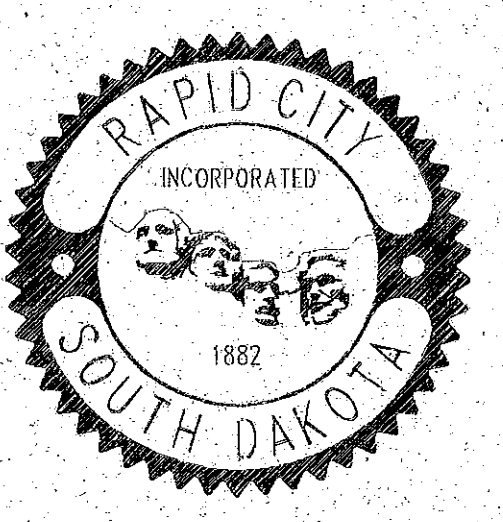
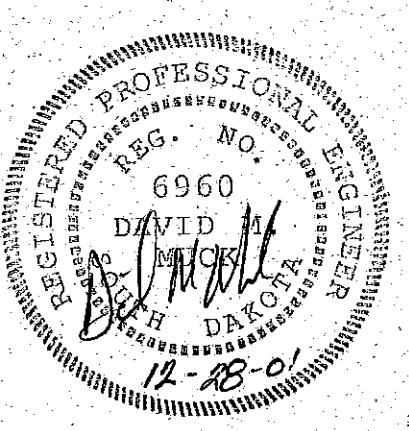
Racetrack Draw Drainage Basin Design Plan

REVISION



City of Rapid City
Engineering Division

December 2001



FERBER ENGINEERING COMPANY
CONSULTING ENGINEERS AND LAND SURVEYORS
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- WATER RESOURCES
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FERBER ENGINEERING COMPANY

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3471 STURGIS ROAD
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PHONE: (605) 343-3311
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December 28, 2001

Mr. Rich Wells, PE/LS
Drainage Engineer
City of Rapid City
300 6th Street
Rapid City, SD 57701

RE: Revision to Racetrack Draw Drainage Basin Design Plan

Dear Rich:

During development of the preliminary design plans for Phase III of the Rushmore Business Park, we revised the upper portion of the Racetrack Draw Drainage Basin Design Plan to reflect updated land use information and revisions to the street network north of East Anamosa Street at the Elk Vale Road intersection. Please find enclosed revised text and model output for a major revision to the Racetrack Draw Drainage Basin Design Plan.

Please review the enclosed information. If the information is correct, please include it in the Racetrack Draw Drainage Basin Design Plan. If you have comments or require additional information, please call.

Sincerely,
FERBER ENGINEERING COMPANY

Dave Muck, PE
Project Engineer

Enclosures: as noted

Introduction:

This Drainage Basin Design Plan *REVISION* has been prepared by Ferber Engineering Company to address regional drainage facilities in the upper reaches of the **Racetrack Draw Drainage Basin**. These changes were requested by the City of Rapid City and are associated with the development of E. Anamosa Street and Turbine Drive within the Rushmore Business Park under CORC Job Number ST01-1138.

Background:

Rushmore Business Park falls on the drainage boundary between the Unnamed Tributary and Racetrack Draw Drainage Basins. In general, the proposed Turbine Drive north of Homestead Street is the drainage divide.

All of the specified drainage facilities for the Unnamed Tributary have been completed prior to this project. In 1998, Detention Cell 100 was constructed during the overlot grading for the Rushmore Business Park Expansion. A major drainage structure will be required where E. Anamosa Street eventually crosses the Unnamed Tributary channel in the upper reaches of the basin. Because land use has changed since the original design plan was completed, a regional detention facility may be required north of E. Anamosa Street. However, we do not address this possibility in this report.

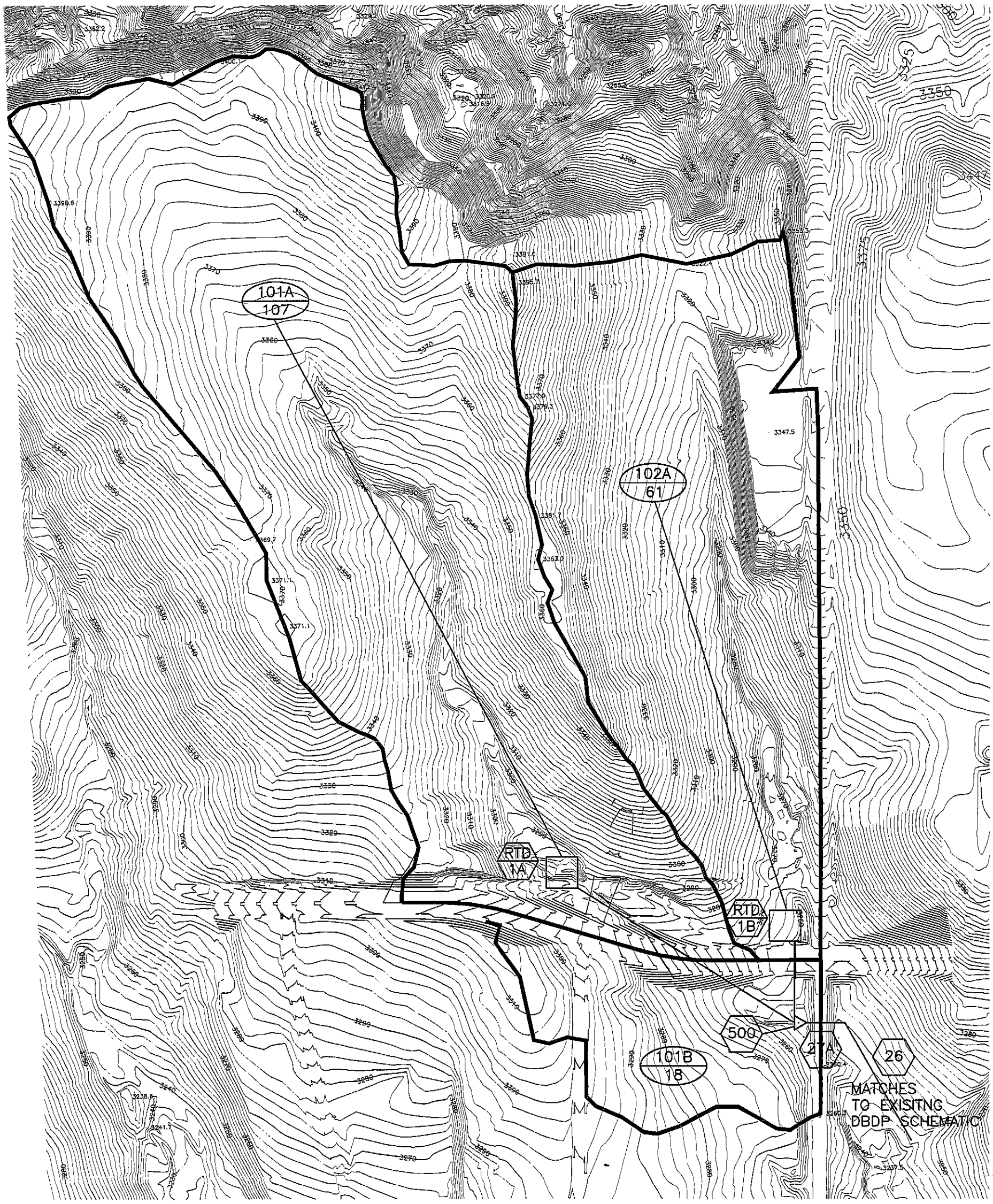
The 1990 Racetrack Draw Drainage Basin Design Plan (RDDBDP) specifies that a regional detention facility, RTD1, be constructed at the Elk Vale Road/E. Anamosa Street intersection. The discharge from RTD 1 is to pass under Elk Vale Road via a 48-inch RCP and continue down the basin. The land use used in the CUHP hydrologic modeling for Sub-basins 101 and 102 was assumed to be residential due to the lack of a formal land use plan for the area. The modeled, fully-developed, 100-year inflow from both Sub-basins into RTD 1 was 439 cfs with a discharge of 140 cfs. RTD 1 requires 18.6 ac-ft of storage with a depth of approximately 8 feet.

Revised Design Plan:

Figure 1 shows the revised drainage boundaries for Sub-basins 101A, 101B and 102A. We have renamed the basins so that it is understood that the Basin Design Plan has been revised. Sub-basins 101A and 102A are north of E. Anamosa Street and represent the general boundaries of Sub-basins 101 and 102 in the original design plan. Sub-basin 101B is the remainder of the original areas and is generally located south of E. Anamosa Street.

The alignment for E. Anamosa Street, landowner sentiment and the location of Turbine Drive north of E. Anamosa Street preclude the use of one regional detention facility. To make use of the natural topographic constraints, the proposed manmade alterations due to road construction and to limit the areal extent of a large regional detention facility, we propose to revise the design plan to include two smaller regional facilities, RTD 1A and RTD 1B, in place of RTD 1.

Figure 2 presents the future land use plan for the Elk Vale Neighborhood. The original design plan used residential land use for both Sub-basins 101 and 102. The land use plan includes



LEGEND

- SUB–BASIN BOUNDARY
- 100A / 104 — SUB–BASIN DESIGNATION / AREA IN ACRES
- DETENTION CELL
- DIRECT FLOW ELEMENT
- HYDROLOGIC ELEMENT DESCRIPTOR

N

N.T.S.

FERBER ENGINEERING COMPANY

12-18-01/JOBDATA/JD1-127/DRNGFIG.dwg

FIGURE 1. SUB-BASIN BOUNDARIES AND DESIGN PLAN HYDROLOGIC SCHEMATIC

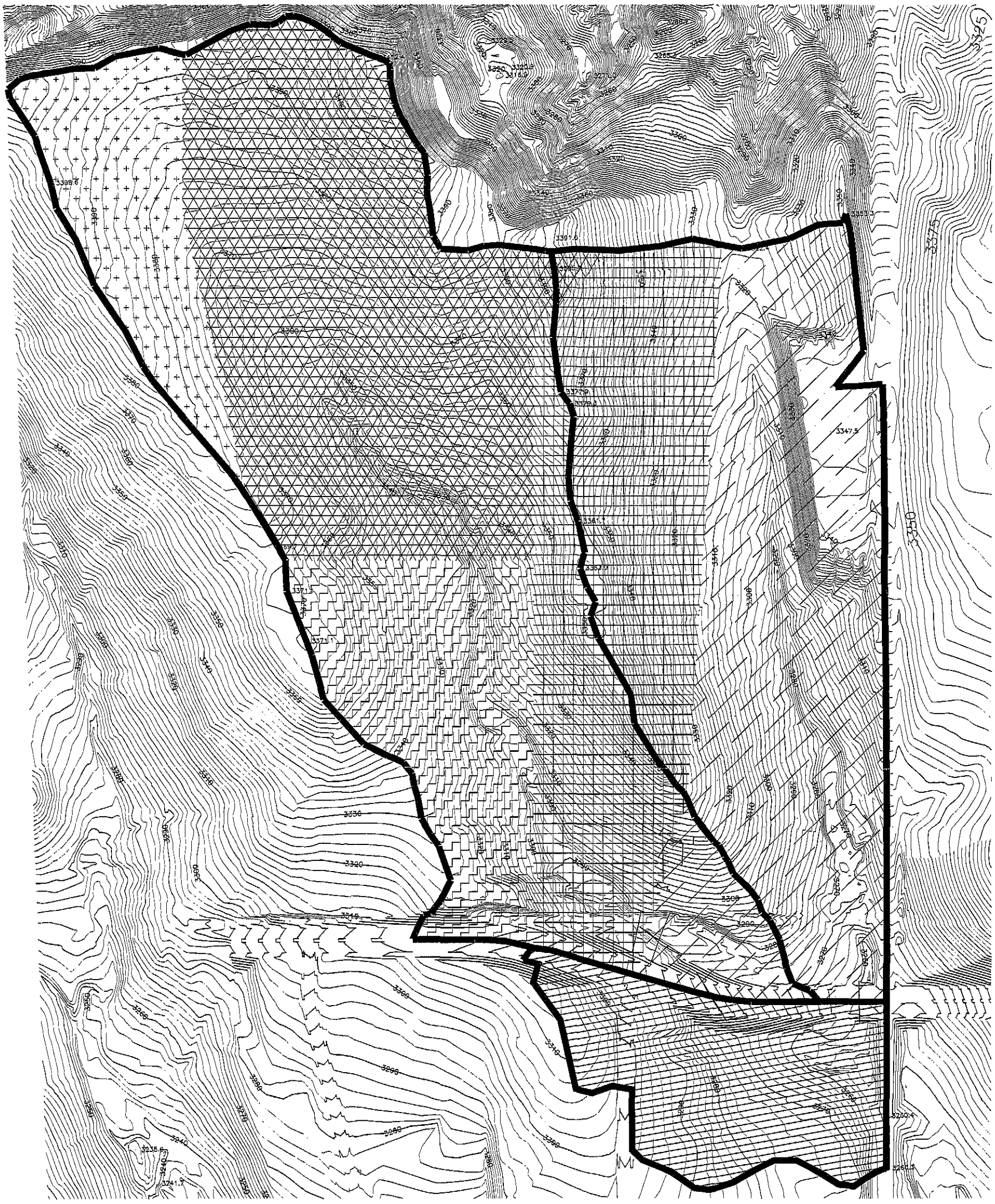


FIGURE 2. SUB-BASIN BOUNDARIES AND FUTURE LAND USE

varying degrees of residential development, light industrial and office and general commercial land uses.

