data

Normal Depth	3.66	ft
Critical Depth	4.00	ft
Channel Slope	0.01000	ft/ft
Critical Slope	0.00876	ft/ft

Worksheet for POND #1 TO POND #2

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.01000	ft/ft
Diameter	3.00	ft
Discharge	65.00	ft^3/s

Results

Normal Depth	2.39	ft
Flow Area	6.05	ft^2
Wetted Perimeter	6.63	ft
Top Width	2.41	ft
Critical Depth	2.59	ft
Percent Full	79.8	%
Critical Slope	0.00877	ft/ft
Velocity	10.75	ft/s
Velocity Head	1.80	ft
Specific Energy	4.19	ft
Froude Number	1.20	
Maximum Discharge	71.74	ft^3/s
Discharge Full	66.69	ft^3/s
Slope Full	0.00950	ft/ft
Flow Type	SuperCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	79.76	%
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s

Worksheet for POND #1 TO POND #2

GVF Output Data

Normal Depth	2.39	ft
Critical Depth	2.59	ft
Channel Slope	0.01000	ft/ft
Critical Slope	0.00877	ft/ft

Worksheet for SC04

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.01000	ft/ft
Diameter	2.00	ft
Discharge	22.70	ft^3/s

Results

Normal Depth	1.65	ft
Flow Area	2.77	ft^2
Wetted Perimeter	4.55	ft
Top Width	1.53	ft
Critical Depth	1.70	ft
Percent Full	82.3	%
Critical Slope	0.00951	ft/ft
Velocity	8.21	ft/s
Velocity Head	1.05	ft
Specific Energy	2.69	ft
Froude Number	1.08	
Maximum Discharge	24.33	ft^3/s
Discharge Full	22.62	ft^3/s
Slope Full	0.01007	ft/ft
Flow Type	SuperCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	82.28	%
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s

Worksheet for SC04

GVF Output Data

Normal Depth	1.65	ft
Critical Depth	1.70	ft
Channel Slope	0.01000	ft/ft
Critical Slope	0.00951	ft/ft

Worksheet for DP1

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.01000	ft/ft
Diameter	2.00	ft
Discharge	19.15	ft^3/s

Results

Normal Depth	1.41	ft
Flow Area	2.37	ft^2
Wetted Perimeter	3.99	ft
Top Width	1.82	ft
Critical Depth	1.57	ft
Percent Full	70.6	%
Critical Slope	0.00775	ft/ft
Velocity	8.08	ft/s
Velocity Head	1.01	ft
Specific Energy	2.43	ft
Froude Number	1.25	
Maximum Discharge	24.33	ft^3/s
Discharge Full	22.62	ft^3/s
Slope Full	0.00717	ft/ft
Flow Type	SuperCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	70.61	%
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s

Worksheet for DP1

GVF Output Data

Normal Depth	1.41	ft
Critical Depth	1.57	ft
Channel Slope	0.01000	ft/ft
Critical Slope	0.00775	ft/ft

Worksheet for DP2

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.01000	ft/ft
Diameter	2.50	ft
Discharge	27.68	ft^3/s

Results

Normal Depth	1.50	ft
Flow Area	3.09	ft^2
Wetted Perimeter	4.44	ft
Top Width	2.45	ft
Critical Depth	1.79	ft
Percent Full	60.2	%
Critical Slope	0.00610	ft/ft
Velocity	8.97	ft/s
Velocity Head	1.25	ft
Specific Energy	2.75	ft
Froude Number	1.41	
Maximum Discharge	44.12	ft^3/s
Discharge Full	41.01	ft^3/s
Slope Full	0.00455	ft/ft
Flow Type	SuperCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	60.18	%
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s

Worksheet for DP2

GVF Output Data

Normal Depth	1.50	ft
Critical Depth	1.79	ft
Channel Slope	0.01000	ft/ft
Critical Slope	0.00610	ft/ft

