Appendix D
Final Cover Water Balance Calculations

744 Heartland Trail (53717-8923) P. O. Box 8923 (53708-8923) Madison, WI (608) 831-4444 FAX: (608) 831-3334 VOICE: (608) 831-1989

PROJECT/PROPOSAL NAME	PREPARED		CHECKED		PROJECT/PROPOSAL NO.
Dairyland Power	By: GMP	Date: 06/27/03	By: BJK	Date: 11/03	3081.58

HELP MODEL ANALYSIS

Purpose:

To determine the water budget for post-closure landfill conditions. This information will be used to determine the efficiency of the proposed cover for the DPC Phase IV Landfill compared to the standard NR 504 final cover and the final cover in DPC's Plan of Operation conditional approval.

Methodology:

A computer program was used to simulate the performance of the proposed cover. The Hydrologic Evaluation of Landfill Performance (HELP) Model is an analytical computer water balance program developed for the USEPA by the U.S. Army Engineer Waterways Experiment Station in Vicksburg, Mississippi (Schroeder et al., 1994). The program was developed to model the movement and quantity of water across, into, through, and out of various landfill liner and cover design configurations. The HELP model estimates these movements and quantities by interpreting the combined effects of precipitation, runoff, percolation, evapotranspiration, moisture storage, and lateral drainage. Landfill systems, including various combinations of vegetation, cover soil, waste layers, drainage layers, and relatively impermeable barrier soil layers, as well as geomembrane liners, may be modeled.

Default climatological data for La Crosse, Wisconsin, were used for the open conditions. The default data were used to synthetically generate 1 to 10 years of climatological data for the landfill.

For the purpose of determining the water balance, the model reported values in inches per unit area per year. The HELP model simulation was performed using an area of 1 acre. To determine the average annual volume, the unit rates are multiplied by the total landfill area in acres and converted to gallons per day.

Assumptions:

To set up and run the HELP model, several assumptions need to be made based on the existing site conditions and the proposed design. These assumptions were kept constant between runs to allow a true comparison between final cover designs. The assumptions that were used for modeling the landfill are as follows:

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Dairyland Power	By: GMP	Date: 06/27/03	By: BJK	Date: 11/03	3081.58

- The evaporation zone depth is 8 inches.
- The maximum leaf index is 3.5.
- The slope and drainage length for the liner are 25 percent and 140 feet.
- The percent of area from which runoff is possible is 100 percent.
- The runoff curve number used was 69, based on the surface water design calculations in the Plan of Operation.

Open Conditions:

The layers used to model the landfill are as follows:

Option A: NR 504.07 Cover

LAYER	THICKNESS (inches)	DESCRIPTION	LAYER TYPE	MATERIAL TEXTURE	USCS* SOIL CLASSIFICATION
1	6	Topsoil	Vertical percolation	9	ML
2	18	Rooting zone	Vertical percolation	22	ML
3	12	Drainage layer	Lateral drainage	5	SM
4	24	Clay barrier	Barrier soil	16	Liner soil

Note:
* Unified Soil Classification System.

Option B: Approved Plan of Operation Cover

LAYER	THICKNESS (inches)	DESCRIPTION	LAYER TYPE	MATERIAL TEXTURE	USCS* SOIL CLASSIFICATION
1	6	Topsoil	Vertical percolation	9	ML
2	18	Rooting zone	Vertical percolation	22	ML
3	12	Drainage layer	Lateral drainage	5	SM
4	.06	Geomembrane	Flexible membrane	35	--
5	.24	GCL	Barrier soil	17	--
6	12	Fine-grained soil	Vertical percolation	22	ML
7	12	Sand capillary break	Vertical percolation	5	SM

Note:
* Unified Soil Classification System.

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PROJECT/PROPOSAL NAME	PREPARED		CHECKED		PROJECT/PROPOSAL NO.
Dairyland Power	By: GMP	Date: 06/27/03	By: BJK	Date: 11/03	3081.58

Option C: Proposed Cover

LAYER	THICKNESS (inches)	DESCRIPTION	LAYER TYPE	MATERIAL TEXTURE	USCS* SOIL CLASSIFICATION
1	6	Topsoil	Vertical percolation	9	ML
2	18	Rooting zone	Vertical percolation	22	ML
3	12	Drainage layer	Lateral drainage	2	CL
4	.06	Geomembrane	Flexible membrane	35	--
5	24	Ash barrier	Barrier soil	30	--

Note:
* Unified Soil Classification System.

Results:

The results of the HELP model simulations are summarized in Table 1. The detailed outputs are attached.

References:

Schroeder, P.R., T.S., Dozier, P.A., Zappi, B.M., McEnroe, J.W., Sjostrom, and R.L., Peyton. 1994a. The Hydrologic Evaluation of Landfill Performance (HELP) model: User's guide for Version 3. EPA/600/9-94/168a. U.S. Environmental Protection Agency Risk Reduction Engineering Laboratory, Cincinnati, Ohio.

Schroeder, P.R., T.S., Dozier, P.A., Zappi, B.M., McEnroe, J.W., Sjostrom, and R.L., Peyton. 1994b. The Hydrologic Evaluation of Landfill Performance (HELP) model: Engineering documentation for Version 3. EPA/600/9-94/168a. U.S. Environmental Protection Agency Risk Reduction Engineering Laboratory, Cincinnati, Ohio.

Table D-1
Water Budget – Average Annual Totals (inches)
DPC Phase IV Landfill

SIMULATION NUMBER	COVER DESIGN	YEARS EVALUATED	PRECIPITATION	RUNOFF	EVAPO-TRANSPIRATION	FINAL COVER LATERAL DRAINAGE	LEAKAGE THROUGH FINAL COVER	MOISTURE STORAGE WITH COVER	COVER EFFICIENCY (percent)
1	NR 504.07	10	29.93	1.575	22.565	4.678	1.00288	0.104	96.6
2	Approved Plan of Operation	10	29.93	1.575	22.565	5.681	0.00015	0.082	99.9995
3	Proposed cover	10	29.93	1.575	22.565	5.678	0.00056	0.107	99.9981

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**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**              HELP MODEL VERSION 3.03  (31 DECEMBER 1994)                 **
**              DEVELOPED BY ENVIRONMENTAL LABORATORY                       **
**              USAE WATERWAYS EXPERIMENT STATION                           **
**              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY             **
**                                                                          **
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PRECIPITATION DATA FILE:      C:\HELP\DATA4.D4
TEMPERATURE DATA FILE:        C:\HELP\DATA7.D7
SOLAR RADIATION DATA FILE:    C:\HELP\DATA13.D13
EVAPOTRANSPIRATION DATA:      C:\HELP\DATA11.D11
SOIL AND DESIGN DATA FILE:    C:\HELP\DATA10.D10
OUTPUT DATA FILE:             C:\HELP\OUT1.OUT


TIME:  9:27     DATE:  6/27/2003


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    TITLE: Dairyland Power NR 504