Figure 1 also shows the revised design plan hydrologic schematic we used in our modeling. CUHPE/PC and UDSWM95 were used for hydrologic and hydraulic modeling, respectively. To limit the complexity of the modeling, our UDSWM95 model only includes the elements shown in Figure 1. All remaining conveyance and detention elements below Element 27 were assumed to match the original design plan. The 2-, 10- and 100-year CUHP and UDSWMM output are presented in Appendix A and B, respectively. 3.5-inch floppy disks have also been provided.

We have provided a revised design plan for Racetrack Draw that accounts for the change in land use in the subbasins north of E. Anamosa Street. The two detention facilities combine to reduce the outflow to slightly over what the original design plan called out for the 100-year event.

Revised Design Plan Conveyance Element Descriptions:

This section contains detailed descriptions of the conveyance and detention elements used to generate this revised design plan. The element numbers, where necessary, have been revised to show that revisions have been made.

Element RTD 1A

RTD 1A is a proposed detention cell to control fully-developed flows from Sub-basin 101A. We propose that RTD 1A be constructed using the embankment created by the future construction of Turbine Drive and E. Anamosa Street. It will be located in the northwest quadrant of the intersection. Grading of the upstream drainage will be necessary to create the required capacity.

For modeling purposes, we assumed a rectangular-shaped detention cell footprint. The bottom dimension of the detention cell was chosen such that it will fit within the existing drainage without large quantities of excavation of either bottom or side slopes. Table 1 shows the pond parameters used in the modeling.

Table 1. RTD 1A Model Configuration Parameters

Parameter	Dimension	Unit
Min. Elevation	3281.0	ft-msl
Bottom Width	100	ft
Bottom Length	400	ft
Area at Min. Elevation	0.9	ac
Side Slopes	4:1	H:V
Inlet Slope	20:1	H:V
Max. Elevation	3292.0	ft-msl
Area At Max. Elevation	2.9	ac
Volume at Max. Elevation	21.1	ac

To control discharge from the 2-, 10- and 100-year runoff events, we used a discharge control structure on the inlet side of the outflow pipe. The structure is a concrete riser with a 12-inch orifice hole at 3281.0 ft-msl to drain the pond and to control the 2-year through 10-year outflow. The crest of the riser was modeled at 3289.2 ft-msl. A 12.6-foot weir length was assumed. An orifice coefficient of 0.6 and weir coefficient of 2.8 were used in the orifice and weir equations, respectively. Table 2 presents the results of the UDSWM95 modeling performed for RTD 1A.

Table 2. UDSWM95 Fully-Developed Output Summary for RTD 1A

Parameter	2-year	10-year	100-year
Inflow	92	201	388
Outflow (cfs)	6	9	47
Storage Volume (ac-ft)	4.1	9.5	16.1
MWSEL (ft-msl)	3284.4	3287.4	3290.2

The control structure will discharge into a 48-inch RCP under Turbine Drive. The additional capacity in the 48-inch RCP will be used as emergency discharge for events larger than the 100-year event to minimize overtopping onto the street. The discharge from this pipe will then pass under E. Anamosa Street via a 54-inch RCP at Station 100+00.

Element RTD 1B

RTD 1B is a proposed detention cell to control fully-developed flows from Sub-basin 102A, which encompasses the area adjacent to the west side of Elk Vale Road. We propose that RTD 1B be constructed using the embankment created by the future construction E. Anamosa Street. It will be located in the northwest quadrant of the intersection E. Anamosa Street/Elk Vale Road intersection. Grading of the upstream drainage will be necessary to create the required capacity.

For modeling purposes, we assumed a rectangular-shaped detention cell footprint. The bottom dimension of the detention cell was chosen such that it will fit within the existing drainage without large quantities of excavation of either bottom or side slopes. Table 3 shows the pond parameters used in the modeling.

To control discharge from the 2-, 10- and 100-year runoff events, we used a discharge control structure. The structure is a concrete riser with a 12-inch orifice hole at 3257.0 ft-msl to drain the pond and to control the 2-year flow, and three 12-inch orifice holes at 3259.0 ft-msl to control the 10-year flow and to limit the crest elevation of the 100-year storage. The crest of the riser was modeled at 3260.5 ft-msl. A 12.6-foot weir length was assumed. An orifice coefficient of 0.6 and weir coefficient of 2.8 were used in the orifice and weir equations, respectively. Table 4 presents the results of the UDSWM95 modeling performed for RTD1B.

The control structure will discharge into a 48-inch RCP under E. Anamosa Street. The additional capacity in the 48-inch RCP will be used as emergency discharge for events larger than the 100-year event to minimize overtopping onto the street.

Table 3. RTD 1B Model Configuration Parameters

Parameter	Dimension	Unit
Min. Elevation	3257.0	ft-msl
Bottom Width	60	Ft
Bottom Length	420	Ft
Area at Min. Elevation	0.58	Ac
Side Slopes	4:1	H:V
Inlet Slope	20:1	H:V
Max. Elevation	3264.0	ft-msl
Area At Max. Elevation	1.6	ac
Volume at Max. Elevation	7.5	ac

Table 4. UDSWM95 Fully-Developed Output Summary for RTD 1B

Parameter	2-year	10-year	100-year
Inflow	65	126	219
Outflow (cfs)	15	49	117
Storage Volume (ac-ft)	2.4	3.8	5.1
MWSEL (ft-msl)	3260.0	3261.3	3262.3

Direct Flow Element 500

This element was added to the model to compute the maximum combined discharge from RTD 1A and RTD 1B. The maximum, modeled 100-year flow at Element 500 is 146 cfs, which is slightly higher than the 140 cfs discharged from RTD 1 in the RDDBDP. This difference is within modeling accuracy and was considered to have a negligible impact on downstream structures.

Element 27A

The original Element 27 was a 48-inch RCP used as the discharge pipe from RTD 1. The SDDOT has changed the size of this pipe to a 60-inch RCP in their reconstruction plans for Elk Vale Road. This revised element was updated in our model and will easily pass the anticipated 146 cfs during the 100-year fully-developed event.

Users of this report are cautioned that while flow depths/storage volumes are calculated for each conveyance element/detention cell and conceptual design information has been provided for the detention cells, the calculated discharges and depths are based upon simplified hydraulic properties. Each element must be designed using accepted hydraulic engineering practices.

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CUHP Output Files

2-year Fully-Developed Output

10-year Fully-Developed Output

100-year Fully-Developed Output

Appendix A

FERBER ENGINEERING COMPANY

2-year CUHP Fully-Developed Output

FERBER ENGINEERING COMPANY

U.D.F.C.D. CUHP RUNOFF ANALYSIS EXECUTED ON DATE AT TIME

CUHPE/PC VERSION MODIFIED IN JANUARY 1985

PRINT OPTION NUMBER SELECTED FOR THIS BASIN IS 7

RACETRACK DRAW, RBP PHIII: 2-YEAR STORM FULLY-DEVELOPED

BASIN ID: RTD101 -- BASIN COMMENT: RACETRACK DRAW, RBP PH III: SUB-BASIN 101A

AREA OF BASIN (SQMI)	LENGTH OF BASIN (MI)	DIST TO CENTROID (MI)	IMPERVIOUS AREA (PCT)	SLOPE (FT/FT)	UNIT DURATION (MIN)
0.16	0.90	0.44	52.40	.0280	5.00

COEFFICIENT (REFLECTING TIME TO PEAK)	COEFFICIENT (RELATED TO PEAK RATE OF RUNOFF)
0.087	0.490

CALCULATED UNIT HYDROGRAPH

TIME TO PEAK (MIN)	TIME OF CONCENTRATION (MIN)	PEAK RATE OF RUNOFF (CFS/SQMI)	UNIT HYDROGRAPH PEAK (CFS)	VOLUME OF RUNOFF (AF)
10.40	35.00	2380.22	385.60	8.64

WIDTH AT 50 = 13. MIN. WIDTH AT 75 = 7. MIN. K50 =0.35 K75 =0.45

RAINFALL LOSSES INPUT W/ BASIN DATA

MAX. PERVIOUS RET. =0.40 IN. MAX. IMPERVIOUS RET. =0.10 IN.
INFILTRATION = 4.30 IN./HR. DECAY = 0.00180/SECOND FNINFL = 0.59 IN./HR.

TIME	UNIT HYDROGRAPH	TIME	UNIT HYDROGRAPH	TIME	UNIT HYDROGRAPH
0.	0.	25.	109.	50.	12.
5.	140.	30.	70.	55.	7.
10.	384.	35.	44.	60.	0.
15.	268.	40.	28.	0.	0.
20.	170.	45.	18.	0.	0.

BASIN ID: RTD101 -- BASIN COMMENT: RACETRACK DRAW, RBP PH III: SUB-BASIN 101A

**** STORM NO. = 1 **** DATE OR RETURN PERIOD = 2-YEAR

TIME (MIN.)	INCREMENT RAINFALL (IN)	TOTAL EXCESS PRECIP	STORM HYDROGRAPH (CFS)	*	TIME (MIN.)	INCREMENT RAINFALL (IN)	TOTAL EXCESS PRECIP	STORM HYDROGRAPH (CFS)	*
0.	0.00	0.000	0.	*	70.	0.02	0.011	24.	*
5.	0.02	0.000	0.	*	75.	0.02	0.011	20.	*
10.	0.04	0.000	0.	*	80.	0.02	0.011	17.	*
15.	0.09	0.029	4.	*	85.	0.02	0.011	16.	*
20.	0.18	0.088	23.	*	90.	0.02	0.011	15.	*
25.	0.28	0.137	61.	*	95.	0.02	0.011	14.	*
30.	0.15	0.077	92.	*	100.	0.02	0.011	14.	*
35.	0.07	0.034	89.	*	105.	0.02	0.011	14.	*
40.	0.05	0.027	72.	*	110.	0.02	0.011	14.	*
45.	0.03	0.016	57.	*	115.	0.01	0.005	13.	*
50.	0.03	0.016	44.	*	120.	0.01	0.005	11.	*
55.	0.03	0.016	36.	*	125.	0.00	0.000	9.	*
60.	0.03	0.016	30.	*	130.	0.00	0.000	6.	*
65.	0.03	0.016	27.	*	135.	0.00	0.000	3.	*

TOTAL PRECIP. = 1.27 (1-HOUR RAIN = 1.10) EXECESS PRECIP. = 0.584 INCHES
VOLUME OF EXCESS PRECIP = 5. ACRE-FEET
PEAK Q = 92. CFS TIME OF PEAK = 30. MIN.
INFILT.= 4.30 IN/HR DECAY =0.00180 FNINF = 0.59 IN/HR
MAX.PERV.RET.=0.40 IN. MAX.IMP.RET.=0.10 IN.