Worksheet for DP3

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.01000	ft/ft
Diameter	2.50	ft
Discharge	36.04	ft^3/s

Results

Normal Depth	1.82	ft
Flow Area	3.82	ft^2
Wetted Perimeter	5.11	ft
Top Width	2.23	ft
Critical Depth	2.04	ft
Percent Full	72.7	%
Critical Slope	0.00781	ft/ft
Velocity	9.43	ft/s
Velocity Head	1.38	ft
Specific Energy	3.20	ft
Froude Number	1.27	
Maximum Discharge	44.12	ft^3/s
Discharge Full	41.01	ft^3/s
Slope Full	0.00772	ft/ft
Flow Type	SuperCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	72.71	%
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s

Worksheet for DP3

GVF Output Data

Normal Depth	1.82	ft
Critical Depth	2.04	ft
Channel Slope	0.01000	ft/ft
Critical Slope	0.00781	ft/ft

Worksheet for DP5

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.01000	ft/ft
Diameter	3.50	ft
Discharge	86.68	ft^3/s

Results

Normal Depth	2.51	ft
Flow Area	7.37	ft^2
Wetted Perimeter	7.06	ft
Top Width	3.16	ft
Critical Depth	2.90	ft
Percent Full	71.6	%
Critical Slope	0.00730	ft/ft
Velocity	11.76	ft/s
Velocity Head	2.15	ft
Specific Energy	4.66	ft
Froude Number	1.36	
Maximum Discharge	108.22	ft^3/s
Discharge Full	100.60	ft^3/s
Slope Full	0.00742	ft/ft
Flow Type	SuperCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	71.58	%
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s

Worksheet for DP5

GVF Output Data

Normal Depth	2.51	ft
Critical Depth	2.90	ft
Channel Slope	0.01000	ft/ft
Critical Slope	0.00730	ft/ft

Worksheet for RD01

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.01000	ft/ft
Diameter	2.00	ft
Discharge	11.60	ft^3/s

Results

Normal Depth	1.01	ft
Flow Area	1.60	ft^2
Wetted Perimeter	3.17	ft
Top Width	2.00	ft
Critical Depth	1.22	ft
Percent Full	50.7	%
Critical Slope	0.00550	ft/ft
Velocity	7.25	ft/s
Velocity Head	0.82	ft
Specific Energy	1.83	ft
Froude Number	1.43	
Maximum Discharge	24.33	ft^3/s
Discharge Full	22.62	ft^3/s
Slope Full	0.00263	ft/ft
Flow Type	SuperCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	50.74	%
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s

Worksheet for RD01

GVF Output Data

Normal Depth	1.01	ft
Critical Depth	1.22	ft
Channel Slope	0.01000	ft/ft
Critical Slope	0.00550	ft/ft

Worksheet for SC03

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.01000	ft/ft
Diameter	3.00	ft
Discharge	66.70	ft^3/s

Results

Normal Depth	2.46	ft
Flow Area	6.20	ft^2
Wetted Perimeter	6.79	ft
Top Width	2.31	ft
Critical Depth	2.61	ft
Percent Full	82.0	%
Critical Slope	0.00912	ft/ft
Velocity	10.76	ft/s
Velocity Head	1.80	ft
Specific Energy	4.26	ft
Froude Number	1.16	
Maximum Discharge	71.74	ft^3/s
Discharge Full	66.69	ft^3/s
Slope Full	0.01000	ft/ft
Flow Type	SuperCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	81.97	%
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s

Worksheet for SC03

GVF Output Data

Normal Depth	2.46	ft
Critical Depth	2.61	ft
Channel Slope	0.01000	ft/ft
Critical Slope	0.00912	ft/ft