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    NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
           COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                 LAYER  1
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                    TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   9
           THICKNESS                  =     6.00   INCHES
           POROSITY                   =     0.5010 VOL/VOL
           FIELD CAPACITY             =     0.2840 VOL/VOL
           WILTING POINT              =     0.1350 VOL/VOL
           INITIAL SOIL WATER CONTENT =     0.3074 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  =  0.190000006000E-03 CM/SEC
         NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  4.63
                FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.
```

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 22

THICKNESS	=	18.00	INCHES
POROSITY	=	0.4190	VOL/VOL
FIELD CAPACITY	=	0.3070	VOL/VOL
WILTING POINT	=	0.1800	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2917	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.189999992000E-04	CM/SEC

LAYER 3

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 5

THICKNESS	=	12.00	INCHES
POROSITY	=	0.4570	VOL/VOL
FIELD CAPACITY	=	0.1310	VOL/VOL
WILTING POINT	=	0.0580	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1380	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC
SLOPE	=	25.00	PERCENT
DRAINAGE LENGTH	=	140.0	FEET

LAYER 4

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 16

THICKNESS	=	24.00	INCHES
POROSITY	=	0.4270	VOL/VOL
FIELD CAPACITY	=	0.4180	VOL/VOL
WILTING POINT	=	0.3670	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4270	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000001000E-06	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

SCS RUNOFF CURVE NUMBER	=	69.00	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	8.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	2.184	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	3.844	INCHES

LOWER LIMIT OF EVAPORATIVE STORAGE	= 1.170	INCHES
INITIAL SNOW WATER	= 0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	= 19.000	INCHES
TOTAL INITIAL WATER	= 19.000	INCHES
TOTAL SUBSURFACE INFLOW	= 0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
LACROSSE WISCONSIN

MAXIMUM LEAF AREA INDEX	= 3.50
START OF GROWING SEASON (JULIAN DATE)	= 130
END OF GROWING SEASON (JULIAN DATE)	= 275
AVERAGE ANNUAL WIND SPEED	= 10.00 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	= 73.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	= 68.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	= 74.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	= 76.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR LACROSSE WISCONSIN

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
0.94	0.89	1.96	3.05	3.61	4.15
3.83	3.70	3.47	2.08	1.50	1.07

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR LACROSSE WISCONSIN

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
14.00	19.70	30.90	47.20	59.40	68.50
73.00	70.90	61.60	50.40	35.30	21.50

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR LACROSSE WISCONSIN

STATION LATITUDE = 43.75 DEGREES

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 10

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.78	0.76	1.64	2.92	4.47	3.61
	4.25	4.01	3.05	2.04	1.29	1.11
STD. DEVIATIONS	0.23	0.45	0.69	1.16	2.17	1.89
	2.26	2.04	1.73	1.06	0.88	0.38
RUNOFF						
TOTALS	0.091	0.163	0.550	0.634	0.001	0.014
	0.000	0.049	0.000	0.000	0.007	0.066
STD. DEVIATIONS	0.097	0.311	0.430	0.741	0.002	0.043
	0.000	0.155	0.000	0.000	0.021	0.101
EVAPOTRANSPIRATION						
TOTALS	0.455	0.624	1.399	2.425	3.099	3.126
	3.920	2.645	2.368	1.305	0.759	0.438
STD. DEVIATIONS	0.093	0.135	0.341	0.735	1.165	1.048
	1.245	1.230	0.877	0.476	0.225	0.106
LATERAL DRAINAGE COLLECTED FROM LAYER 3						
TOTALS	0.1503	0.0352	0.0203	0.1220	0.4405	0.6630
	0.6050	0.6674	0.6018	0.5651	0.4849	0.3228
STD. DEVIATIONS	0.2156	0.0641	0.0612	0.2362	0.4406	0.5879
	0.5757	0.4686	0.3458	0.4827	0.3620	0.3499
PERCOLATION/LEAKAGE THROUGH LAYER 4						
TOTALS	0.0613	0.0330	0.0152	0.0357	0.0992	0.1119
	0.1127	0.1154	0.1110	0.1110	0.0991	0.0974
STD. DEVIATIONS	0.0496	0.0438	0.0353	0.0415	0.0221	0.0087
	0.0117	0.0070	0.0051	0.0134	0.0351	0.0352

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ACROSS LAYER 4						
AVERAGES	0.5065	0.1319	0.0688	0.4268	1.4913	2.3193
	2.0484	2.2597	2.1055	1.9131	1.6963	1.0929
STD. DEVIATIONS	0.7294	0.2402	0.2073	0.8264	1.4916	2.0567
	1.9491	1.5866	1.2097	1.6341	1.2666	1.1847

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 10

	INCHES		CU. FEET	PERCENT
PRECIPITATION	29.93	(3.273)	108627.8	100.00
RUNOFF	1.575	(0.9711)	5716.84	5.263
EVAPOTRANSPIRATION	22.565	(1.7313)	81909.50	75.404
LATERAL DRAINAGE COLLECTED FROM LAYER 3	4.67832	(2.38029)	16982.312	15.63349
PERCOLATION/LEAKAGE THROUGH LAYER 4	1.00288	(0.12671)	3640.464	3.35132
AVERAGE HEAD ACROSS TOP OF LAYER 4	1.338	(0.681)		
CHANGE IN WATER STORAGE	0.104	(0.9731)	378.64	0.349

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 10

	(INCHES)	(CU. FT.)
PRECIPITATION	3.09	11216.699
RUNOFF	1.056	3834.6309
DRAINAGE COLLECTED FROM LAYER 3	0.07585	275.31897
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.004530	16.44289
AVERAGE HEAD ACROSS LAYER 4	7.960	
SNOW WATER	1.68	6098.3999
MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4696	
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0960	

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FINAL WATER STORAGE AT END OF YEAR 10

LAYER	(INCHES)	(VOL/VOL)
1	1.8192	0.3032
2	5.5664	0.3092
3	1.6358	0.1363
4	10.2480	0.4270
SNOW WATER	0.000	

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**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**               HELP MODEL VERSION 3.03  (31 DECEMBER 1994)                **
**                 DEVELOPED BY ENVIRONMENTAL LABORATORY                    **
**                   USAE WATERWAYS EXPERIMENT STATION                      **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
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PRECIPITATION DATA FILE:      C:\HELP\DATA4.D4
TEMPERATURE DATA FILE:        C:\HELP\DATA7.D7
SOLAR RADIATION DATA FILE:    C:\HELP\DATA13.D13
EVAPOTRANSPIRATION DATA:      C:\HELP\DATA11.D11
SOIL AND DESIGN DATA FILE:    C:\HELP\DATA8.D10
OUTPUT DATA FILE:             C:\HELP\OUT2.OUT


TIME:  9:33     DATE:  6/27/2003


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     TITLE:  Dairyland Power DPC Approved

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                   LAYER  1
                                   --------

                      TYPE 1 - VERTICAL PERCOLATION LAYER
                          MATERIAL TEXTURE NUMBER   9
           THICKNESS                  =      6.00   INCHES
           POROSITY                   =      0.5010 VOL/VOL
           FIELD CAPACITY             =      0.2840 VOL/VOL
           WILTING POINT              =      0.1350 VOL/VOL
           INITIAL SOIL WATER CONTENT =      0.3074 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  =  0.190000006000E-03 CM/SEC
         NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  4.63
                  FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.
```

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 22

THICKNESS	=	18.00	INCHES
POROSITY	=	0.4190	VOL/VOL
FIELD CAPACITY	=	0.3070	VOL/VOL
WILTING POINT	=	0.1800	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2917	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.189999992000E-04	CM/SEC

LAYER 3

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 5

THICKNESS	=	12.00	INCHES
POROSITY	=	0.4570	VOL/VOL
FIELD CAPACITY	=	0.1310	VOL/VOL
WILTING POINT	=	0.0580	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1480	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC
SLOPE	=	25.00	PERCENT
DRAINAGE LENGTH	=	140.0	FEET

LAYER 4

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.06	INCHES
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999996000E-12	CM/SEC
FML PINHOLE DENSITY	=	1.00	HOLES/ACRE
FML INSTALLATION DEFECTS	=	1.00	HOLES/ACRE
FML PLACEMENT QUALITY	=	3 - GOOD	

LAYER 5

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 17

THICKNESS	=	0.24	INCHES
POROSITY	=	0.7500	VOL/VOL
FIELD CAPACITY	=	0.7470	VOL/VOL
WILTING POINT	=	0.4000	VOL/VOL

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INITIAL SOIL WATER CONTENT  =        0.7500 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.300000003000E-08 CM/SEC
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LAYER 6

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TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 22
THICKNESS                   =        12.00   INCHES
POROSITY                    =        0.4190 VOL/VOL
FIELD CAPACITY              =        0.3070 VOL/VOL
WILTING POINT               =        0.1800 VOL/VOL
INITIAL SOIL WATER CONTENT  =        0.3053 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.189999992000E-04 CM/SEC
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LAYER 7

```
TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER  5
THICKNESS                   =        12.00   INCHES
POROSITY                    =        0.4570 VOL/VOL
FIELD CAPACITY              =        0.1310 VOL/VOL
WILTING POINT               =        0.0580 VOL/VOL
INITIAL SOIL WATER CONTENT  =        0.1298 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC
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GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

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SCS RUNOFF CURVE NUMBER              =      69.00
FRACTION OF AREA ALLOWING RUNOFF     =     100.0     PERCENT
AREA PROJECTED ON HORIZONTAL PLANE   =       1.000   ACRES
EVAPORATIVE ZONE DEPTH               =       8.0     INCHES
INITIAL WATER IN EVAPORATIVE ZONE    =       2.184   INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE   =       3.844   INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE   =       1.170   INCHES
INITIAL SNOW WATER                   =       0.000   INCHES
INITIAL WATER IN LAYER MATERIALS     =      14.271   INCHES
TOTAL INITIAL WATER                  =      14.271   INCHES
TOTAL SUBSURFACE INFLOW              =       0.00    INCHES/YEAR
```

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
LACROSSE WISCONSIN

MAXIMUM LEAF AREA INDEX = 3.50
START OF GROWING SEASON (JULIAN DATE) = 130
END OF GROWING SEASON (JULIAN DATE) = 275
AVERAGE ANNUAL WIND SPEED = 10.00 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY = 73.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY = 68.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY = 74.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY = 76.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR LACROSSE WISCONSIN

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
0.94	0.89	1.96	3.05	3.61	4.15
3.83	3.70	3.47	2.08	1.50	1.07

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR LACROSSE WISCONSIN

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
14.00	19.70	30.90	47.20	59.40	68.50
73.00	70.90	61.60	50.40	35.30	21.50

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR LACROSSE WISCONSIN

STATION LATITUDE = 43.75 DEGREES

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 10

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.78	0.76	1.64	2.92	4.47	3.61
	4.25	4.01	3.05	2.04	1.29	1.11

STD. DEVIATIONS	0.23	0.45	0.69	1.16	2.17	1.89
	2.26	2.04	1.73	1.06	0.88	0.38

RUNOFF

TOTALS	0.091	0.163	0.550	0.634	0.001	0.014
	0.000	0.049	0.000	0.000	0.007	0.066
STD. DEVIATIONS	0.097	0.311	0.430	0.741	0.002	0.043
	0.000	0.155	0.000	0.000	0.021	0.101

EVAPOTRANSPIRATION

TOTALS	0.455	0.624	1.399	2.425	3.099	3.126
	3.920	2.645	2.368	1.305	0.759	0.438
STD. DEVIATIONS	0.093	0.135	0.341	0.735	1.165	1.048
	1.245	1.230	0.877	0.476	0.225	0.106

LATERAL DRAINAGE COLLECTED FROM LAYER 3

TOTALS	0.2397	0.0929	0.0606	0.1506	0.4959	0.7490
	0.7090	0.7773	0.7111	0.6786	0.5899	0.4266
STD. DEVIATIONS	0.2378	0.0944	0.0911	0.2552	0.4550	0.5983
	0.5868	0.4756	0.3497	0.4876	0.3738	0.3642

PERCOLATION/LEAKAGE THROUGH LAYER 5

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

PERCOLATION/LEAKAGE THROUGH LAYER 7

TOTALS	0.0020	0.0018	0.0019	0.0019	0.0019	0.0018
	0.0019	0.0019	0.0018	0.0019	0.0018	0.0018
STD. DEVIATIONS	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004
	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ACROSS LAYER 5

AVERAGES	0.8081	0.3484	0.2051	0.5267	1.6789	2.6204
	2.4002	2.6316	2.4876	2.2974	2.0636	1.4444
STD. DEVIATIONS	0.8039	0.3540	0.3084	0.8929	1.5405	2.0930
	1.9868	1.6101	1.2234	1.6507	1.3076	1.2330