RATIONAL FORMULA C = 0.46
I = 1.6 INCHES/HOUR
A = 103.7 ACRES
Q = 75. CFS

U.D.F.C.D. CUHP RUNOFF ANALYSIS EXECUTED ON DATE AT TIME

CUHPE/PC VERSION MODIFIED IN JANUARY 1985

PRINT OPTION NUMBER SELECTED FOR THIS BASIN IS 7

RACETRACK DRAW, RBP PHIII: 2-YEAR STORM FULLY-DEVELOPED

BASIN ID: RTD301 -- BASIN COMMENT: RACETRACK DRAW RBP PH III: SUB-BASIN 101B

AREA OF BASIN (SQMI)	LENGTH OF BASIN (MI)	DIST TO CENTROID (MI)	IMPERVIOUS AREA (PCT)	SLOPE (FT/FT)	UNIT DURATION (MIN)
0.03	0.35	0.13	70.00	.0300	5.00

COEFFICIENT (REFLECTING TIME TO PEAK)	COEFFICIENT (RELATED TO PEAK RATE OF RUNOFF)
0.080	0.445

CALCULATED UNIT HYDROGRAPH

TIME TO PEAK (MIN)	TIME OF CONCENTRATION (MIN)	PEAK RATE OF RUNOFF (CFS/SQMI)	UNIT HYDROGRAPH PEAK (CFS)	VOLUME OF RUNOFF (AF)
7.02	15.00	3777.32	109.54	1.55

*** NOTE : THE TIME TO PEAK IS CALCULATED BASED ON THE TIME OF CONCENTRATION PROVIDED BY THE USER, REPLACING THE ONE COMPUTED BY CUHPD (TP= 5.02)

WIDTH AT 50 = 8. MIN. WIDTH AT 75 = 4. MIN. K50 =0.35 K75 =0.45

RAINFALL LOSSES INPUT W/ BASIN DATA

MAX. PERVIOUS RET. =0.40 IN. MAX. IMPERVIOUS RET. =0.10 IN.
INFILTRATION = 4.50 IN./HR. DECAY = 0.00180/SECOND FNINFL = 0.60 IN./HR.

TIME	UNIT HYDROGRAPH	TIME	UNIT HYDROGRAPH	TIME	UNIT HYDROGRAPH
0.	0.	15.	39.	30.	0.
5.	77.	20.	21.	0.	0.
10.	75.	25.	11.	0.	0.

BASIN ID: RTD301 -- BASIN COMMENT: RACETRACK DRAW RBP PH III: SUB-BASIN 101B

**** STORM NO. = 1 **** DATE OR RETURN PERIOD = 2-YEAR

TIME (MIN.)	INCREMENT RAINFALL (IN)	TOTAL EXCESS PRECIP	STORM HYDROGRAPH (CFS)	TIME (MIN.)	INCREMENT RAINFALL (IN)	TOTAL EXCESS PRECIP	STORM HYDROGRAPH (CFS)
0.	0.00	0.000	0.	60.	0.03	0.022	5.
5.	0.02	0.000	0.	65.	0.03	0.022	5.
10.	0.04	0.000	0.	70.	0.02	0.015	4.
15.	0.09	0.039	3.	75.	0.02	0.015	4.
20.	0.18	0.117	12.	80.	0.02	0.015	4.
25.	0.28	0.183	24.	85.	0.02	0.015	3.
30.	0.15	0.102	27.	90.	0.02	0.015	3.
35.	0.07	0.046	21.	95.	0.02	0.015	3.
40.	0.05	0.037	15.	100.	0.02	0.015	3.
45.	0.03	0.022	10.	105.	0.02	0.015	3.
50.	0.03	0.022	7.	110.	0.02	0.015	3.
55.	0.03	0.022	5.	115.	0.01	0.007	3.

TOTAL PRECIP. = 1.27 (1-HOUR RAIN = 1.10) EXECESS PRECIP. = 0.780 INCHES
VOLUME OF EXCESS PRECIP = 1. ACRE-FEET
PEAK Q = 27. CFS TIME OF PEAK = 30. MIN.
INFILT.= 4.50 IN/HR DECAY =0.00180 FNINF = 0.60 IN/HR
MAX.PERV.RET.=0.40 IN. MAX.IMP.RET.=0.10 IN.

RATIONAL FORMULA C = 0.61
I = 2.5 INCHES/HOUR
A = 18.6 ACRES
Q = 28. CFS

U.D.F.C.D. CUHP RUNOFF ANALYSIS EXECUTED ON DATE AT TIME

CUHPE/PC VERSION MODIFIED IN JANUARY 1985

PRINT OPTION NUMBER SELECTED FOR THIS BASIN IS 7

RACETRACK DRAW, RBP PHIII: 2-YEAR STORM FULLY-DEVELOPED

BASIN ID: RTD102 -- BASIN COMMENT: RACETRACK DRAW RBP PH III: SUB-BASIN 102A

AREA OF BASIN (SQMI)	LENGTH OF BASIN (MI)	DIST TO CENTROID (MI)	IMPERVIOUS AREA (PCT)	SLOPE (FT/FT)	UNIT DURATION (MIN)
0.09	0.69	0.32	69.80	.0310	5.00

COEFFICIENT (REFLECTING TIME TO PEAK)	COEFFICIENT (RELATED TO PEAK RATE OF RUNOFF)
0.080	0.531

CALCULATED UNIT HYDROGRAPH

TIME TO PEAK (MIN)	TIME OF CONCENTRATION (MIN)	PEAK RATE OF RUNOFF (CFS/SQMI)	UNIT HYDROGRAPH PEAK (CFS)	VOLUME OF RUNOFF (AF)
13.30	30.00	1886.71	179.24	5.07

*** NOTE : THE TIME TO PEAK IS CALCULATED BASED ON THE TIME OF CONCENTRATION PROVIDED BY THE USER, REPLACING THE ONE COMPUTED BY CUHPD (TP= 7.89)

WIDTH AT 50 = 16. MIN. WIDTH AT 75 = 8. MIN. K50 =0.35 K75 =0.45

RAINFALL LOSSES INPUT W/ BASIN DATA

MAX. PERVIOUS RET. =0.40 IN. MAX. IMPERVIOUS RET. =0.10 IN.
INFILTRATION = 4.20 IN./HR. DECAY = 0.00180/SECOND FMINFL = 0.58 IN./HR.

TIME	UNIT HYDROGRAPH		TIME	UNIT HYDROGRAPH		TIME	UNIT HYDROGRAPH	
0.	0.	*	25.	82.	*	50.	15.	*
5.	42.	*	30.	58.	*	55.	11.	*
10.	145.	*	35.	42.	*	60.	8.	*
15.	172.	*	40.	30.	*	65.	0.	*
20.	118.	*	45.	21.	*	0.	0.	*

BASIN ID: RTD102 -- BASIN COMMENT: RACETRACK DRAW RBP PH III: SUB-BASIN 102A

**** STORM NO. = 1 **** DATE OR RETURN PERIOD = 2-YEAR

TIME (MIN.)	INCREMENT RAINFALL (IN)	TOTAL EXCESS PRECIP	STORM HYDROGRAPH (CFS)	TIME (MIN.)	INCREMENT RAINFALL (IN)	TOTAL EXCESS PRECIP	STORM HYDROGRAPH (CFS)
0.	0.00	0.000	0.	75.	0.02	0.015	20.
5.	0.02	0.000	0.	80.	0.02	0.015	16.
10.	0.04	0.000	0.	85.	0.02	0.015	14.
15.	0.09	0.039	2.	90.	0.02	0.015	13.
20.	0.18	0.117	10.	95.	0.02	0.015	12.
25.	0.28	0.182	31.	100.	0.02	0.015	11.
30.	0.15	0.102	55.	105.	0.02	0.015	11.
35.	0.07	0.046	65.	110.	0.02	0.015	11.
40.	0.05	0.036	59.	115.	0.01	0.007	11.
45.	0.03	0.022	49.	120.	0.01	0.007	10.
50.	0.03	0.022	41.	125.	0.00	0.000	8.
55.	0.03	0.022	34.	130.	0.00	0.000	6.
60.	0.03	0.022	29.	135.	0.00	0.000	4.
65.	0.03	0.022	25.	140.	0.00	0.000	3.
70.	0.02	0.015	23.	145.	0.00	0.000	2.

TOTAL PRECIP. = 1.27 (1-HOUR RAIN = 1.10) EXECESS PRECIP. = 0.778 INCHES
VOLUME OF EXCESS PRECIP = 4. ACRE-FEET
PEAK Q = 65. CFS TIME OF PEAK = 35. MIN.
INFILT.= 4.20 IN/HR DECAY =0.00180 FNINF = 0.58 IN/HR
MAX.PERV.RET.=0.40 IN. MAX.IMP.RET.=0.10 IN.

RATIONAL FORMULA C = 0.61
I = 1.7 INCHES/HOUR
A = 60.8 ACRES
Q = 64. CFS

10-year CUHP Fully-Developed Output

FERBER ENGINEERING COMPANY

U.D.F.C.D. CUHP RUNOFF ANALYSIS EXECUTED ON DATE AT TIME

CUHPE/PC VERSION MODIFIED IN JANUARY 1985

PRINT OPTION NUMBER SELECTED FOR THIS BASIN IS 7

RACETRACK DRAW, RBP PHIII: 10-YEAR STORM FULLY-DEVELOPED

BASIN ID: RTD101 -- BASIN COMMENT: RACETRACK DRAW, RBP PH III: SUB-BASIN 101A

AREA OF BASIN (SQMI)	LENGTH OF BASIN (MI)	DIST TO CENTROID (MI)	IMPERVIOUS AREA (PCT)	SLOPE (FT/FT)	UNIT DURATION (MIN)
0.16	0.90	0.44	52.40	.0280	5.00

COEFFICIENT (REFLECTING TIME TO PEAK)	COEFFICIENT (RELATED TO PEAK RATE OF RUNOFF)
0.087	0.490

CALCULATED UNIT HYDROGRAPH

TIME TO PEAK (MIN)	TIME OF CONCENTRATION (MIN)	PEAK RATE OF RUNOFF (CFS/SQMI)	UNIT HYDROGRAPH PEAK (CFS)	VOLUME OF RUNOFF (AF)
10.40	35.00	2380.22	385.60	8.64

WIDTH AT 50 = 13. MIN. WIDTH AT 75 = 7. MIN. K50 =0.35 K75 =0.45

RAINFALL LOSSES INPUT W/ BASIN DATA

MAX. PERVIOUS RET. =0.40 IN. MAX. IMPERVIOUS RET. =0.10 IN.
INFILTRATION = 4.30 IN./HR. DECAY = 0.00180/SECOND FNINFL = 0.59 IN./HR.

TIME	UNIT HYDROGRAPH	TIME	UNIT HYDROGRAPH	TIME	UNIT HYDROGRAPH
0.	0.	25.	109.	50.	12.
5.	140.	30.	70.	55.	7.
10.	384.	35.	44.	60.	0.
15.	268.	40.	28.	0.	0.
20.	170.	45.	18.	0.	0.

BASIN ID: RTD101 -- BASIN COMMENT: RACETRACK DRAW, RBP PH III: SUB-BASIN 101A

**** STORM NO. = 1 **** DATE OR RETURN PERIOD = 10-YEAR

TIME (MIN.)	INCREMENT RAINFALL (IN)	TOTAL EXCESS PRECIP	STORM HYDROGRAPH (CFS)	*	TIME (MIN.)	INCREMENT RAINFALL (IN)	TOTAL EXCESS PRECIP	STORM HYDROGRAPH (CFS)	*
0.	0.00	0.000	0.	*	75.	0.06	0.034	49.	*
5.	0.04	0.000	0.	*	80.	0.05	0.023	44.	*
10.	0.07	0.003	0.	*	85.	0.04	0.018	37.	*
15.	0.15	0.076	12.	*	90.	0.04	0.018	31.	*
20.	0.28	0.139	49.	*	95.	0.04	0.018	28.	*
25.	0.47	0.324	120.	*	100.	0.04	0.018	26.	*
30.	0.22	0.186	201.	*	105.	0.04	0.018	24.	*
35.	0.10	0.074	201.	*	110.	0.04	0.018	23.	*
40.	0.08	0.052	161.	*	115.	0.03	0.016	23.	*
45.	0.07	0.044	126.	*	120.	0.02	0.012	21.	*
50.	0.06	0.034	99.	*	125.	0.00	0.000	17.	*
55.	0.06	0.034	79.	*	130.	0.00	0.000	11.	*
60.	0.06	0.034	66.	*	135.	0.00	0.000	7.	*
65.	0.06	0.034	58.	*	140.	0.00	0.000	4.	*
70.	0.06	0.034	52.	*	145.	0.00	0.000	3.	*

TOTAL PRECIP. = 2.15 (1-HOUR RAIN = 1.86) EXECESS PRECIP. = 1.260 INCHES
VOLUME OF EXCESS PRECIP = 11. ACRE-FEET
PEAK Q = 201. CFS TIME OF PEAK = 30. MIN.
INFILT.= 4.30 IN/HR DECAY =0.00180 FNINF = 0.59 IN/HR
MAX.PERV.RET.=0.40 IN. MAX.IMP.RET.=0.10 IN.