APPENDIX C

STANDARD DESIGN CHARTS AND TABLES

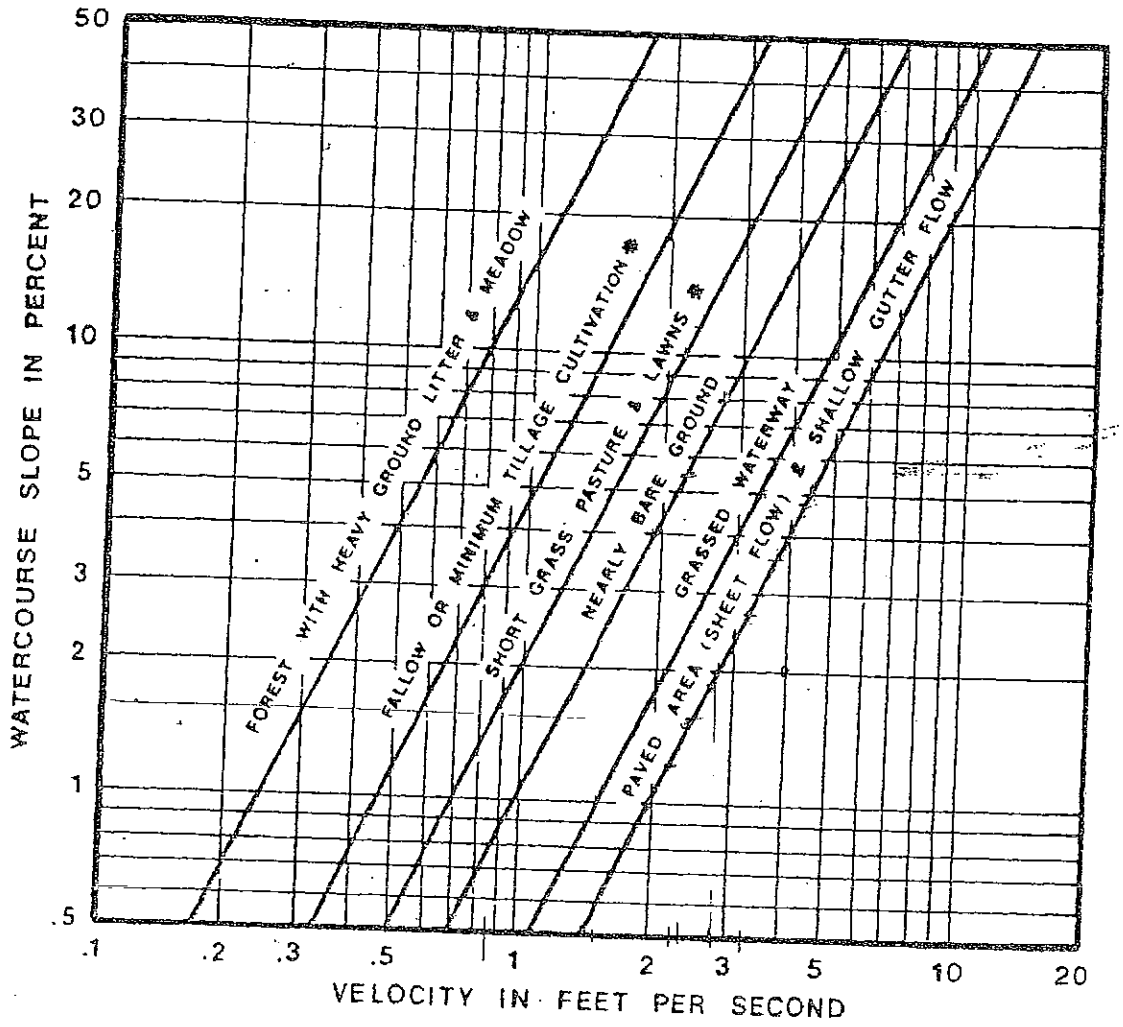


FIGURE RO-1

Estimate of Average Overland Flow Velocity for Use With the Rational Formula

TABLE 5-1

RECOMMENDED AVERAGE RUNOFF COEFFICIENTS AND PERCENT IMPERVIOUS

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

APPENDIX D

DRAINAGE MAPS