****

****

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 10

	INCHES	CU. FEET	PERCENT
PRECIPITATION	29.93 (3.273)	108627.8	100.00
RUNOFF	1.575 (0.9711)	5716.84	5.263
EVAPOTRANSPIRATION	22.565 (1.7313)	81909.50	75.404
LATERAL DRAINAGE COLLECTED FROM LAYER 3	5.68111 (2.46024)	20622.424	18.98449
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.00015 (0.00007)	0.531	0.00049
AVERAGE HEAD ACROSS TOP OF LAYER 5	1.626 (0.704)		
PERCOLATION/LEAKAGE THROUGH LAYER 7	0.02238 (0.00487)	81.239	0.07479
CHANGE IN WATER STORAGE	0.082 (1.0111)	297.75	0.274

****

****

PEAK DAILY VALUES FOR YEARS 1 THROUGH 10

	(INCHES)	(CU. FT.)
PRECIPITATION	3.09	11216.699
RUNOFF	1.056	3834.6309
DRAINAGE COLLECTED FROM LAYER 3	0.07979	289.65002
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.000003	0.00976
AVERAGE HEAD ACROSS LAYER 5	8.375	
PERCOLATION/LEAKAGE THROUGH LAYER 7	0.000105	0.38248
SNOW WATER	1.68	6098.3999
MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4696	
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0960	

****

****

FINAL WATER STORAGE AT END OF YEAR 10

LAYER	(INCHES)	(VOL/VOL)
1	1.8192	0.3032
2	5.5664	0.3092
3	1.7553	0.1463
4	0.0000	0.0000
5	0.1770	0.7500
6	3.5334	0.2945
7	1.4660	0.1222
SNOW WATER	0.000	

****
****

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**             HELP MODEL VERSION 3.03  (31 DECEMBER 1994)                  **
**                DEVELOPED BY ENVIRONMENTAL LABORATORY                     **
**                  USAE WATERWAYS EXPERIMENT STATION                       **
**          FOR USEPA RISK REDUCTION ENGINEERING LABORATORY                 **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************
```

```
PRECIPITATION DATA FILE:      C:\HELP\DATA4.D4
TEMPERATURE DATA FILE:        C:\HELP\DATA7.D7
SOLAR RADIATION DATA FILE:    C:\HELP\DATA13.D13
EVAPOTRANSPIRATION DATA:      C:\HELP\DATA11.D11
SOIL AND DESIGN DATA FILE:    C:\HELP\DATA6.D10
OUTPUT DATA FILE:             C:\HELP\OUT3.OUT
```

```
TIME:  9:40    DATE:  6/27/2003
```

```
******************************************************************************

     TITLE:  Dairyland Power DPC Proposed

******************************************************************************
```

```
     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                    LAYER  1
                                    --------

                       TYPE 1 - VERTICAL PERCOLATION LAYER
                           MATERIAL TEXTURE NUMBER   9
            THICKNESS                  =         6.00   INCHES
            POROSITY                   =       0.5010 VOL/VOL
            FIELD CAPACITY             =       0.2840 VOL/VOL
            WILTING POINT              =       0.1350 VOL/VOL
            INITIAL SOIL WATER CONTENT =       0.3074 VOL/VOL
            EFFECTIVE SAT. HYD. COND.  =   0.190000006000E-03 CM/SEC
          NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  4.63
                   FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.
```

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER

MATERIAL TEXTURE NUMBER 22

```
THICKNESS                  =    18.00   INCHES
POROSITY                   =     0.4190 VOL/VOL
FIELD CAPACITY             =     0.3070 VOL/VOL
WILTING POINT              =     0.1800 VOL/VOL
INITIAL SOIL WATER CONTENT =     0.2917 VOL/VOL
EFFECTIVE SAT. HYD. COND.  = 0.189999992000E-04 CM/SEC
```

LAYER 3

TYPE 2 - LATERAL DRAINAGE LAYER

MATERIAL TEXTURE NUMBER 2

```
THICKNESS                  =    12.00   INCHES
POROSITY                   =     0.4370 VOL/VOL
FIELD CAPACITY             =     0.0620 VOL/VOL
WILTING POINT              =     0.0240 VOL/VOL
INITIAL SOIL WATER CONTENT =     0.0620 VOL/VOL
EFFECTIVE SAT. HYD. COND.  = 0.579999993000E-02 CM/SEC
SLOPE                      =    25.00   PERCENT
DRAINAGE LENGTH            =   140.0    FEET
```

LAYER 4

TYPE 4 - FLEXIBLE MEMBRANE LINER

MATERIAL TEXTURE NUMBER 35

```
THICKNESS                  =     0.06   INCHES
POROSITY                   =     0.0000 VOL/VOL
FIELD CAPACITY             =     0.0000 VOL/VOL
WILTING POINT              =     0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT =     0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.  = 0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY        =     1.00   HOLES/ACRE
FML INSTALLATION DEFECTS   =     1.00   HOLES/ACRE
FML PLACEMENT QUALITY      = 3 - GOOD
```

LAYER 5

TYPE 3 - BARRIER SOIL LINER

MATERIAL TEXTURE NUMBER 0