RATIONAL FORMULA C = 0.59
I = 2.7 INCHES/HOUR
A = 103.7 ACRES
Q = 161. CFS

U.D.F.C.D. CUHP RUNOFF ANALYSIS EXECUTED ON DATE AT TIME

CUHPE/PC VERSION MODIFIED IN JANUARY 1985

PRINT OPTION NUMBER SELECTED FOR THIS BASIN IS 7

RACETRACK DRAW, RBP PHIII: 10-YEAR STORM FULLY-DEVELOPED

BASIN ID: RTD301 -- BASIN COMMENT: RACETRACK DRAW RBP PH III: SUB-BASIN 101B

AREA OF BASIN (SQMI)	LENGTH OF BASIN (MI)	DIST TO CENTROID (MI)	IMPERVIOUS AREA (PCT)	SLOPE (FT/FT)	UNIT DURATION (MIN)
0.03	0.35	0.13	70.00	.0300	5.00

COEFFICIENT (REFLECTING TIME TO PEAK)	COEFFICIENT (RELATED TO PEAK RATE OF RUNOFF)
0.080	0.445

CALCULATED UNIT HYDROGRAPH

TIME TO PEAK (MIN)	TIME OF CONCENTRATION (MIN)	PEAK RATE OF RUNOFF (CFS/SQMI)	UNIT HYDROGRAPH PEAK (CFS)	VOLUME OF RUNOFF (AF)
7.02	15.00	3777.32	109.54	1.55

*** NOTE : THE TIME TO PEAK IS CALCULATED BASED ON THE TIME OF CONCENTRATION PROVIDED BY THE USER, REPLACING THE ONE COMPUTED BY CUHPD (TP= 5.02)

WIDTH AT 50 = 8. MIN. WIDTH AT 75 = 4. MIN. K50 =0.35 K75 =0.45

RAINFALL LOSSES INPUT W/ BASIN DATA

MAX. PERVIOUS RET. =0.40 IN. MAX. IMPERVIOUS RET. =0.10 IN.
INFILTRATION = 4.50 IN./HR. DECAY = 0.00180/SECOND FNINFL = 0.60 IN./HR.

TIME	UNIT HYDROGRAPH	*	TIME	UNIT HYDROGRAPH	*	TIME	UNIT HYDROGRAPH	*
0.	0.	*	15.	39.	*	30.	0.	*
5.	77.	*	20.	21.	*	0.	0.	*
10.	75.	*	25.	11.	*	0.	0.	*

BASIN ID: RTD301 -- BASIN COMMENT: RACETRACK DRAW RBP PH III: SUB-BASIN 101B

**** STORM NO. = 1 **** DATE OR RETURN PERIOD = 10-YEAR

TIME (MIN.)	INCREMENT RAINFALL (IN)	TOTAL EXCESS PRECIP	STORM HYDROGRAPH (CFS)	*	TIME (MIN.)	INCREMENT RAINFALL (IN)	TOTAL EXCESS PRECIP	STORM HYDROGRAPH (CFS)	*
0.	0.00	0.000	0.	*	65.	0.06	0.042	10.	*
5.	0.04	0.000	0.	*	70.	0.06	0.042	9.	*
10.	0.07	0.004	0.	*	75.	0.06	0.042	9.	*
15.	0.15	0.101	8.	*	80.	0.05	0.031	9.	*
20.	0.28	0.186	22.	*	85.	0.04	0.024	7.	*
25.	0.47	0.365	46.	*	90.	0.04	0.024	6.	*
30.	0.22	0.195	52.	*	95.	0.04	0.024	6.	*
35.	0.10	0.083	40.	*	100.	0.04	0.024	5.	*
40.	0.08	0.060	28.	*	105.	0.04	0.024	5.	*
45.	0.07	0.052	20.	*	110.	0.04	0.024	5.	*
50.	0.06	0.042	13.	*	115.	0.03	0.021	5.	*
55.	0.06	0.042	11.	*	120.	0.02	0.016	4.	*
60.	0.06	0.042	10.	*	125.	0.00	0.000	3.	*

TOTAL PRECIP. = 2.15 (1-HOUR RAIN = 1.86) EXECESS PRECIP. = 1.509 INCHES
VOLUME OF EXCESS PRECIP = 2. ACRE-FEET
PEAK Q = 52. CFS TIME OF PEAK = 30. MIN.
INFILT.= 4.50 IN/HR DECAY =0.00180 FNINF = 0.60 IN/HR
MAX.PERV.RET.=0.40 IN. MAX.IMP.RET.=0.10 IN.

RATIONAL FORMULA C = 0.70
I = 4.2 INCHES/HOUR
A = 18.6 ACRES
Q = 55. CFS

U.D.F.C.D. CUHP RUNOFF ANALYSIS EXECUTED ON DATE AT TIME

CUHPE/PC VERSION MODIFIED IN JANUARY 1985

PRINT OPTION NUMBER SELECTED FOR THIS BASIN IS 7

RACETRACK DRAW, RBP PHIII: 10-YEAR STORM FULLY-DEVELOPED

BASIN ID: RTD102 -- BASIN COMMENT: RACETRACK DRAW RBP PH III: SUB-BASIN 102A

AREA OF BASIN (SQMI)	LENGTH OF BASIN (MI)	DIST TO CENTROID (MI)	IMPERVIOUS AREA (PCT)	SLOPE (FT/FT)	UNIT DURATION (MIN)
0.09	0.69	0.32	69.80	.0310	5.00

COEFFICIENT (REFLECTING TIME TO PEAK)	COEFFICIENT (RELATED TO PEAK RATE OF RUNOFF)
0.080	0.531

CALCULATED UNIT HYDROGRAPH

TIME TO PEAK (MIN)	TIME OF CONCENTRATION (MIN)	PEAK RATE OF RUNOFF (CFS/SQMI)	UNIT HYDROGRAPH PEAK (CFS)	VOLUME OF RUNOFF (AF)
13.30	30.00	1886.71	179.24	5.07

*** NOTE : THE TIME TO PEAK IS CALCULATED BASED ON THE TIME OF CONCENTRATION PROVIDED BY THE USER, REPLACING THE ONE COMPUTED BY CUHPD (TP= 7.89)

WIDTH AT 50 = 16. MIN. WIDTH AT 75 = 8. MIN. K50 =0.35 K75 =0.45

RAINFALL LOSSES INPUT W/ BASIN DATA

MAX. PERVIOUS RET. =0.40 IN. MAX. IMPERVIOUS RET. =0.10 IN.
INFILTRATION = 4.20 IN./HR. DECAY = 0.00180/SECOND FNINFL = 0.58 IN./HR.

TIME	UNIT HYDROGRAPH	TIME	UNIT HYDROGRAPH	TIME	UNIT HYDROGRAPH
0.	0.	25.	82.	50.	15.
5.	42.	30.	58.	55.	11.
10.	145.	35.	42.	60.	8.
15.	172.	40.	30.	65.	0.
20.	118.	45.	21.	0.	0.

BASIN ID: RTD102 -- BASIN COMMENT: RACETRACK DRAW RBP PH III: SUB-BASIN 102A

**** STORM NO. = 1 **** DATE OR RETURN PERIOD = 10-YEAR

TIME (MIN.)	INCREMENT RAINFALL (IN)	TOTAL EXCESS PRECIP	STORM HYDROGRAPH (CFS)	*	TIME (MIN.)	INCREMENT RAINFALL (IN)	TOTAL EXCESS PRECIP	STORM HYDROGRAPH (CFS)	*
0.	0.00	0.000	0.	*	80.	0.05	0.031	37.	*
5.	0.04	0.000	0.	*	85.	0.04	0.023	31.	*
10.	0.07	0.004	0.	*	90.	0.04	0.023	27.	*
15.	0.15	0.101	5.	*	95.	0.04	0.023	24.	*
20.	0.28	0.185	23.	*	100.	0.04	0.023	22.	*
25.	0.47	0.369	60.	*	105.	0.04	0.023	20.	*
30.	0.22	0.196	106.	*	110.	0.04	0.023	19.	*
35.	0.10	0.083	126.	*	115.	0.03	0.021	19.	*
40.	0.08	0.061	113.	*	120.	0.02	0.016	18.	*
45.	0.07	0.053	94.	*	125.	0.00	0.000	15.	*
50.	0.06	0.042	78.	*	130.	0.00	0.000	12.	*
55.	0.06	0.043	65.	*	135.	0.00	0.000	8.	*
60.	0.06	0.043	56.	*	140.	0.00	0.000	5.	*
65.	0.06	0.043	49.	*	145.	0.00	0.000	4.	*
70.	0.06	0.043	44.	*	150.	0.00	0.000	3.	*
75.	0.06	0.043	40.	*	155.	0.00	0.000	2.	*

TOTAL PRECIP. = 2.15 (1-HOUR RAIN = 1.86) EXECESS PRECIP. = 1.517 INCHES
VOLUME OF EXCESS PRECIP = 8. ACRE-FEET
PEAK Q = 126. CFS TIME OF PEAK = 35. MIN.
INFILT.= 4.20 IN/HR DECAY =0.00180 FNINF = 0.58 IN/HR
MAX.PERV.RET.=0.40 IN. MAX.IMP.RET.=0.10 IN.

RATIONAL FORMULA C = 0.70
I = 2.9 INCHES/HOUR
A = 60.8 ACRES
Q = 125. CFS

100-year CUHP Fully-Developed Output

FERBER ENGINEERING COMPANY

U.D.F.C.D. CUHP RUNOFF ANALYSIS EXECUTED ON DATE AT TIME

CUHPE/PC VERSION MODIFIED IN JANUARY 1985

PRINT OPTION NUMBER SELECTED FOR THIS BASIN IS 7

RACETRACK DRAW, RBP PHIII: 100-YEAR STORM FULLY-DEVELOPED

BASIN ID: RTD101 -- BASIN COMMENT: RACETRACK DRAW, RBP PH III: SUB-BASIN 101A

AREA OF BASIN (SQMI)	LENGTH OF BASIN (MI)	DIST TO CENTROID (MI)	IMPERVIOUS AREA (PCT)	SLOPE (FT/FT)	UNIT DURATION (MIN)
0.16	0.90	0.44	52.40	.0280	5.00

COEFFICIENT (REFLECTING TIME TO PEAK)	COEFFICIENT (RELATED TO PEAK RATE OF RUNOFF)
0.087	0.490

CALCULATED UNIT HYDROGRAPH

TIME TO PEAK (MIN)	TIME OF CONCENTRATION (MIN)	PEAK RATE OF RUNOFF (CFS/SQMI)	UNIT HYDROGRAPH PEAK (CFS)	VOLUME OF RUNOFF (AF)
10.40	35.00	2380.22	385.60	8.64

WIDTH AT 50 = 13. MIN. WIDTH AT 75 = 7. MIN. K50 =0.35 K75 =0.45

RAINFALL LOSSES INPUT W/ BASIN DATA

MAX. PERVIOUS RET. =0.40 IN. MAX. IMPERVIOUS RET. =0.10 IN.
INFILTRATION = 4.30 IN./HR. DECAY = 0.00180/SECOND FNINFL = 0.59 IN./HR.

TIME	UNIT HYDROGRAPH		TIME	UNIT HYDROGRAPH		TIME	UNIT HYDROGRAPH	
0.	0.	*	25.	109.	*	50.	12.	*
5.	140.	*	30.	70.	*	55.	7.	*
10.	384.	*	35.	44.	*	60.	0.	*
15.	268.	*	40.	28.	*	0.	0.	*
20.	170.	*	45.	18.	*	0.	0.	*

BASIN ID: RTD101 -- BASIN COMMENT: RACETRACK DRAW, RBP PH III: SUB-BASIN 101A

**** STORM NO. = 1 **** DATE OR RETURN PERIOD = 100-YEAR

TIME (MIN.)	INCREMENT RAINFALL (IN)	TOTAL EXCESS PRECIP	STORM HYDROGRAPH (CFS)	TIME (MIN.)	INCREMENT RAINFALL (IN)	TOTAL EXCESS PRECIP	STORM HYDROGRAPH (CFS)
0.	0.00	0.000	0.	80.	0.07	0.047	84.
5.	0.06	0.000	0.	85.	0.06	0.030	72.
10.	0.11	0.033	5.	90.	0.06	0.030	60.
15.	0.24	0.118	29.	95.	0.06	0.030	51.
20.	0.44	0.239	88.	100.	0.06	0.030	46.
25.	0.73	0.670	223.	105.	0.06	0.030	43.
30.	0.35	0.308	388.	110.	0.06	0.030	41.
35.	0.16	0.130	372.	115.	0.05	0.025	39.
40.	0.12	0.095	296.	120.	0.04	0.019	35.
45.	0.11	0.082	231.	125.	0.00	0.000	28.
50.	0.09	0.066	183.	130.	0.00	0.000	18.
55.	0.09	0.066	148.	135.	0.00	0.000	11.
60.	0.09	0.067	125.	140.	0.00	0.000	7.
65.	0.09	0.067	110.	145.	0.00	0.000	4.
70.	0.09	0.067	100.	150.	0.00	0.000	3.
75.	0.09	0.067	93.	155.	0.00	0.000	2.

TOTAL PRECIP. = 3.36 (1-HOUR RAIN = 2.90) EXECESS PRECIP. = 2.348 INCHES
VOLUME OF EXCESS PRECIP = 20. ACRE-FEET
PEAK Q = 388. CFS TIME OF PEAK = 30. MIN.
INFILT.= 4.30 IN/HR DECAY =0.00180 FNINF = 0.59 IN/HR
MAX.PERV.RET.=0.40 IN. MAX.IMP.RET.=0.10 IN.

RATIONAL FORMULA C = 0.70
I = 4.1 INCHES/HOUR
A = 103.7 ACRES
Q = 300. CFS

U.D.F.C.D. CUHP RUNOFF ANALYSIS EXECUTED ON DATE AT TIME

CUHPE/PC VERSION MODIFIED IN JANUARY 1985

PRINT OPTION NUMBER SELECTED FOR THIS BASIN IS 7

RACETRACK DRAW, RBP PHIII: 100-YEAR STORM FULLY-DEVELOPED

BASIN ID: RTD102 -- BASIN COMMENT: RACETRACK DRAW RBP PH III: SUB-BASIN 102A

AREA OF BASIN (SQMI)	LENGTH OF BASIN (MI)	DIST TO CENTROID (MI)	IMPERVIOUS AREA (PCT)	SLOPE (FT/FT)	UNIT DURATION (MIN)
0.09	0.69	0.32	69.80	.0310	5.00

COEFFICIENT (REFLECTING TIME TO PEAK)	COEFFICIENT (RELATED TO PEAK RATE OF RUNOFF)
0.080	0.531

CALCULATED UNIT HYDROGRAPH

TIME TO PEAK (MIN)	TIME OF CONCENTRATION (MIN)	PEAK RATE OF RUNOFF (CFS/SQMI)	UNIT HYDROGRAPH PEAK (CFS)	VOLUME OF RUNOFF (AF)
13.30	30.00	1886.71	179.24	5.07

*** NOTE : THE TIME TO PEAK IS CALCULATED BASED ON THE TIME OF CONCENTRATION PROVIDED BY THE USER, REPLACING THE ONE COMPUTED BY CUHPD (TP= 7.89)

WIDTH AT 50 = 16. MIN. WIDTH AT 75 = 8. MIN. K50 =0.35 K75 =0.45

RAINFALL LOSSES INPUT W/ BASIN DATA

MAX. PERVIOUS RET. =0.40 IN. MAX. IMPERVIOUS RET. =0.10 IN.
INFILTRATION = 4.20 IN./HR. DECAY = 0.00180/SECOND FNINFL = 0.58 IN./HR.

TIME	UNIT HYDROGRAPH		TIME	UNIT HYDROGRAPH		TIME	UNIT HYDROGRAPH	
0.	0.	*	25.	82.	*	50.	15.	*
5.	42.	*	30.	58.	*	55.	11.	*
10.	145.	*	35.	42.	*	60.	8.	*
15.	172.	*	40.	30.	*	65.	0.	*
20.	118.	*	45.	21.	*	0.	0.	*

BASIN ID: RTD102 -- BASIN COMMENT: RACETRACK DRAW RBP PH III: SUB-BASIN 102A

**** STORM NO. = 1 **** DATE OR RETURN PERIOD = 100-YEAR

TIME (MIN.)	INCREMENT RAINFALL (IN)	TOTAL EXCESS PRECIP	STORM HYDROGRAPH (CFS)	TIME (MIN.)	INCREMENT RAINFALL (IN)	TOTAL EXCESS PRECIP	STORM HYDROGRAPH (CFS)
0.	0.00	0.000	0.	80.	0.07	0.055	64.
5.	0.06	0.000	0.	85.	0.06	0.039	55.
10.	0.11	0.043	2.	90.	0.06	0.039	47.
15.	0.24	0.158	13.	95.	0.06	0.039	41.
20.	0.44	0.304	43.	100.	0.06	0.039	37.
25.	0.73	0.677	105.	105.	0.06	0.039	34.
30.	0.35	0.317	186.	110.	0.06	0.039	32.
35.	0.16	0.139	219.	115.	0.05	0.033	31.
40.	0.12	0.104	195.	120.	0.04	0.025	29.
45.	0.11	0.091	161.	125.	0.00	0.000	25.
50.	0.09	0.074	134.	130.	0.00	0.000	19.
55.	0.09	0.075	113.	135.	0.00	0.000	13.
60.	0.09	0.075	97.	140.	0.00	0.000	9.
65.	0.09	0.075	85.	145.	0.00	0.000	6.
70.	0.09	0.075	77.	150.	0.00	0.000	4.
75.	0.09	0.075	70.	155.	0.00	0.000	3.

TOTAL PRECIP. = 3.36 (1-HOUR RAIN = 2.90) EXECESS PRECIP. = 2.627 INCHES
VOLUME OF EXCESS PRECIP = 13. ACRE-FEET
PEAK Q = 219. CFS TIME OF PEAK = 35. MIN.
INFILT.= 4.20 IN/HR DECAY =0.00180 FNINF = 0.58 IN/HR
MAX.PERV.RET.=0.40 IN. MAX.IMP.RET.=0.10 IN.

RATIONAL FORMULA C = 0.78
I = 4.5 INCHES/HOUR
A = 60.8 ACRES
Q = 216. CFS

U.D.F.C.D. CUHP RUNOFF ANALYSIS EXECUTED ON DATE AT TIME

CUHPE/PC VERSION MODIFIED IN JANUARY 1985

PRINT OPTION NUMBER SELECTED FOR THIS BASIN IS 7

RACETRACK DRAW, RBP PHIII: 100-YEAR STORM FULLY-DEVELOPED

BASIN ID: RTD301 -- BASIN COMMENT: RACETRACK DRAW RBP PH III: SUB-BASIN 101B

AREA OF BASIN (SQMI)	LENGTH OF BASIN (MI)	DIST TO CENTROID (MI)	IMPERVIOUS AREA (PCT)	SLOPE (FT/FT)	UNIT DURATION (MIN)
0.03	0.35	0.13	70.00	.0300	5.00

COEFFICIENT (REFLECTING TIME TO PEAK)	COEFFICIENT (RELATED TO PEAK RATE OF RUNOFF)
0.080	0.445

CALCULATED UNIT HYDROGRAPH

TIME TO PEAK (MIN)	TIME OF CONCENTRATION (MIN)	PEAK RATE OF RUNOFF (CFS/SQMI)	UNIT HYDROGRAPH PEAK (CFS)	VOLUME OF RUNOFF (AF)
6.18	13.00	4635.81	134.44	1.55

*** NOTE : THE TIME TO PEAK IS CALCULATED BASED ON THE TIME OF CONCENTRATION PROVIDED BY THE USER, REPLACING THE ONE COMPUTED BY CUHPD (TP= 5.02)

WIDTH AT 50 = 6. MIN. WIDTH AT 75 = 3. MIN. K50 =0.35 K75 =0.45

RAINFALL LOSSES INPUT W/ BASIN DATA

MAX. PERVIOUS RET. =0.40 IN. MAX. IMPERVIOUS RET. =0.10 IN.
INFILTRATION = 4.50 IN./HR. DECAY = 0.00180/SECOND FNINFL = 0.60 IN./HR.

TIME	UNIT HYDROGRAPH		TIME	UNIT HYDROGRAPH		TIME	UNIT HYDROGRAPH	
0.	0.	*	10.	73.	*	20.	14.	*
5.	115.	*	15.	32.	*	25.	0.	*

BASIN ID: RTD301 -- BASIN COMMENT: RACETRACK DRAW RBP PH III: SUB-BASIN 101B

**** STORM NO. = 1 **** DATE OR RETURN PERIOD = 100-YEAR

TIME (MIN.)	INCREMENT RAINFALL (IN)	TOTAL EXCESS PRECIP	STORM HYDROGRAPH (CFS)	TIME (MIN.)	INCREMENT RAINFALL (IN)	TOTAL EXCESS PRECIP	STORM HYDROGRAPH (CFS)
0.	0.00	0.000	0.	65.	0.09	0.074	17.
5.	0.06	0.000	0.	70.	0.09	0.074	17.
10.	0.11	0.043	5.	75.	0.09	0.075	17.
15.	0.24	0.158	21.	80.	0.07	0.055	15.
20.	0.44	0.301	47.	85.	0.06	0.038	12.
25.	0.73	0.676	105.	90.	0.06	0.038	10.
30.	0.35	0.316	97.	95.	0.06	0.038	9.
35.	0.16	0.139	65.	100.	0.06	0.038	9.
40.	0.12	0.104	42.	105.	0.06	0.038	9.
45.	0.11	0.090	27.	110.	0.06	0.038	9.
50.	0.09	0.074	20.	115.	0.05	0.033	8.
55.	0.09	0.074	18.	120.	0.04	0.025	7.
60.	0.09	0.074	18.	125.	0.00	0.000	3.

TOTAL PRECIP. = 3.36 (1-HOUR RAIN = 2.90) EXECESS PRECIP. = 2.615 INCHES
VOLUME OF EXCESS PRECIP = 4. ACRE-FEET
PEAK Q = 105. CFS TIME OF PEAK = 25. MIN.
INFILT.= 4.50 IN/HR DECAY =0.00180 FNINF = 0.60 IN/HR
MAX.PERV.RET.=0.40 IN. MAX.IMP.RET.=0.10 IN.

RATIONAL FORMULA C = 0.78
I = 7.0 INCHES/HOUR
A = 18.6 ACRES
Q = 101. CFS

INDEX

UDSWMM Output Files

2-year Fully-Developed Output

10-year Fully-Developed Output

100-year Fully-Developed Output

Appendix B

FERBER ENGINEERING COMPANY

2-year UDSWMM Fully-Developed Output

FERBER ENGINEERING COMPANY

URBAN DRAINAGE STORM WATER MANAGEMENT MODEL - 32 BIT VERSION 1998
REVISED BY UNIVERSITY OF COLORADO AT DENVER

*** ENTRY MADE TO RUNOFF MODEL ***

RACETRACK DRAW, FUTURE FACILITIES, RPB III RAPID CITY, SD
FERBER ENGINEERING COMPANY, FUSWMM.IN, DEC 2001, DMM/FEC

ONUMBER OF TIME STEPS 72
OINTEGRATION TIME INTERVAL (MINUTES), 5.00

25.0 PERCENT OF IMPERVIOUS AREA HAS ZERO DETENTION DEPTH
1

RACETRACK DRAW, FUTURE FACILITIES, RPB III RAPID CITY, SD
FERBER ENGINEERING COMPANY, FUSWMM.IN, DEC 2001, DMM/FEC

HYDROGRAPHS FROM CUHPF MODEL ARE LISTED FOR THE FOLLOWING 3 SUBCATCHMENTS

TIME(HR/MIN)		101	102	301
0	0.	0.	0.	0.
0	5.	0.	0.	0.
0	10.	0.	0.	0.
0	15.	4.	2.	3.
0	20.	23.	10.	12.
0	25.	61.	31.	24.
0	30.	92.	55.	27.
0	35.	89.	65.	21.
0	40.	72.	59.	15.
0	45.	57.	49.	10.
0	50.	44.	41.	7.
0	55.	36.	34.	5.
1	0.	30.	29.	5.
1	5.	27.	25.	5.
1	10.	24.	23.	4.
1	15.	20.	20.	4.
1	20.	17.	16.	4.
1	25.	16.	14.	3.
1	30.	15.	13.	3.
1	35.	14.	12.	3.
1	40.	14.	11.	3.
1	45.	14.	11.	3.
1	50.	14.	11.	3.
1	55.	13.	11.	3.
2	0.	11.	10.	2.
2	5.	9.	8.	0.
2	10.	6.	6.	0.
2	15.	3.	4.	0.
2	20.	2.	3.	0.
2	25.	0.	2.	0.