```
THICKNESS                  =    24.00   INCHES
POROSITY                   =     0.5410 VOL/VOL
FIELD CAPACITY             =     0.1870 VOL/VOL
WILTING POINT              =     0.0470 VOL/VOL
```

INITIAL SOIL WATER CONTENT = 0.5410 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.999999997000E-06 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

SCS RUNOFF CURVE NUMBER	=	69.00	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	8.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	2.184	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	3.844	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	1.170	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	20.825	INCHES
TOTAL INITIAL WATER	=	20.825	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
LACROSSE WISCONSIN

MAXIMUM LEAF AREA INDEX	=	3.50
START OF GROWING SEASON (JULIAN DATE)	=	130
END OF GROWING SEASON (JULIAN DATE)	=	275
AVERAGE ANNUAL WIND SPEED	=	10.00 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	73.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	68.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	74.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	76.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR LACROSSE WISCONSIN

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
0.94	0.89	1.96	3.05	3.61	4.15
3.83	3.70	3.47	2.08	1.50	1.07

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR LACROSSE WISCONSIN

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
14.00	19.70	30.90	47.20	59.40	68.50
73.00	70.90	61.60	50.40	35.30	21.50

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR LACROSSE WISCONSIN

STATION LATITUDE = 43.75 DEGREES

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 10

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.78	0.76	1.64	2.92	4.47	3.61
	4.25	4.01	3.05	2.04	1.29	1.11
STD. DEVIATIONS	0.23	0.45	0.69	1.16	2.17	1.89
	2.26	2.04	1.73	1.06	0.88	0.38
RUNOFF						
TOTALS	0.091	0.163	0.550	0.634	0.001	0.014
	0.000	0.049	0.000	0.000	0.007	0.066
STD. DEVIATIONS	0.097	0.311	0.430	0.741	0.002	0.043
	0.000	0.155	0.000	0.000	0.021	0.101
EVAPOTRANSPIRATION						
TOTALS	0.455	0.624	1.399	2.425	3.099	3.126
	3.920	2.645	2.368	1.305	0.759	0.438
STD. DEVIATIONS	0.093	0.135	0.341	0.735	1.165	1.048
	1.245	1.230	0.877	0.476	0.225	0.106
LATERAL DRAINAGE COLLECTED FROM LAYER 3						
TOTALS	0.0671	0.0015	0.0481	0.2873	0.8518	0.8962
	0.6192	0.8421	0.6993	0.5761	0.5111	0.2784
STD. DEVIATIONS	0.1170	0.0033	0.1519	0.5712	0.7434	0.9365
	0.5249	0.7151	0.6629	0.5482	0.4928	0.3763
PERCOLATION/LEAKAGE THROUGH LAYER 5						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001

	0.0001	0.0001	0.0001	0.0001	0.0001	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0001	0.0001	0.0001
	0.0000	0.0001	0.0001	0.0001	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ACROSS LAYER 5

AVERAGES	0.0390	0.0010	0.0281	0.1733	0.4972	0.5406
	0.3615	0.4916	0.4218	0.3363	0.3083	0.1625
STD. DEVIATIONS	0.0682	0.0021	0.0887	0.3445	0.4339	0.5649
	0.3064	0.4174	0.3999	0.3200	0.2972	0.2197

****

****

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 10

	INCHES		CU. FEET	PERCENT
PRECIPITATION	29.93	(3.273)	108627.8	100.00
RUNOFF	1.575	(0.9711)	5716.84	5.263
EVAPOTRANSPIRATION	22.565	(1.7313)	81909.50	75.404
LATERAL DRAINAGE COLLECTED FROM LAYER 3	5.67829	(2.60985)	20612.191	18.97507
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.00056	(0.00023)	2.016	0.00186
AVERAGE HEAD ACROSS TOP OF LAYER 5	0.280	(0.129)		
CHANGE IN WATER STORAGE	0.107	(0.6512)	387.21	0.356

****

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 10

	(INCHES)	(CU. FT.)
PRECIPITATION	3.09	11216.699
RUNOFF	1.056	3834.6309
DRAINAGE COLLECTED FROM LAYER 3	0.16227	589.04468
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.000014	0.05028
AVERAGE HEAD ACROSS LAYER 5	2.936	
SNOW WATER	1.68	6098.3999
MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4696	
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0960	

****

****

FINAL WATER STORAGE AT END OF YEAR 10

LAYER	(INCHES)	(VOL/VOL)
1	1.8192	0.3032
2	5.5664	0.3092
3	0.7478	0.0623
4	0.0000	0.0000
5	12.9840	0.5410
SNOW WATER	0.000	

****
****

Appendix E
Revised Closure Cost Estimates

Worst-case Site Closure Scenario (Cell 3)

Assumptions

- Cell 3 closure is the worst-case closure scenario. Closure of Cell 3 includes a portion of Cells 1, 2A, and 2B due to the intermediate slopes for a total of approximately 12.4 acres (542,300 SF).
- Proper drainage grades are established upon closure of Cell 3, and no additional grading costs are encountered.
- The conditioned and compacted ash component of the final cover is not yet placed. Imported fine-grained soil is utilized for construction of the 2-foot-thick barrier component of the final cover.
- Unit prices are based on previous liner and final cover construction projects.

Final Cover System

■ Barrier Layer (24 inches thick) 40,170 cy x $6.50/cy =	$261,100
■ 40 mil VFPE geomembrane 542,300 sf x $0.36 =	195,200
■ Granular drainage layer (12 inches thick) 60,260 sy x $5.57 =	335,700
■ Vegetative layer (12 inches thick) 60,260 sy x $1.26 =	75,900
■ Topsoil (6 inches thick) 10,000 cy x $1.50 =	15,000
■ Surface water control system	50,000
■ Seed, fertilize, and mulch 12.4 acre x $1,350/acre =	16,700
Cost:	$949,600

Engineering Fees

■ Construction plans	$ 20,000
■ Construction observation (16 weeks at $5,500 week)	88,000
■ Documentation report	20,000
Cost:	$ 128,000
Subtotal	$1,077,600
25% contingencies:	$ 269,400
Total cost:	**$1,347,000**

J.2
Saturated Head on the Final Cover Liner

PROJECT / LOCATION: DPC CCR Landfill, Alma, Wisconsin		PROJECT / PROPOSAL NO.
SUBJECT: Maximum Head on Final Cover		
PREPARED BY: Z. Bauman	DATE: 12.21.2022	FINAL ☐
CHECKED BY: A. Graham	DATE: 12.30.2022	REVISION ☐

MAXIMUM SATURATED DEPTH
(McENROE'S 1993 METHOD)

Summary: Per s. NR 504.07(6)(a), a drainage layer shall consist of a minimum of one foot of sand with a minimum hydraulic conductivity of 1 x 10^{-3} cm/sec. This calculation demonstrates the anticipated maximum head in the drainage layer is less than the thickness of the drainage layer, based on anticipated annual rainfall and infiltration into the cover system.

Inputs:

Inflow rate, r	=	5.04	in/month
Hyd. cond. of drainage layer, K	=	0.010	cm/sec
Slope of drainage layer, S	=	25	%
Drainage distance, L	=	200	feet
Drainage Layer Thickness	=	30.48	cm

Calculated Values:

r	=	4.87E-06	cm/sec
alpha, α	=	0.2449787	radians
S	=	0.25	ft/ft
R	=	0.0083	(unitless)

Results:

For R < 1/4

A	=	0.9833			
Y_{max}	=	0.01			
Head in Cover Drainage, y_{max}	=	0.40	feet		
Head in Cover Drainage, y_{max}	=	**4.81**	inches	**12.00**	OK!

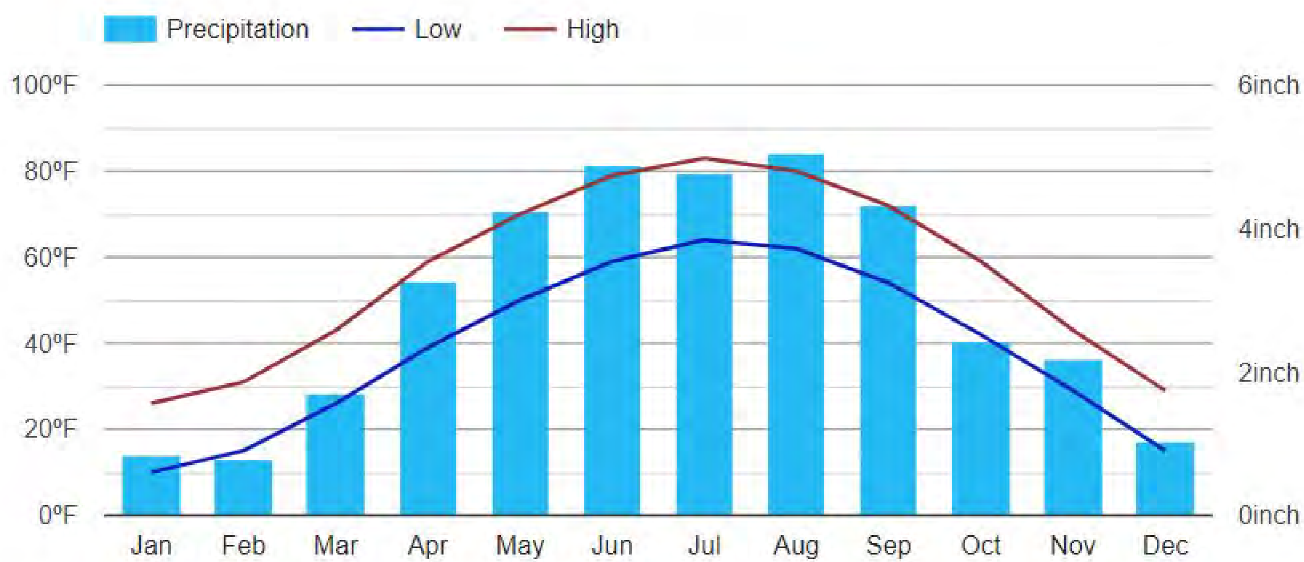
Assumptions:

1. Inflow rate (r) is based on the largest monthly average rainfall (August) in Alma, Wisconsin from the U.S. Climate Data website.

2. The K value is based on historical hydraulic conductivity test results used at the site for closure construction.

	Jul	Aug	Sep	Oct	Nov	Dec
Average high in °F	83	80	72	59	43	29
Average low in °F	64	62	54	42	29	15
Av. precipitation in inch	4.77	5.04	4.32	2.44	2.18	1.03
Av. snowfall in inch	0	0	0	0	2	10

Alma Climate Graph - Wisconsin Climate Chart



Alma weather averages

Annual high temperature	56°F
Annual low temperature	39°F
Average annual precip.	35.46 inch
Av. annual snowfall	36 inch

Share

Station Data

Monthly averages Alma
Longitude: -91.9149, Latitude: 44.32
Average weather Alma, WI - 54610

Monthly: 1981-2010 normals

J.3
Final Cover Event 2A Interface Stability Evaluation

Phase IV, Cell 2A, Final Cover Construction Documentation Report WDNR License No. 4126

Dairyland Power Cooperative
Alma Off-Site Ash Disposal Facility

December 2011

Prepared For
Dairyland Power Cooperative
La Crosse, Wisconsin

Todd W. Martin
Solid Waste Team Leader

Curtis D. Madsen, P.E.
Senior Project Manager

Nicholas Bower
Environmental Specialist

Interface Slope Stability Calculation

INTERFACE SLOPE STABILITY

Table of Contents

RMT®
744 Heartland Trail
Madison, WI 53717
Tel. (608) 831-4444 • Fax (608) 831-3334

PROJECT / PROPOSAL NAME / LOCATION: DPC Phase IV, Cell 2A Final Cover Construction		PROJECT / PROPOSAL NO.
SUBJECT: Interface Slope Stability		02250.25.002
PREPARED BY: T. Halena	DATE: 8/04/11	FINAL ☐
CHECKED BY: S. Inman	DATE: 08/06/11	REVISION ☐

INTERFACE SLOPE STABILITY

Purpose:

The purpose of this analysis is to evaluate the stability of the final cover system against slippage along the critical interfaces of the geomembrane and adjacent soil.

Methodology:

The cover system interface stability was evaluated following the procedure outlined in Giroud and Beach (1989). Giroud and Beach derived an equation using a classical two-wedge analysis that determines the magnitude of tension forces developed in the geosynthetics from the weight of the soil cover. This equation has been modified by Druschel and Underwood (1993) to include hydrostatic pressures in the cover soil, and by Bourdeau, Ludlow, and Simpson (1993) to include adhesion between the critical interfaces.

Assumptions:

Final Cover Design

The final cover system components consist of the following, from top to bottom:

- a 6-inch-thick topsoil layer
- a 1.5-foot-thick soil cover (general fill) layer (rooting zone layer)
- a 1-foot-thick sand drainage layer
- a 40-mil textured LLDPE geomembrane
- a 2-foot-thick conditioned and compacted fly ash layer

Soil Strength Parameters

Soil strength parameters were assumed from typical engineering values and previous test results)

Interface Strength Parameters

Direct shear testing was performed on the sand/40-mil LLDPE textured geomembrane and the fly ash/40-mil LLDPE textured geomembrane interfaces to determine site specific values for these interfaces and the associated strength parameters. Each interface was evaluated for confining pressures of 200, 600, and 1,000 pounds per square foot. The sand was lightly tamped into the box for direct shear testing. The fly ash was a blend of approximately 65 percent (by weight) JPM fly ash and approximately 35 percent (by weight) ALMA-I5 fly ash and was remolded at 11 percent moisture content. The interface was soaked and loading was applied for 24 hours prior to interface testing.

Direct shear testing was performed on the above-described cover system in accordance with ASTM D6243/D5321. Interface strength parameters (friction angle and adhesion) were measured at the peak strength and residual (large displacement) strength. The testing results are summarized below.

FINAL COVER INTERFACE	PEAK FRICTION ANGLE (degrees)	PEAK ADHESION (psf)	RESIDUAL FRICTION ANGLE (degrees)	RESIDUAL ADHESION (psf)
Sand/40-mil LLDPE textured geomembrane	33.2	86	30.4	48
Fly ash/40-mil LLDPE textured geomembrane	61.0	389	22.2	93

Slope Stability Analysis

The Giroud and Beach stability method assumes the following:

- Slope failures slide as a block.
- The slope toe is buttressed where the cover soil on the slope meets the smaller inclined cover soil at the toe of slope.
- The cover soil is free draining and has a uniform thickness.

Geometry

The critical geometry for the designed landfill is shown on Sheet 4 of 10 and is described as follows:

- Slope angle = 14 degrees (4H:1V slope)
- Slope height = 26 feet

Seepage Thickness

The seepage thickness within the final cover system was estimated assuming that the 1-foot-thick sand drainage layer, the 1.5-foot-thick soil cover (general fill) layer, and the 6-inch-thick topsoil layer are fully saturated, which is the worst-case scenario. The geomembrane acts as an

PROJECT / PROPOSAL NAME / LOCATION: DPC Phase IV, Cell 2A Final Cover Construction		PROJECT / PROPOSAL NO.
SUBJECT: Interface Slope Stability		02250.25.002
PREPARED BY: T. Halena	DATE: 8/04/11	FINAL ☐
CHECKED BY: S. Inman	DATE: 08/06/11	REVISION ☐

impermeable barrier which allows no seepage through to the interface with the underlying fly ash layer.

Soil Characteristics

The soil characteristics are from typical engineering values:

- Cover soil internal friction angle = 30 degrees
- Cohesion = 0 lbs/ ft^2
- Cover soil unit weight = 115 lbs/ft^3

Results:

The cover system analysis indicates a minimum factor of safety of 1.70. The factor of safety is above the design factor of safety of 1.3, as specified in NR 514.07 (1) (b). The computer printouts for the analyses are attached.

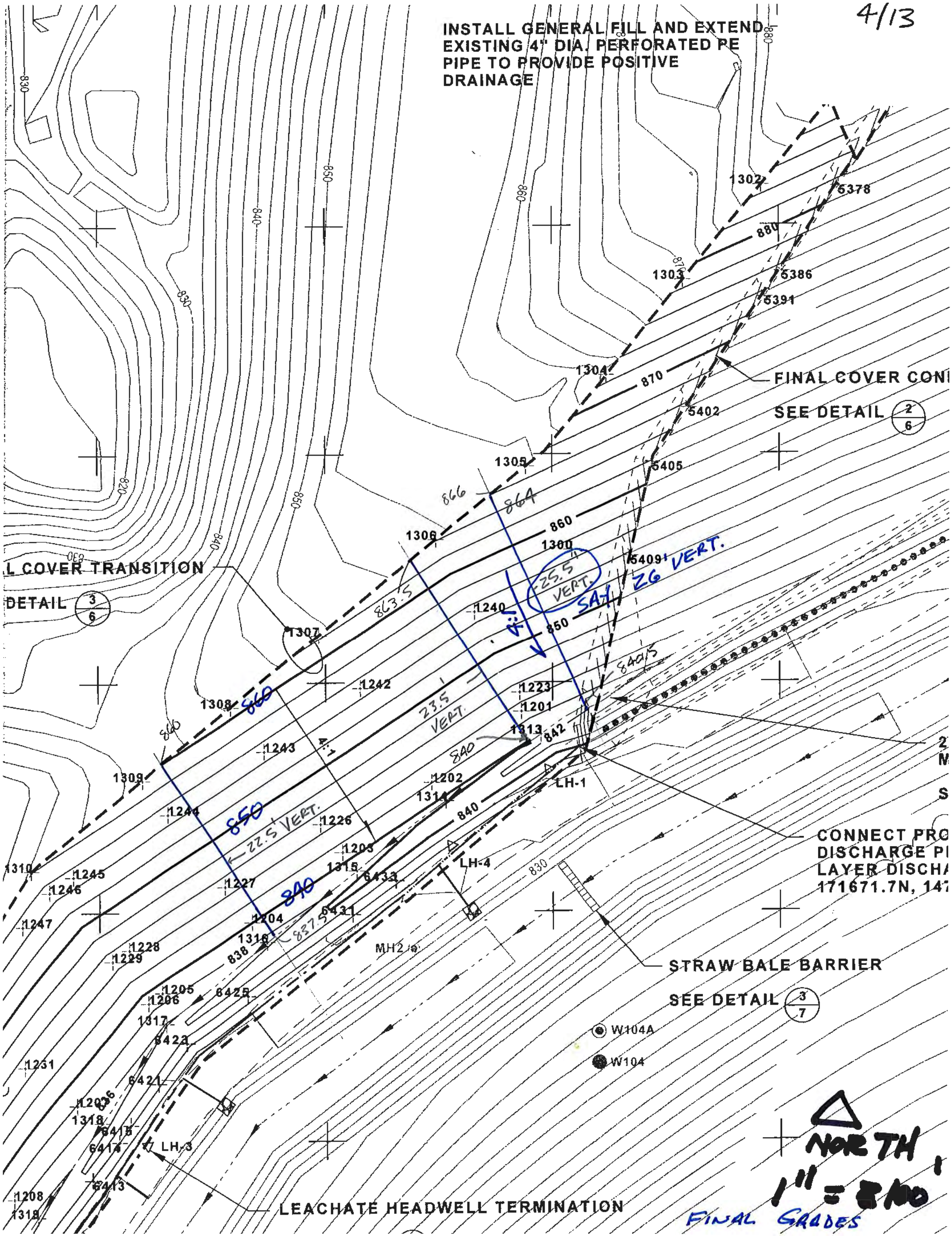
References:

Bourdeau, P.L., Ludlow, S.J., and Simpson, B.E., (1993) Stability of Soil-Covered Geosynthetic-Lined Slopes: A Parametric Study, presented at the Geosynthetics 1993 Conference in Vancouver, Canada.

Druschel, S.J. and Underwood, E.R., (1993) Design of Lining and Cover System Sideslopes, presented at the Geosynthetics 1993 Conference in Vancouver, Canada.

Giroud, J.P. and Beach, J.F., (1989) Stability of Soil Layers on Geosynthetic Lining Systems, presented at the Geosynthetics 1989 Conference in San Diego, California.

RMT, Inc., (2009), Phase IV, Cell 1, Final Cover Documentation Report, WDNR Lic. No. 4126.



4/13
INSTALL GENERAL FILL AND EXTEND EXISTING 4" DIA. PERFORATED PE PIPE TO PROVIDE POSITIVE DRAINAGE
FINAL COVER CON
SEE DETAIL 2/6
L COVER TRANSITION
DETAIL 3/6
CONNECT PRO
DISCHARGE PI
LAYER DISCHA
171671.7N, 14
STRAW BALE BARRIER
SEE DETAIL 3/7
LEACHATE HEADWELL TERMINATION
LH-1
LH-3
LH-4
MH2
W104A
W104
25.5 VERT.
26 VERT.
23.5 VERT.
22.5' VERT.
4:1
NORTH
1" = 80'
FINAL GRADES

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PROJECT / PROPOSAL NAME / LOCATION: DPC Phase IV, Cell 2A Final Cover Construction		PROJECT / PROPOSAL NO.
SUBJECT: Interface Slope Stability		02250.25.005
PREPARED BY: T. Halena	DATE: 8/04/11	FINAL
CHECKED BY: S. Inman	DATE: 8/06/11	REVISION

GEOSYNTHETIC TENSION CALCULATION

Location/condition modeled: Waubasha Sand Dr. Layer/Textured GSE Geomem.Interface (Peak Results)

Variables

Slope Angle (deg)	14.0	
Interface Friction Angle (deg)	33.2	
Adhesion (psf)	86.0	Waubasha Sand Drainage Layer/Textured GSE Geomembrane
Cover Soil Friction Angle (deg)	30.0	
Cohesion (psf)	0	
Slope Height (ft)	26	
Cover Soil Thickness (ft)	3.0	
Cover Soil Unit Weight (pcf)	115.0	
Seepage Thickness (ft)	3.000	Assume Full Saturation

Calculated Values

Weight Passive (lb/ft)	2205
Weight Active (lb/ft)	34873
Adhesion Force (lb/ft)	9243
Cohesion Force (lb/ft)	0
Seepage Toe Weight (lb/ft)	1196
Seepage Slope Weight (lb/ft)	18923

Geosynthetic Tension (lb/in)

FS = 1.0	-981
FS = 1.2	-668
FS = 1.5	-375
FS = 2.0	-94

Geosynthetic Tension = 0 when **FS = 2.26**

6/13

RMT
744 Heartland Trail
Madison, WI 53717
(608) 831-4444 • Fax (608) 831-3334

PROJECT / PROPOSAL NAME / LOCATION: DPC Phase IV, Cell 2A Final Cover Construction		PROJECT / PROPOSAL NO.
SUBJECT: Interface Slope Stability		02250.25.005
PREPARED BY: T. Halena	DATE: 8/04/11	FINAL ☐
CHECKED BY: S. Inman	DATE: 8/06/11	REVISION ☐

GEOSYNTHETIC TENSION CALCULATION

Location/condition modeled: Textured GSE Geomembrane/Waubasha Sand Dr. Layer Interface (Residual)

Variables

Slope Angle (deg)	14.0	
Interface Friction Angle (deg)	30.4	
Adhesion (psf)	48.0	Waubasha Sand Drainage LayerTextured Geomembrane
Cover Soil Friction Angle (deg)	30.0	
Cohesion (psf)	0	
Slope Height (ft)	26	
Cover Soil Thickness (ft)	3.0	
Cover Soil Unit Weight (pcf)	115.0	
Seepage Thickness (ft)	3.000	Assume Full Saturation

Calculated Values

Weight Passive (lb/ft)	2205
Weight Active (lb/ft)	34873
Adhesion Force (lb/ft)	5159
Cohesion Force (lb/ft)	0
Seepage Toe Weight (lb/ft)	1196
Seepage Slope Weight (lb/ft)	18923

Geosynthetic Tension (lb/in)

FS = 1.0	-554
FS = 1.2	-319
FS = 1.5	-99
FS = 2.0	110

Geosynthetic Tension = 0 when FS = 1.70

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7/13

RMT
744 Heartland Trail
Madison, WI 53717
(608) 831-4444 • Fax (608) 831-3334

PROJECT / PROPOSAL NAME / LOCATION: DPC Phase IV, Cell 2A Final Cover Construction		PROJECT / PROPOSAL NO.
SUBJECT: Interface Slope Stability		02250.25.005
PREPARED BY: T. Halena	DATE: 8/04/11	FINAL ☐