RACETRACK DRAW, FUTURE FACILITIES, RPB III RAPID CITY, SD
FERBER ENGINEERING COMPANY, FUSWMM.IN, DEC 2001, DMM/FEC

GUTTER NUMBER	GUTTER CONNECTION	NDP	NP		WIDTH OR DIAM (FT)	LENGTH (FT)	INVERT SLOPE (FT/FT)	SIDE SLOPES HORIZ TO VERT L	R	MANNING N	OVERBANK/SURCHARGE DEPTH	JK (FT)
101	500	13	2	PIPE	.1	1.	.0100	.0	.0	.016	.10	0
		RESERVOIR STORAGE IN ACRE-FEET VS SPILLWAY OUTFLOW										
		.0	.0	1.0	3.0	2.2	5.0	3.6	6.0	5.1	7.0	6.9	8.0
		8.8	9.0	10.9	10.0	13.1	11.0	15.6	36.0	18.3	97.0	21.1	177.0
		24.1	273.0										
102	500	8	2	PIPE	.1	1.	.0100	.0	.0	.016	.10	0
		RESERVOIR STORAGE IN ACRE-FEET VS SPILLWAY OUTFLOW										
		.0	.0	.6	3.0	1.4	5.0	2.4	14.0	3.4	33.0	4.7	91.0
		6.0	169.0	7.5	264.0								
27	26	0	2	PIPE	5.0	128.	.0300	.0	.0	.016	5.00	0
500	27	0	3		.0	1.	.0010	.0	.0	.001	10.00	0

OTOTAL NUMBER OF GUTTERS/PIPES, 4
1

RACETRACK DRAW, FUTURE FACILITIES, RPB III RAPID CITY, SD
FERBER ENGINEERING COMPANY, FUSWMM.IN, DEC 2001, DMM/FEC

ARRANGEMENT OF SUBCATCHMENTS AND GUTTERS/PIPES

GUTTER	TRIBUTARY GUTTER/PIPE										TRIBUTARY SUBAREA										D.A.(AC)
27	500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	183.0
101	0	0	0	0	0	0	0	0	0	0	101	0	0	0	0	0	0	0	0	0	103.7
102	0	0	0	0	0	0	0	0	0	0	102	0	0	0	0	0	0	0	0	0	60.8
500	101	102	0	0	0	0	0	0	0	0	301	0	0	0	0	0	0	0	0	0	183.0

1

RACETRACK DRAW, FUTURE FACILITIES, RPB III RAPID CITY, SD
FERBER ENGINEERING COMPANY, FUSWMM.IN, DEC 2001, DMM/FEC

HYDROGRAPHS ARE LISTED FOR THE FOLLOWING 5 CONVEYANCE ELEMENTS

THE UPPER NUMBER IS DISCHARGE IN CFS
THE LOWER NUMBER IS ONE OF THE FOLLOWING CASES:
( ) DENOTES DEPTH ABOVE INVERT IN FEET
(S) DENOTES STORAGE IN AC-FT FOR DETENTION DAM. DISCHARGE INCLUDES SPILLWAY OUTFLOW.
(I) DENOTES GUTTER INFLOW IN CFS FROM SPECIFIED INFLOW HYDROGRAPH
(D) DENOTES DISCHARGE IN CFS DIVERTED FROM THIS GUTTER
(O) DENOTES STORAGE IN AC-FT FOR SURCHARGED GUTTER

TIME(HR/MIN)		101	102	500	27	26
0	5.	0.	0.	0.	0.	0.
		.0(S)	.0(S)	.0( )	.0( )	.0( )
0	10.	0.	0.	0.	0.	0.
		.0(S)	.0(S)	.0( )	.0( )	.0( )
0	15.	0.	0.	3.	3.	3.
		.0(S)	.0(S)	.0( )	.3( )	.0( )
0	20.	0.	0.	12.	12.	12.
		.1(S)	.0(S)	.0( )	.6( )	.0( )
0	25.	1.	1.	26.	26.	26.
		.4(S)	.2(S)	.0( )	.9( )	.0( )
0	30.	3.	2.	32.	32.	32.
		.9(S)	.5(S)	.0( )	1.0( )	.0( )
0	35.	4.	4.	29.	29.	29.
		1.5(S)	.9(S)	.0( )	.9( )	.0( )
0	40.	5.	5.	25.	25.	25.

		2.0(S)	1.3(S)	.0( )	.9( )	.0( )
0	45.	5. 2.4(S)	7. 1.6(S)	22. .0( )	22. .8( )	22. .0( )
0	50.	5. 2.8(S)	9. 1.9(S)	21. .0( )	21. .8( )	21. .0( )
0	55.	6. 3.0(S)	11. 2.0(S)	22. .0( )	22. .8( )	22. .0( )
1	0.	6. 3.2(S)	12. 2.2(S)	23. .0( )	23. .8( )	23. .0( )
1	5.	6. 3.3(S)	13. 2.3(S)	24. .0( )	24. .9( )	24. .0( )
1	10.	6. 3.5(S)	14. 2.4(S)	24. .0( )	24. .9( )	24. .0( )
1	15.	6. 3.6(S)	15. 2.4(S)	24. .0( )	24. .9( )	24. .0( )
1	20.	6. 3.7(S)	15. 2.4(S)	25. .0( )	25. .9( )	25. .0( )
1	25.	6. 3.7(S)	15. 2.4(S)	24. .0( )	24. .9( )	24. .0( )
1	30.	6. 3.8(S)	15. 2.4(S)	24. .0( )	24. .9( )	24. .0( )
1	35.	6. 3.9(S)	14. 2.4(S)	24. .0( )	24. .9( )	24. .0( )
1	40.	6. 3.9(S)	14. 2.4(S)	24. .0( )	24. .9( )	24. .0( )
1	45.	6. 4.0(S)	14. 2.4(S)	23. .0( )	23. .9( )	23. .0( )
1	50.	6. 4.0(S)	14. 2.3(S)	23. .0( )	23. .9( )	23. .0( )
1	55.	6. 4.1(S)	14. 2.3(S)	23. .0( )	23. .8( )	23. .0( )
2	0.	6. 4.1(S)	13. 2.3(S)	22. .0( )	22. .8( )	22. .0( )
2	5.	6. 4.1(S)	13. 2.3(S)	19. .0( )	20. .8( )	20. .0( )
2	10.	6. 4.1(S)	13. 2.2(S)	19. .0( )	19. .8( )	19. .0( )
2	15.	6. 4.1(S)	12. 2.2(S)	19. .0( )	19. .8( )	19. .0( )
2	20.	6. 4.1(S)	12. 2.1(S)	18. .0( )	18. .8( )	18. .0( )
2	25.	6. 4.1(S)	11. 2.1(S)	17. .0( )	17. .7( )	17. .0( )
2	30.	6. 4.0(S)	10. 2.0(S)	17. .0( )	17. .7( )	17. .0( )
2	35.	6. 4.0(S)	10. 1.9(S)	16. .0( )	16. .7( )	16. .0( )
2	40.	6. 3.9(S)	9. 1.9(S)	15. .0( )	15. .7( )	15. .0( )
2	45.	6. 3.9(S)	8. 1.8(S)	15. .0( )	15. .7( )	15. .0( )
2	50.	6. 3.8(S)	8. 1.7(S)	14. .0( )	14. .7( )	14. .0( )
2	55.	6. 3.8(S)	7. 1.7(S)	14. .0( )	14. .7( )	14. .0( )

3	0.	6. 3.8(S)	7. 1.6(S)	13. .0( )	13. .6( )	13. .0( )
3	5.	6. 3.7(S)	6. 1.6(S)	13. .0( )	13. .6( )	13. .0( )
3	10.	6. 3.7(S)	6. 1.5(S)	12. .0( )	12. .6( )	12. .0( )
3	15.	6. 3.6(S)	6. 1.5(S)	12. .0( )	12. .6( )	12. .0( )
3	20.	6. 3.6(S)	5. 1.5(S)	11. .0( )	11. .6( )	11. .0( )
3	25.	6. 3.6(S)	5. 1.4(S)	11. .0( )	11. .6( )	11. .0( )
3	30.	6. 3.5(S)	5. 1.4(S)	11. .0( )	11. .6( )	11. .0( )
3	35.	6. 3.5(S)	5. 1.4(S)	11. .0( )	11. .6( )	11. .0( )
3	40.	6. 3.4(S)	5. 1.3(S)	11. .0( )	11. .6( )	11. .0( )
3	45.	6. 3.4(S)	5. 1.3(S)	11. .0( )	11. .6( )	11. .0( )
3	50.	6. 3.4(S)	5. 1.3(S)	10. .0( )	10. .6( )	10. .0( )
3	55.	6. 3.3(S)	4. 1.2(S)	10. .0( )	10. .6( )	10. .0( )
4	0.	6. 3.3(S)	4. 1.2(S)	10. .0( )	10. .6( )	10. .0( )
4	5.	6. 3.2(S)	4. 1.2(S)	10. .0( )	10. .6( )	10. .0( )
4	10.	6. 3.2(S)	4. 1.1(S)	10. .0( )	10. .6( )	10. .0( )
4	15.	6. 3.2(S)	4. 1.1(S)	10. .0( )	10. .6( )	10. .0( )
4	20.	6. 3.1(S)	4. 1.1(S)	10. .0( )	10. .6( )	10. .0( )
4	25.	6. 3.1(S)	4. 1.1(S)	10. .0( )	10. .6( )	10. .0( )
4	30.	6. 3.0(S)	4. 1.0(S)	10. .0( )	10. .6( )	10. .0( )
4	35.	6. 3.0(S)	4. 1.0(S)	9. .0( )	10. .6( )	10. .0( )
4	40.	6. 3.0(S)	4. 1.0(S)	9. .0( )	9. .6( )	9. .0( )
4	45.	6. 2.9(S)	4. 1.0(S)	9. .0( )	9. .5( )	9. .0( )
4	50.	6. 2.9(S)	4. .9(S)	9. .0( )	9. .5( )	9. .0( )
4	55.	5. 2.8(S)	4. .9(S)	9. .0( )	9. .5( )	9. .0( )
5	0.	5. 2.8(S)	4. .9(S)	9. .0( )	9. .5( )	9. .0( )
5	5.	5. 2.8(S)	4. .9(S)	9. .0( )	9. .5( )	9. .0( )
5	10.	5. 2.7(S)	3. .8(S)	9. .0( )	9. .5( )	9. .0( )
5	15.	5. 2.7(S)	3. .8(S)	9. .0( )	9. .5( )	9. .0( )

5	20.	5. 2.7(S)	3. .8(S)	9. .0( )	9. .5( )	9. .0( )
5	25.	5. 2.6(S)	3. .8(S)	9. .0( )	9. .5( )	9. .0( )
5	30.	5. 2.6(S)	3. .7(S)	9. .0( )	9. .5( )	9. .0( )
5	35.	5. 2.5(S)	3. .7(S)	8. .0( )	8. .5( )	8. .0( )
5	40.	5. 2.5(S)	3. .7(S)	8. .0( )	8. .5( )	8. .0( )
5	45.	5. 2.5(S)	3. .7(S)	8. .0( )	8. .5( )	8. .0( )
5	50.	5. 2.4(S)	3. .7(S)	8. .0( )	8. .5( )	8. .0( )
5	55.	5. 2.4(S)	3. .6(S)	8. .0( )	8. .5( )	8. .0( )
6	0.	5. 2.4(S)	3. .6(S)	8. .0( )	8. .5( )	8. .0( )

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RACETRACK DRAW, FUTURE FACILITIES, RPB III RAPID CITY, SD
FERBER ENGINEERING COMPANY, FUSWMM.IN, DEC 2001, DMM/FEC

*** PEAK FLOWS, STAGES AND STORAGES OF GUTTERS AND DETENTION DAMS ***

CONVEYANCE ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)	TIME (HR/MIN)
102	15.	.1	2.4	1 25.
101	6.	.1	4.1	2 10.
500	32.	(DIRECT FLOW)		0 30.
27	32.	1.0		0 30.
26	32.	(DIRECT FLOW)		0 30.