CHECKED BY: S. Inman	DATE: 8/06/11	REVISION ☐

GEOSYNTHETIC TENSION CALCULATION

Location/condition modeled: Fly Ash Composite/Textured GSE Geomem. Interface (Peak Results)

Variables

Slope Angle (deg)	14.0	
Interface Friction Angle (deg)	61.0	
Adhesion (psf)	389.0	Composite Fly Ash/Textured Geomembrane
Cover Soil Friction Angle (deg)	30.0	
Cohesion (psf)	0	
Slope Height (ft)	26	
Cover Soil Thickness (ft)	3.0	
Cover Soil Unit Weight (pcf)	115.0	
Seepage Thickness (ft)	0.000	

Calculated Values

Weight Passive (lb/ft)	2205
Weight Active (lb/ft)	34873
Adhesion Force (lb/ft)	41807
Cohesion Force (lb/ft)	0
Seepage Toe Weight (lb/ft)	0
Seepage Slope Weight (lb/ft)	0

Geosynthetic Tension (lb/in)

FS = 1.0	-7996
FS = 1.2	-5762
FS = 1.5	-4118
FS = 2.0	-2754

Geosynthetic Tension = 0 when FS = >> 9.0 Program Limit!!!

RMT
744 Heartland Trail
Madison, WI 53717
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PROJECT / PROPOSAL NAME / LOCATION: DPC Phase IV, Cell 1 Final Cover Construction		PROJECT / PROPOSAL NO.
SUBJECT: Interface Slope Stability		02250.25.005
PREPARED BY: T. Halena	DATE: 8/04/11	FINAL ☐
CHECKED BY: S. Inman	DATE: 8/06/11	REVISION ☐

GEOSYNTHETIC TENSION CALCULATION

Location/condition modeled: Fly Ash Composite/Textured GSE Geomem. Interface (Residual)

Variables

Slope Angle (deg)	14.0	
Interface Friction Angle (deg)	22.2	
Adhesion (psf)	93.0	Composite Fly Ash/Textured Geomembrane
Cover Soil Friction Angle (deg)	30.0	
Cohesion (psf)	0	
Slope Height (ft)	26	
Cover Soil Thickness (ft)	3.0	
Cover Soil Unit Weight (pcf)	115.0	
Seepage Thickness (ft)	0.000	

Calculated Values

Weight Passive (lb/ft)	2205
Weight Active (lb/ft)	34873
Adhesion Force (lb/ft)	9995
Cohesion Force (lb/ft)	0
Seepage Toe Weight (lb/ft)	0
Seepage Slope Weight (lb/ft)	0

Geosynthetic Tension (lb/in)

FS = 1.0	-1408
FS = 1.2	-1034
FS = 1.5	-673
FS = 2.0	-321

Geosynthetic Tension = 0 when FS = 2.90

p:02250\25\002\residualinterface080411.xls

TRI/ENVIRONMENTAL, INC.
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9/13

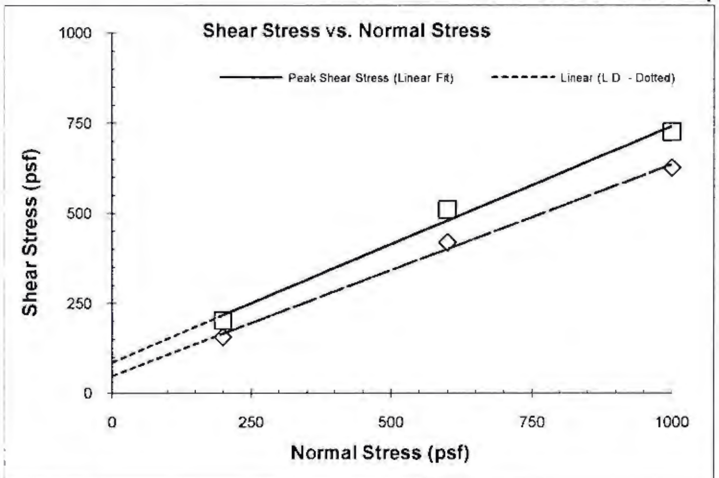
Interface Friction Test Report

Client: **TRC**
Project: **Dairyland Power - Alma Off-site Cell 2A**
Test Date: 08/02/11-08/02/11

TRI Log#: E2357-20-05
Test Method: ASTM D 5321

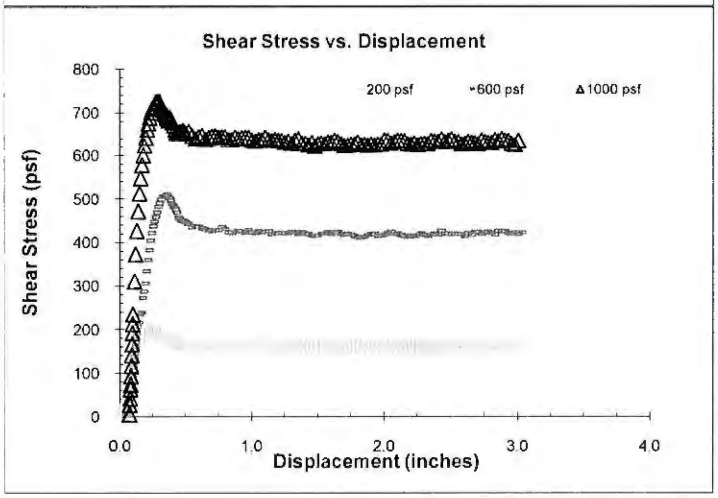
John M. Allen, P.E., 08/02/2011
Quality Review/Date

Tested Interface: Drainage Layer Sand (Wabasha Pit) vs. GSE 40 mil LLDPE Textured Geomembrane (105153620)



Test Results		
	Peak	Large Displacement (@ 3.0 in.)
Friction Angle (degrees):	33.2	30.4
Y-intercept or Adhesion (psf):	86	48

Shearing occurred at the interface.



Test Conditions	
Upper Box &	Drainage Layer Sand (Wabasha Pit) tamped in place
Lower Box	GSE 40 mil LLDPE textured geomembrane
Box Dimensions: 12"x12"x4"	
Interface Conditioning:	Interface soaked and loading applied for a minimum of 24 hours prior to shear.
Test Condition: Wet	
Shearing Rate: 0.04 inches/minute	

Test Data

Specimen No.	1	2	3
Bearing Slide Resistance (lbs)	10	14	18
Normal Stress (psf)	200	600	1000
Corrected Peak Shear Stress (psf)	201	510	725
Corrected Large Displacement Shear Stress (psf)	156	419	626
Peak Secant Angle (degrees)	45.2	40.4	36.0
Large Displacement Secant Angle (degrees)	38.0	34.9	32.0
Asperity (mils)	20.4	20.6	19.0

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10/13

TRI/ENVIRONMENTAL, INC.
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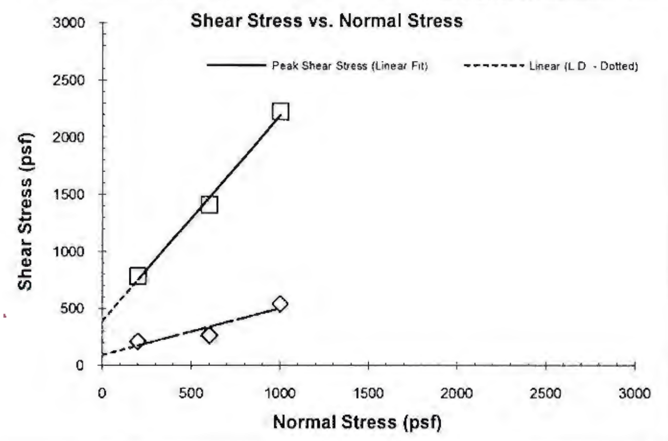
Interface Friction Test Report

Client: **TRC**
Project: **Dairyland Power - Alma Off-site Cell 2A**
Test Date: 08/02/11-08/03/11

TRI Log#: E2357-20-05
Test Method: ASTM D 5321

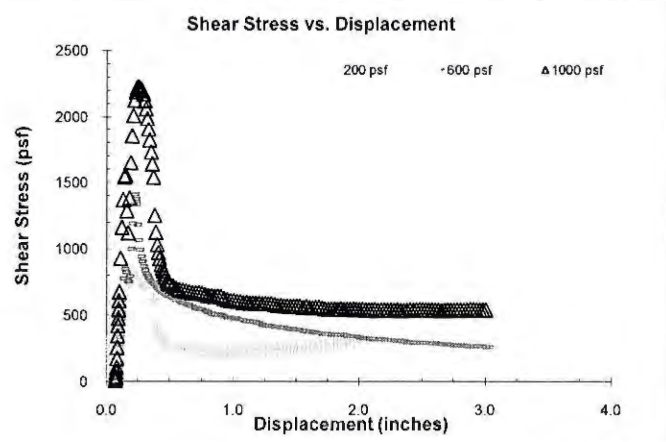
John M. Allen, P.E., 08/03/2011
Quality Review/Date

Tested Interface: Select Fly Ash vs. GSE 40 mil LLDPE Textured Geomembrane (105153620)



Test Results		
	Peak	Large Displacement (@ 3.0 in.)
Friction Angle (degrees):	61.0	22.2
Y-intercept or Adhesion (psf):	389	93

Shearing occurred at the interface. It was noted that the ash became cemented in the shear box.



Test Conditions	
Upper Box &	Select Fly Ash - tamped in place at 11% moisture content
Lower Box	GSE 40 mil LLDPE textured geomembrane
Box Dimensions: 12"x12"x4"	
Interface Conditioning:	Interface soaked and loading applied for a minimum of 24 hours prior to shear.
Test Condition: Wet	
Shearing Rate: 0.04 inches/minute	

Test Data

Specimen No.	1	2	3
Bearing Slide Resistance (lbs)	10	14	18
Normal Stress (psf)	200	600	1000
Corrected Peak Shear Stress (psf)	781	1410	2226
Corrected Large Displacement Shear Stress (psf)	212	264	539
Peak Secant Angle (degrees)	75.6	66.9	65.8
Large Displacement Secant Angle (degrees)	46.7	23.7	28.3
Asperity (mils)	24.2	22.8	22.2

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11/13

RMT, Inc.
Constant Head Permeability Test (ASTM D2434)

QC: [initials]
QA: [initials]

Project Name:	DPC		
Project #:	3081.95	USCS Description:	Poorly graded sand
Sample Name:	Select Granular Fill, Sample #1	USCS Classification:	SP
Visual Descript:	Poorly graded sand	Average k_v =	8.4E-02 cm./sec.

Sample Diameter (in):	4.00		
Sample Height (in):	4.63		
Specific Gravity:	2.70		
Tare & Wet Soil (g):	770.00		
Tare & Dry Soil (g):	758.80	Sample Type:	Remolded
Tare (g):	268.98	Beaker Tare Wt. (g):	392.32

	Initial Values		Final Values
Mold & Wet Soil (g):	5024.00	Mold & Wet Soil (g):	5216.00
Mold & Dry Soil (g):	4986.87	Mold & Dry Soil (g):	4986.87
Tare of Mold (g):	3363.00	Tare of Mold (g):	3363.00
Wet Density (pcf):	108.87	Wet Density (pcf):	121.46
Dry Density (pcf):	106.44	Dry Density (pcf):	106.44
% Saturation:	10.59%	% Saturation:	65.36%
% Moisture:	2.29%	% Moisture:	14.11%

Date			Time		Flow Vol	Flow	Head			k_v *
YY	MM	DD	Sec.	Temp.	Readings	Vol.	Bottom	Top	h	cm/sec
2009	9	16	60	26	481.5	89.18	74.50	76.10	1.6	8.4E-02
2009	9	16	60	26	481.5	89.18	74.50	76.10	1.6	8.4E-02
2009	9	16	60	26	481.7	89.38	74.50	76.10	1.6	8.4E-02
2009	9	16	60	26	482.1	89.78	74.50	76.10	1.6	8.4E-02

k_v = QL/Aht cm./sec.

Q = 89.38 ml. (ave. measured flow volume)

L = 3.313 in. (flow length)

A = 12.57 sq. cm. (area of sample)

h = 1.60 cm. (ave. head)

t = 60.00 sec. (average run time)

i = 0.19 (average gradient)

k_v = 8.4E-02 cm/sec (ave. k value)

* k_v adjusted for temperature

12/13

RMT, Inc.
Constant Head Permeability Test (ASTM D2434)

QC: HJW
QA: [initials]

Project Name:	Dairyland Power		
Project #:	3081.95	USCS Description:	Poorly graded sand
Sample Name:	Select Granular Fill, Sample #4	USCS Classification:	SP
Visual Descript:	Poorly graded sand	Average k_v =	5.1E-02 cm./sec.

Sample Diameter (in):	4.00		
Sample Height (in):	4.63		
Specific Gravity:	2.70		
Tare & Wet Soil (g):	767.80		
Tare & Dry Soil (g):	748.70	Sample Type:	Remolded
Tare (g):	268.16	Beaker Tare Wt. (g):	392.32

	Initial Values		Final Values
Mold & Wet Soil (g):	5161.00	Mold & Wet Soil (g):	5302.00
Mold & Dry Soil (g):	5092.27	Mold & Dry Soil (g):	5092.27
Tare of Mold (g):	3363.00	Tare of Mold (g):	3363.00
Wet Density (pcf):	117.85	Wet Density (pcf):	127.09
Dry Density (pcf):	113.35	Dry Density (pcf):	113.35
% Saturation:	22.06%	% Saturation:	67.32%
% Moisture:	3.97%	% Moisture:	12.13%

Date YY	MM	DD	Time Sec.	Temp.	Flow Vol Readings	Flow Vol.	Head Bottom	Top	h	k_v * cm/sec
2009	10	14	60	26	507.5	115.18	74.50	77.90	3.4	5.1E-02
2009	10	14	60	26	507.5	115.18	74.50	77.90	3.4	5.1E-02
2009	10	14	60	26	507.5	115.18	74.50	77.90	3.4	5.1E-02
2009	10	14	60	26	507.5	115.18	74.50	77.90	3.4	5.1E-02

k_v = QL/Aht cm./sec.

Q = 115.18 ml. (ave. measured flow volume)

L = 3.313 in. (flow length)

A = 12.57 sq. cm. (area of sample)

h = 3.40 cm. (ave. head)

t = 60.00 sec. (average run time)

i = 0.40 (average gradient)

k_v = 5.1E-02 cm/sec (ave. k value)

* k_v adjusted for temperature

RMT, Inc.

Constant Head Permeability Test (ASTM D2434)

QC: [initials]
QA: [initials]

Project Name:	Dairyland Power		
Project #:	3081.95	USCS Description:	Poorly graded sand
Sample Name:	Select Granular Fill, Sample #6	USCS Classification:	SP