10-year UDSWMM Fully-Developed Output

FERBER ENGINEERING COMPANY

URBAN DRAINAGE STORM WATER MANAGEMENT MODEL - 32 BIT VERSION 1998
REVISED BY UNIVERSITY OF COLORADO AT DENVER

*** ENTRY MADE TO RUNOFF MODEL ***

RACETRACK DRAW, FUTURE FACILITIES, RPB III RAPID CITY, SD
FERBER ENGINEERING COMPANY, FUSWMM.IN, DEC 2001, DMM/FEC

ONUMBER OF TIME STEPS 72
OINTEGRATION TIME INTERVAL (MINUTES), 5.00

25.0 PERCENT OF IMPERVIOUS AREA HAS ZERO DETENTION DEPTH

RACETRACK DRAW, FUTURE FACILITIES, RPB III RAPID CITY, SD
FERBER ENGINEERING COMPANY, FUSWMM.IN, DEC 2001, DMM/FEC

HYDROGRAPHS FROM CUHPF MODEL ARE LISTED FOR THE FOLLOWING 3 SUBCATCHMENTS

TIME(HR/MIN)		101	102	301
0	0.	0.	0.	0.
0	5.	0.	0.	0.
0	10.	0.	0.	0.
0	15.	12.	5.	8.
0	20.	49.	23.	22.
0	25.	120.	60.	46.
0	30.	201.	106.	52.
0	35.	201.	126.	40.
0	40.	161.	113.	28.
0	45.	126.	94.	20.
0	50.	99.	78.	13.
0	55.	79.	65.	11.
1	0.	66.	56.	10.
1	5.	58.	49.	10.
1	10.	52.	44.	9.
1	15.	49.	40.	9.
1	20.	44.	37.	9.
1	25.	37.	31.	7.
1	30.	31.	27.	6.
1	35.	28.	24.	6.
1	40.	26.	22.	5.
1	45.	24.	20.	5.
1	50.	23.	19.	5.
1	55.	23.	19.	5.
2	0.	21.	18.	4.
2	5.	17.	15.	3.
2	10.	11.	12.	0.
2	15.	7.	8.	0.
2	20.	4.	5.	0.
2	25.	3.	4.	0.
2	30.	2.	3.	0.
2	35.	0.	2.	0.

RACETRACK DRAW, FUTURE FACILITIES, RPB III RAPID CITY, SD
FERBER ENGINEERING COMPANY, FUSWMM.IN, DEC 2001, DMM/FEC

GUTTER NUMBER	GUTTER CONNECTION	NDP	NP		WIDTH OR DIAM (FT)	LENGTH (FT)	INVERT SLOPE (FT/FT)	SIDE SLOPES HORIZ TO VERT L	R	MANNING N	OVERBANK/SURCHARGE DEPTH	JK (FT)
101	500	13	2	PIPE	.1	1.	.0100	.0	.0	.016	.10	0
		RESERVOIR STORAGE IN ACRE-FEET VS SPILLWAY OUTFLOW										
		.0	.0	1.0	3.0	2.2	5.0	3.6	6.0	5.1	7.0	6.9	8.0
		8.8	9.0	10.9	10.0	13.1	11.0	15.6	36.0	18.3	97.0	21.1	177.0
		24.1	273.0										
102	500	8	2	PIPE	.1	1.	.0100	.0	.0	.016	.10	0
		RESERVOIR STORAGE IN ACRE-FEET VS SPILLWAY OUTFLOW										
		.0	.0	.6	3.0	1.4	5.0	2.4	14.0	3.4	33.0	4.7	91.0
		6.0	169.0	7.5	264.0								
27	26	0	2	PIPE	5.0	128.	.0300	.0	.0	.016	5.00	0
500	27	0	3		.0	1.	.0010	.0	.0	.001	10.00	0

OTOTAL NUMBER OF GUTTERS/PIPES, 4
1

RACETRACK DRAW, FUTURE FACILITIES, RPB III RAPID CITY, SD
FERBER ENGINEERING COMPANY, FUSWMM.IN, DEC 2001, DMM/FEC

ARRANGEMENT OF SUBCATCHMENTS AND GUTTERS/PIPES

GUTTER	TRIBUTARY GUTTER/PIPE										TRIBUTARY SUBAREA										D.A.(AC)
27	500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	183.0
101	0	0	0	0	0	0	0	0	0	0	101	0	0	0	0	0	0	0	0	0	103.7
102	0	0	0	0	0	0	0	0	0	0	102	0	0	0	0	0	0	0	0	0	60.8
500	101	102	0	0	0	0	0	0	0	0	301	0	0	0	0	0	0	0	0	0	183.0

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RACETRACK DRAW, FUTURE FACILITIES, RPB III RAPID CITY, SD
FERBER ENGINEERING COMPANY, FUSWMM.IN, DEC 2001, DMM/FEC

HYDROGRAPHS ARE LISTED FOR THE FOLLOWING 5 CONVEYANCE ELEMENTS

THE UPPER NUMBER IS DISCHARGE IN CFS
THE LOWER NUMBER IS ONE OF THE FOLLOWING CASES:
( ) DENOTES DEPTH ABOVE INVERT IN FEET
(S) DENOTES STORAGE IN AC-FT FOR DETENTION DAM. DISCHARGE INCLUDES SPILLWAY OUTFLOW.
(I) DENOTES GUTTER INFLOW IN CFS FROM SPECIFIED INFLOW HYDROGRAPH
(D) DENOTES DISCHARGE IN CFS DIVERTED FROM THIS GUTTER
(O) DENOTES STORAGE IN AC-FT FOR SURCHARGED GUTTER

TIME(HR/MIN)		101	102	500	27	26
0	5.	0. .0(S)	0. .0(S)	0. .0( )	0. .0( )	0. .0( )
0	10.	0. .0(S)	0. .0(S)	0. .0( )	0. .1( )	0. .0( )
0	15.	0. .0(S)	0. .0(S)	8. .0( )	8. .5( )	8. .0( )
0	20.	1. .3(S)	1. .1(S)	23. .0( )	23. .8( )	23. .0( )
0	25.	2. .8(S)	2. .4(S)	50. .0( )	49. 1.2( )	49. .0( )
0	30.	5. 1.9(S)	4. .9(S)	60. .0( )	61. 1.4( )	61. .0( )
0	35.	6. 3.3(S)	8. 1.7(S)	54. .0( )	53. 1.3( )	53. .0( )
0	40.	7.	15.	50.	50.	50.

		4.5(S)	2.4(S)	.0( )	1.3( )	.0( )
0	45.	7. 5.4(S)	25. 3.0(S)	53. .0( )	52. 1.3( )	52. .0( )
0	50.	8. 6.1(S)	32. 3.4(S)	53. .0( )	54. 1.3( )	54. .0( )
0	55.	8. 6.7(S)	43. 3.6(S)	61. .0( )	60. 1.4( )	60. .0( )
1	0.	8. 7.1(S)	48. 3.7(S)	66. .0( )	66. 1.4( )	66. .0( )
1	5.	8. 7.5(S)	49. 3.8(S)	67. .0( )	67. 1.4( )	67. .0( )
1	10.	9. 7.8(S)	48. 3.8(S)	66. .0( )	67. 1.4( )	67. .0( )
1	15.	9. 8.1(S)	47. 3.7(S)	65. .0( )	65. 1.4( )	65. .0( )
1	20.	9. 8.4(S)	44. 3.7(S)	62. .0( )	62. 1.4( )	62. .0( )
1	25.	9. 8.6(S)	41. 3.6(S)	58. .0( )	57. 1.3( )	57. .0( )
1	30.	9. 8.8(S)	38. 3.5(S)	53. .0( )	53. 1.3( )	53. .0( )
1	35.	9. 8.9(S)	34. 3.5(S)	49. .0( )	49. 1.2( )	49. .0( )
1	40.	9. 9.0(S)	32. 3.4(S)	47. .0( )	47. 1.2( )	47. .0( )
1	45.	9. 9.1(S)	31. 3.3(S)	45. .0( )	45. 1.2( )	45. .0( )
1	50.	9. 9.2(S)	30. 3.3(S)	44. .0( )	44. 1.2( )	44. .0( )
1	55.	9. 9.3(S)	28. 3.2(S)	43. .0( )	43. 1.2( )	43. .0( )
2	0.	9. 9.4(S)	27. 3.1(S)	41. .0( )	41. 1.1( )	41. .0( )
2	5.	9. 9.5(S)	26. 3.0(S)	38. .0( )	38. 1.1( )	38. .0( )
2	10.	9. 9.5(S)	25. 3.0(S)	34. .0( )	34. 1.0( )	34. .0( )
2	15.	9. 9.5(S)	23. 2.9(S)	32. .0( )	32. 1.0( )	32. .0( )
2	20.	9. 9.5(S)	21. 2.8(S)	30. .0( )	31. 1.0( )	31. .0( )
2	25.	9. 9.4(S)	19. 2.7(S)	28. .0( )	28. .9( )	28. .0( )
2	30.	9. 9.4(S)	17. 2.6(S)	27. .0( )	27. .9( )	27. .0( )
2	35.	9. 9.3(S)	16. 2.5(S)	25. .0( )	25. .9( )	25. .0( )
2	40.	9. 9.3(S)	14. 2.4(S)	23. .0( )	23. .9( )	23. .0( )
2	45.	9. 9.2(S)	13. 2.3(S)	22. .0( )	22. .8( )	22. .0( )
2	50.	9. 9.1(S)	12. 2.2(S)	21. .0( )	21. .8( )	21. .0( )
2	55.	9. 9.1(S)	11. 2.1(S)	20. .0( )	20. .8( )	20. .0( )

3	0.	9. 9.0(S)	11. 2.0(S)	20. .0( )	20. .8( )	20. .0( )
3	5.	9. 9.0(S)	10. 1.9(S)	19. .0( )	19. .8( )	19. .0( )
3	10.	9. 8.9(S)	9. 1.9(S)	18. .0( )	18. .8( )	18. .0( )
3	15.	9. 8.8(S)	9. 1.8(S)	18. .0( )	18. .7( )	18. .0( )
3	20.	9. 8.8(S)	8. 1.8(S)	17. .0( )	17. .7( )	17. .0( )
3	25.	9. 8.7(S)	8. 1.7(S)	17. .0( )	17. .7( )	17. .0( )
3	30.	9. 8.6(S)	7. 1.7(S)	16. .0( )	16. .7( )	16. .0( )
3	35.	9. 8.6(S)	7. 1.6(S)	16. .0( )	16. .7( )	16. .0( )
3	40.	9. 8.5(S)	6. 1.6(S)	15. .0( )	15. .7( )	15. .0( )
3	45.	9. 8.5(S)	6. 1.5(S)	15. .0( )	15. .7( )	15. .0( )
3	50.	9. 8.4(S)	5. 1.5(S)	14. .0( )	14. .7( )	14. .0( )
3	55.	9. 8.3(S)	5. 1.4(S)	14. .0( )	14. .7( )	14. .0( )
4	0.	9. 8.3(S)	5. 1.4(S)	14. .0( )	14. .7( )	14. .0( )
4	5.	9. 8.2(S)	5. 1.4(S)	14. .0( )	14. .7( )	14. .0( )
4	10.	9. 8.2(S)	5. 1.3(S)	13. .0( )	13. .7( )	13. .0( )
4	15.	9. 8.1(S)	5. 1.3(S)	13. .0( )	13. .7( )	13. .0( )
4	20.	9. 8.0(S)	5. 1.3(S)	13. .0( )	13. .6( )	13. .0( )
4	25.	9. 8.0(S)	5. 1.3(S)	13. .0( )	13. .6( )	13. .0( )
4	30.	9. 7.9(S)	4. 1.2(S)	13. .0( )	13. .6( )	13. .0( )
4	35.	9. 7.9(S)	4. 1.2(S)	13. .0( )	13. .6( )	13. .0( )
4	40.	8. 7.8(S)	4. 1.2(S)	13. .0( )	13. .6( )	13. .0( )
4	45.	8. 7.7(S)	4. 1.1(S)	13. .0( )	13. .6( )	13. .0( )
4	50.	8. 7.7(S)	4. 1.1(S)	13. .0( )	13. .6( )	13. .0( )
4	55.	8. 7.6(S)	4. 1.1(S)	12. .0( )	12. .6( )	12. .0( )
5	0.	8. 7.6(S)	4. 1.0(S)	12. .0( )	12. .6( )	12. .0( )
5	5.	8. 7.5(S)	4. 1.0(S)	12. .0( )	12. .6( )	12. .0( )
5	10.	8. 7.5(S)	4. 1.0(S)	12. .0( )	12. .6( )	12. .0( )
5	15.	8. 7.4(S)	4. 1.0(S)	12. .0( )	12. .6( )	12. .0( )

5	20.	8. 7.3(S)	4. .9(S)	12. .0( )	12. .6( )	12. .0( )
5	25.	8. 7.3(S)	4. .9(S)	12. .0( )	12. .6( )	12. .0( )
5	30.	8. 7.2(S)	4. .9(S)	12. .0( )	12. .6( )	12. .0( )
5	35.	8. 7.2(S)	4. .9(S)	12. .0( )	12. .6( )	12. .0( )
5	40.	8. 7.1(S)	3. .8(S)	12. .0( )	12. .6( )	12. .0( )
5	45.	8. 7.1(S)	3. .8(S)	12. .0( )	12. .6( )	12. .0( )
5	50.	8. 7.0(S)	3. .8(S)	11. .0( )	11. .6( )	11. .0( )
5	55.	8. 6.9(S)	3. .8(S)	11. .0( )	11. .6( )	11. .0( )
6	0.	8. 6.9(S)	3. .7(S)	11. .0( )	11. .6( )	11. .0( )

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RACETRACK DRAW, FUTURE FACILITIES, RPB III RAPID CITY, SD
FERBER ENGINEERING COMPANY, FUSWMM.IN, DEC 2001, DMM/FEC

*** PEAK FLOWS, STAGES AND STORAGES OF GUTTERS AND DETENTION DAMS ***

CONVEYANCE ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)	TIME (HR/MIN)
102	49.	.1	3.8	1 5.
101	9.	.1	9.5	2 10.
500	67.	(DIRECT FLOW)		1 5.
27	67.	1.4		1 10.
26	67.	(DIRECT FLOW)		1 10.