Visual Descript:	Poorly graded sand	Average K_v =	4.7E-02 cm./sec.

Sample Diameter (in):	4.00		
Sample Height (in):	4.63		
Specific Gravity:	2.70		
Tare & Wet Soil (g):	3318.60		
Tare & Dry Soil (g):	3216.50	Sample Type:	Remolded
Tare (g):	429.85	Beaker Tare Wt. (g):	392.32

	Initial Values		Final Values
Mold & Wet Soil (g):	5154.00	Mold & Wet Soil (g):	5279.00
Mold & Dry Soil (g):	5090.70	Mold & Dry Soil (g):	5090.70
Tare of Mold (g):	3363.00	Tare of Mold (g):	3363.00
Wet Density (pcf):	117.39	Wet Density (pcf):	125.59
Dry Density (pcf):	113.24	Dry Density (pcf):	113.24
% Saturation:	20.28%	% Saturation:	60.33%
% Moisture:	3.66%	% Moisture:	10.90%

Date YY	MM	DD	Time Sec.	Temp.	Flow Vol Readings	Flow Vol.	Head Bottom	Top	h	K_v * cm/sec
2009	10	19	60	26	519.2	126.88	76.10	80.20	4.1	4.7E-02
2009	10	19	60	26	519.5	127.18	76.10	80.20	4.1	4.7E-02
2009	10	19	60	26	519.8	127.48	76.10	80.20	4.1	4.7E-02
2009	10	19	60	26	520.5	128.18	76.10	80.20	4.1	4.7E-02

K_v = QL/Aht cm./sec.

Q = 127.43 ml. (ave. measured flow volume)

L = 3.313 in. (flow length)

A = 12.57 sq. cm. (area of sample)

h = 4.10 cm. (ave. head)

t = 60.00 sec. (average run time)

i = 0.49 (average gradient)

K_v = 4.7E-02 cm/sec (ave. k value)

* K_v adjusted for temperature

Appendix K: Run-on and Run-off Control System Plan

Run-On and Run-Off Control System Plan

Alma Offsite Disposal Facility
Phase IV Landfill
Alma, Wisconsin

October 2016
Revised October 2021

Prepared For:

Dairyland Power Cooperative
3200 East Avenue South
La Crosse, Wisconsin 54601

Prepared By:

TRC
708 Heartland Trail, Suite 3000
Madison, Wisconsin 53717

Jonathan N. Hotstream, P.E., P.G.
Senior Geological Engineer

Todd Martin
Principal Project Manager

TABLE OF CONTENTS

APPENDICES

Revision History

Revision Number	Revision Date	Section Revised	Summary of Revisions
1	10/6/2021	1.2, 2.2, 2.3, 3.0, App. B	5-year periodic revision, revised text and Appendix B

1.0 Introduction

1.1 Purpose and Scope

This Run-On and Run-Off Control System Plan (Plan) was prepared by TRC Environmental Corporation (TRC) on behalf of Dairyland Power Cooperative (DPC) for the Alma Offsite Disposal Facility, Phase IV Landfill (Landfill) where coal combustion residuals (CCR) are disposed. The approximately 32.1 acre Landfill is located in Sections 18 and 19, T21N, R12W, Town of Belvidere, Buffalo County, Wisconsin.

This Plan meets the run-on and run-off control system requirements of the United States Environmental Protection Agency's (USEPA) CCR Rule (Title 40 Code of Federal Regulations (CFR) part 257 Subpart D – "Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments"). This text and its accompanying appendices and plan sheets present the plans and specifications of the run-off and run-on control systems of the Landfill. The plan sheets and the text, with its appendices, complement each other and should be reviewed and used as one document.

2.0 Engineering Design Concepts for Controlling Run-On and Run-Off

2.1 General

The Landfill design has been developed to provide environmentally sound CCR disposal. The storm water run-on and run-off control systems for the Landfill have been designed and meet the requirements of 40 CFR 257.81.

The supporting calculations for the run-on and run-off design are referenced throughout the text and are included in the appendices. Details and drawings illustrating design layout and specifications are referenced as applicable and presented on the plan sheets and figures. The majority of the calculations provided in the appendices were prepared during the initial permitting of the Phase IV Disposal Area and included in the October 2000 Plan of Operation (POO) in accordance with Wisconsin Administrative Code, Chapters 500 through 520, and conversations with the Wisconsin Department of Natural Resources (WDNR). Plan sheets included in Appendix C are the relevant plan sheets from the October 2000 POO drawing plan set. For the purposes of this Plan, the terms surface water and storm water have been used interchangeably and reflect precipitation routed over land or temporarily stored to manage run-on and run-off. No streams, wetlands, or bodies of water are located in areas that would impact run-on and run-off at the Landfill.

2.2 Run-On Control System

2.2.1 General

The run-on control system for the Landfill consists of perimeter berms, diversion berms, downslope flumes, ditching, sedimentation basins, and culverts, designed and constructed to control surface water during both the operational and post-closure periods of the Landfill. The design of the surface water controls have been performed for the operational periods when the combination of surface conditions and contributing acreage would result in the greatest run-off volume, and for the post-closure period. Given the location of the site, the surface water management system was designed utilizing the 100-year, 24-hour storm event at the time of the design, which exceeds the current 25-year, 24-hour storm event required by 40 CFR 257.81(a)(1). Calculations for the surface water run-on control designs are included in Appendix A.

The surface water control system design has been performed to meet the following requirements:

- Run-off curve numbers (RCNs) used in the analysis provide a conservative analysis of the potential land uses of the upland areas. Upland areas within the watershed primarily include wooded areas and agricultural lands. The wooded areas are located on the steeper-sloped areas of the valley and are unlikely to be affected by future land uses. High RCNs for the agricultural lands were selected to represent a conservative fallow condition with exposed bare soil. The RCNs selected for these areas were 86.

- Surface water run-on controls have been designed to divert off-site surface water away from the active fill areas. On-site surface water is routed to sedimentation basins, except surface water in contact with active fill areas, which is treated as leachate.

2.2.2 Control of Surrounding Run-On

Surface water from areas west, north, and east of the Landfill currently drain to existing drainage channels that have formed in the valleys near the Landfill. These drainage channels converge at the location of the Landfill, are conveyed around the Landfill by perimeter diversion ditches, and continue to the south in a single drainage ditch. The main drainage ditch then routes the water to the south for approximately 1.5 miles before discharging into the Mississippi River (see Plan Sheet 5 in Appendix C).

Diversion ditches are designed to route off-site surface water around the Landfill in a controlled manner. These ditches are constructed in phases as the Landfill is developed.

During previous construction events, the perimeter drainage ditch along the eastern, western, and northern sides of the Landfill were constructed to route storm water from the east, west, and north around the Landfill. Cells 1, 2, and 3 of the Landfill have been constructed (see Plan Sheet 9 in Appendix C). A temporary drainage ditch/diversion berm was constructed on the northwestern side of the Landfill to route surface water from areas northwest of the Landfill around the Landfill. During Cell 4, Module B development, the remaining surface water controls will be completed (see Plan Sheets 11 and 12 in Appendix C).

Temporary and permanent ditching and diversion berms were designed and constructed to manage the peak flows associated with the 100-year, 24-hour storm event.

2.2.3 Diversion Berms

Diversion berms are designed along the final cover system to collect and transfer surface water to the receiving downslope flume or sedimentation basin (see Detail 2 on Plan Sheet 19 in Appendix C). These diversion berms concentrate and control flow, and discharge the non-contact surface water (water that has not come into contact with the CCR) from the Landfill away from the final cover. The swales created by the diversion berms are designed at 2 percent typical slopes along the flow lines. The locations of the surface water diversion berms are shown on Plan Sheet 12 in Appendix C.