100-year UDSWMM Fully-Developed Output

FERBER ENGINEERING COMPANY

URBAN DRAINAGE STORM WATER MANAGEMENT MODEL - 32 BIT VERSION 1998
REVISED BY UNIVERSITY OF COLORADO AT DENVER

RACETRACK DRAW, FUTURE FACILITIES, RPB III RAPID CITY, SD
FERBER ENGINEERING COMPANY, FUSWMM.IN, DEC 2001, DMM/FEC

ONUMBER OF TIME STEPS 72
OINTEGRATION TIME INTERVAL (MINUTES), 5.00

25.0 PERCENT OF IMPERVIOUS AREA HAS ZERO DETENTION DEPTH

RACETRACK DRAW, FUTURE FACILITIES, RPB III RAPID CITY, SD
FERBER ENGINEERING COMPANY, FUSWMM.IN, DEC 2001, DMM/FEC

HYDROGRAPHS FROM CUHPF MODEL ARE LISTED FOR THE FOLLOWING 3 SUBCATCHMENTS

TIME(HR/MIN)		101	102	301
0	0.	0.	0.	0.
0	5.	0.	0.	0.
0	10.	5.	2.	5.
0	15.	29.	13.	21.
0	20.	88.	43.	47.
0	25.	223.	105.	105.
0	30.	388.	186.	97.
0	35.	372.	219.	65.
0	40.	296.	195.	42.
0	45.	231.	161.	27.
0	50.	183.	134.	20.
0	55.	148.	113.	18.
1	0.	125.	97.	18.
1	5.	110.	85.	17.
1	10.	100.	77.	17.
1	15.	93.	70.	17.
1	20.	84.	64.	15.
1	25.	72.	55.	12.
1	30.	60.	47.	10.
1	35.	51.	41.	9.
1	40.	46.	37.	9.
1	45.	43.	34.	9.
1	50.	41.	32.	9.
1	55.	39.	31.	8.
2	0.	35.	29.	7.
2	5.	28.	25.	3.
2	10.	18.	19.	0.
2	15.	11.	13.	0.
2	20.	7.	9.	0.
2	25.	4.	6.	0.
2	30.	3.	4.	0.
2	35.	2.	3.	0.
2	40.	0.	2.	0.

RACETRACK DRAW, FUTURE FACILITIES, RPB III RAPID CITY, SD
FERBER ENGINEERING COMPANY, FUSWMM.IN, DEC 2001, DMM/FEC

GUTTER NUMBER	GUTTER CONNECTION	NDP	NP		WIDTH OR DIAM (FT)	LENGTH (FT)	INVERT SLOPE (FT/FT)	SIDE SLOPES HORIZ TO VERT L	R	MANNING N	OVERBANK/SURCHARGE DEPTH	JK (FT)
101	500	13	2	PIPE	.1	1.	.0100	.0	.0	.016	.10	0
		RESERVOIR STORAGE IN ACRE-FEET VS SPILLWAY OUTFLOW										
		.0	.0	1.0	3.0	2.2	5.0	3.6	6.0	5.1	7.0	6.9	8.0
		8.8	9.0	10.9	10.0	13.1	11.0	15.6	36.0	18.3	97.0	21.1	177.0
		24.1	273.0										
102	500	8	2	PIPE	.1	1.	.0100	.0	.0	.016	.10	0
		RESERVOIR STORAGE IN ACRE-FEET VS SPILLWAY OUTFLOW										
		.0	.0	.6	3.0	1.4	5.0	2.4	14.0	3.4	33.0	4.7	91.0
		6.0	169.0	7.5	264.0								
27	26	0	2	PIPE	5.0	128.	.0300	.0	.0	.016	5.00	0
500	27	0	3		.0	1.	.0010	.0	.0	.001	10.00	0

OTOTAL NUMBER OF GUTTERS/PIPES, 4
1

RACETRACK DRAW, FUTURE FACILITIES, RPB III RAPID CITY, SD
FERBER ENGINEERING COMPANY, FUSWMM.IN, DEC 2001, DMM/FEC

ARRANGEMENT OF SUBCATCHMENTS AND GUTTERS/PIPES

GUTTER	TRIBUTARY GUTTER/PIPE										TRIBUTARY SUBAREA										D.A.(AC)
27	500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	183.0
101	0	0	0	0	0	0	0	0	0	0	101	0	0	0	0	0	0	0	0	0	103.7
102	0	0	0	0	0	0	0	0	0	0	102	0	0	0	0	0	0	0	0	0	60.8
500	101	102	0	0	0	0	0	0	0	0	301	0	0	0	0	0	0	0	0	0	183.0

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RACETRACK DRAW, FUTURE FACILITIES, RPB III RAPID CITY, SD
FERBER ENGINEERING COMPANY, FUSWMM.IN, DEC 2001, DMM/FEC

HYDROGRAPHS ARE LISTED FOR THE FOLLOWING 5 CONVEYANCE ELEMENTS

THE UPPER NUMBER IS DISCHARGE IN CFS
THE LOWER NUMBER IS ONE OF THE FOLLOWING CASES:
( ) DENOTES DEPTH ABOVE INVERT IN FEET
(S) DENOTES STORAGE IN AC-FT FOR DETENTION DAM. DISCHARGE INCLUDES SPILLWAY OUTFLOW.
(I) DENOTES GUTTER INFLOW IN CFS FROM SPECIFIED INFLOW HYDROGRAPH
(D) DENOTES DISCHARGE IN CFS DIVERTED FROM THIS GUTTER
(O) DENOTES STORAGE IN AC-FT FOR SURCHARGED GUTTER

TIME(HR/MIN)		101	102	500	27	26
0	5.	0.	0.	0.	0.	0.
		.0(S)	.0(S)	.0( )	.0( )	.0( )
0	10.	0.	0.	5.	4.	4.
		.0(S)	.0(S)	.0( )	.4( )	.0( )
0	15.	0.	0.	22.	21.	21.
		.1(S)	.1(S)	.0( )	.8( )	.0( )
0	20.	2.	1.	50.	49.	49.
		.5(S)	.2(S)	.0( )	1.2( )	.0( )
0	25.	4.	3.	112.	111.	111.
		1.6(S)	.7(S)	.0( )	1.9( )	.0( )
0	30.	6.	8.	111.	112.	112.
		3.6(S)	1.7(S)	.0( )	1.9( )	.0( )
0	35.	8.	25.	97.	96.	96.
		6.2(S)	3.0(S)	.0( )	1.7( )	.0( )
0	40.	9.	64.	115.	115.	115.
		8.5(S)	4.1(S)	.0( )	1.9( )	.0( )

0	45.	10. 10.2(S)	97. 4.8(S)	134. .0( )	133. 2.1( )	133. .0( )
0	50.	10. 11.6(S)	114. 5.1(S)	145. .0( )	145. 2.2( )	145. .0( )
0	55.	11. 12.6(S)	117. 5.1(S)	146. .0( )	146. 2.2( )	146. .0( )
1	0.	14. 13.5(S)	113. 5.0(S)	145. .0( )	146. 2.2( )	146. .0( )
1	5.	21. 14.2(S)	106. 4.9(S)	144. .0( )	144. 2.2( )	144. .0( )
1	10.	27. 14.7(S)	98. 4.8(S)	142. .0( )	142. 2.2( )	142. .0( )
1	15.	32. 15.2(S)	90. 4.6(S)	139. .0( )	139. 2.1( )	139. .0( )
1	20.	36. 15.6(S)	83. 4.5(S)	134. .0( )	135. 2.1( )	135. .0( )
1	25.	41. 15.8(S)	77. 4.4(S)	130. .0( )	130. 2.1( )	130. .0( )
1	30.	45. 16.0(S)	69. 4.2(S)	124. .0( )	125. 2.0( )	125. .0( )
1	35.	47. 16.1(S)	62. 4.1(S)	118. .0( )	118. 1.9( )	118. .0( )
1	40.	47. 16.1(S)	56. 3.9(S)	111. .0( )	112. 1.9( )	112. .0( )
1	45.	47. 16.1(S)	50. 3.8(S)	105. .0( )	105. 1.8( )	105. .0( )
1	50.	46. 16.0(S)	45. 3.7(S)	100. .0( )	100. 1.8( )	100. .0( )
1	55.	45. 16.0(S)	41. 3.6(S)	95. .0( )	95. 1.7( )	95. .0( )
2	0.	44. 15.9(S)	38. 3.5(S)	89. .0( )	89. 1.7( )	89. .0( )
2	5.	42. 15.9(S)	35. 3.5(S)	80. .0( )	80. 1.6( )	80. .0( )
2	10.	39. 15.8(S)	32. 3.4(S)	72. .0( )	72. 1.5( )	72. .0( )
2	15.	36. 15.6(S)	30. 3.3(S)	66. .0( )	66. 1.4( )	66. .0( )
2	20.	34. 15.4(S)	28. 3.2(S)	62. .0( )	62. 1.4( )	62. .0( )
2	25.	32. 15.2(S)	26. 3.0(S)	58. .0( )	58. 1.3( )	58. .0( )
2	30.	30. 15.0(S)	23. 2.9(S)	54. .0( )	54. 1.3( )	54. .0( )
2	35.	28. 14.9(S)	21. 2.8(S)	49. .0( )	49. 1.2( )	49. .0( )
2	40.	26. 14.7(S)	19. 2.6(S)	45. .0( )	46. 1.2( )	46. .0( )
2	45.	25. 14.5(S)	17. 2.5(S)	41. .0( )	41. 1.1( )	41. .0( )
2	50.	23. 14.3(S)	15. 2.4(S)	38. .0( )	38. 1.1( )	38. .0( )
2	55.	21. 14.2(S)	14. 2.3(S)	35. .0( )	35. 1.0( )	35. .0( )
3	0.	20.	13.	33.	33.	33.

5	20.	10. 11.7(S)	4. 1.0(S)	14. .0( )	14. .7( )	14. .0( )
5	25.	10. 11.6(S)	4. 1.0(S)	14. .0( )	14. .7( )	14. .0( )
5	30.	10. 11.6(S)	4. 1.0(S)	14. .0( )	14. .7( )	14. .0( )
5	35.	10. 11.5(S)	4. .9(S)	14. .0( )	14. .7( )	14. .0( )
5	40.	10. 11.4(S)	4. .9(S)	14. .0( )	14. .7( )	14. .0( )
5	45.	10. 11.4(S)	4. .9(S)	14. .0( )	14. .7( )	14. .0( )
5	50.	10. 11.3(S)	4. .9(S)	14. .0( )	14. .7( )	14. .0( )
5	55.	10. 11.2(S)	3. .8(S)	14. .0( )	14. .7( )	14. .0( )
6	0.	10. 11.1(S)	3. .8(S)	14. .0( )	14. .7( )	14. .0( )

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RACETRACK DRAW, FUTURE FACILITIES, RPB III RAPID CITY, SD
FERBER ENGINEERING COMPANY, FUSWMM.IN, DEC 2001, DMM/FEC

*** PEAK FLOWS, STAGES AND STORAGES OF GUTTERS AND DETENTION DAMS ***

CONVEYANCE ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)	TIME (HR/MIN)
102	117.	.1	5.1	0 55.
101	47.	.1	16.1	1 40.
500	146.	(DIRECT FLOW)		0 55.
27	146.	2.2		0 55.
26	146.	(DIRECT FLOW)		0 55.