Drainage areas for the Landfill are defined by the proposed surface water diversion berms at the site. Run-off computations were performed for the site with the proposed diversion berms in-place and are contained in Appendix A. Figure K-2 in Appendix A shows the post-closure drainage areas for the Landfill.

2.2.4 Downslope Flumes

Downslope flumes are included in the design to collect and transfer surface water from the diversion berms on the final cover to the sedimentation basins. Plan Sheet 12 shows the location of the downslope flumes. The downslope flumes have been designed as enclosed pipe flumes to limit erosion and to control the flow as it crosses roads. Downslope flume calculations are included in the culvert design subsection of Appendix A.

2.2.5 Ditching

Surface water ditching has been designed to minimize velocities and depths of flow. Velocities for the grass-lined ditching have been limited to 4 feet per second (fps). In areas where velocities exceed 4 fps, permanent erosion matting, or grouted riprap are used to limit erosion and reduce velocities. Ditch sizing calculations are contained in Appendix A. Designed ditch locations are shown on Figure K-3 in Appendix A. The ditching to route surface water around the Landfill and away from the active areas of the Landfill are designed at a minimum 2-foot depth as shown on Detail 8 on Plan Sheet 23 in Appendix A. Ditch sizing calculations for operational and post-closure conditions show that a minimum freeboard of 0.4 feet occurs as the worst case condition in the ditches for the 100-year 24-hour storm event. Therefore, the calculations indicate that run-on to the active areas of the Landfill should not occur for the 25-year 24-hour storm event as required by 40 CFR 257.81(a)(1).

2.2.6 Sedimentation Basins

Two permanent sedimentation basins are designed to capture and treat non-contact run-off from the Landfill final cover system. The locations of the permanent sedimentation basins are shown on Plan Sheet 5 in Appendix C. The basins have been designed with a minimum surface area that exceeds the surface area required to settle 0.015 mm particles. The sedimentation basins are designed to accommodate the surface water run-off from a 100-year, 24-hour storm event. The emergency spillways are designed to control the run-off from a storm greater than the 100-year, 24-hour storm event.

2.2.7 Culverts

Several culverts are designed to transport non-contact run-off from the Landfill final cover and surrounding areas. The locations of the permanent culverts are shown on Plan Sheet 12 in Appendix C. The culverts have been designed to allow the peak run-off associated with a 100-year, 24-hour storm to pass through it without creating surface water breaching (i.e., berm overflow and run-on into active areas of the Landfill) or excessive backwater levels. Culvert sizing was performed using design charts developed by the U.S. Department of Transportation Federal Highway Administration. Culvert sizing calculations are provided in Appendix A.

2.2.8 Temporary Surface Water Controls

In addition to the permanent surface water management features discussed above, temporary surface water controls are also implemented during operation of the Landfill to control surface water from entering the active disposal area and to limit erosion of the final cover. These temporary control features include diversion berms, downslope discharge structure, and culverts. Temporary diversion berms will be constructed as needed along the transition from an active area to an area that has reached final grade, or that has intermediate cover, in order to control surface water from entering the active area. Temporary downslope discharge structures will be used to route non-contact run-off from diversion berms (either temporary or permanent) to the perimeter ditches.

2.3 Run-Off Control System

2.3.1 General

The leachate collection and handling system in conjunction with cell delineation berms (see detail 5 on Plan Sheet 17 in Appendix C) and perimeter berms comprise the control system for preventing contact surface water run-off from the active portions of the Landfill. Contact surface water is managed as leachate. The leachate collection system for the Landfill has been designed to provide effective drainage, collection, and removal of leachate from the Landfill.

2.3.2 Leachate Collection System

The primary components of the leachate collection system consist of a drainage layer, leachate collection and transfer piping, cleanouts, manholes, a storage tank, and a load-out facility. The leachate collection system layout is shown on Plan Sheet 5 in Appendix C. The drainage layer is placed over the geomembrane on the base and sidewalls. The drainage layer promotes the efficient transmission of leachate to the leachate collection trenches and pipes. The drainage layer is a minimum of 12 inches thick and has a minimum hydraulic conductivity of 1.0×10^{-2} centimeters per second (cm/s).

The leachate collection piping is placed in vee-shaped trenches and consists of 6-inch–diameter perforated high density polyethylene (HDPE) pipe. Pipe bedding material is placed around the perforated pipe and mounded as shown on Plan Sheet 17 in Appendix C.

Leachate collection pipes in each cell are placed parallel to each other in valleys over the herringbone design across the base. These lines drain at a 4 to 6 percent slope to the leachate removal and transfer system.

Temporary cell delineation berms are used along the cell boundaries to control surface water run-off from exiting the active areas of the Landfill. Refer to Detail 5 on Plan Sheet 17 for further details on the temporary cell delineation berm design.

2.3.3 Leachate Removal and Transfer System

The perforated leachate collection piping will transition to 6-inch–diameter nonperforated leachate transfer piping within the Landfill just prior to where the transfer piping penetrates the liner system at the southern toe-of-slope of each cell. The horizontal pipe penetration has been designed to prevent leachate from leaving the Landfill liner system through the liner penetration.

Outside of the limits of CCR, concrete manholes provide a location for transfer piping to manifold into a single perimeter transfer pipe around the southern end of the Landfill, and to provide a location for cleanout access piping.

The combined transfer piping then extends to the leachate storage tank located near the ash processing facility. Leachate collected in the tank is pumped into tanker trucks and transported to a nearby wastewater treatment plan for treatment which complies with 40 CFR 257.81(b). Plan Sheet 5 illustrates the location of the transfer piping, manholes, and the storage tank.

2.3.4 Leachate Storage Capacity From a 25-Year 24-Hour Storm Event

The proposed phasing plans and existing conditions were reviewed to determine the worst-case scenario for leachate generation. This worst-case scenario was used to show that run-off from the active area of the Landfill would not occur from a 25-year 24-hour storm event. Calculations contained in Appendix B show that there is approximately 14,700 cubic feet of leachate storage capacity remaining in the leachate collection system after a 25-year 24-hour storm event. Therefore, sufficient infrastructure is provided to prevent run-off from the active area of the Landfill as required by 40 CFR 257.81(a)(2).

2.3.5 Conclusions

This Plan has demonstrated that the Landfill has a run-on control system and a run-off control system sufficient to prevent flow onto or off of the active portion during a 24-hour 25-year storm event. The Landfill is in compliance with the requirements of 40 CFR 257.81.

3.0 Amendment of the Plan and Notification

This Plan was been completed in compliance with the requirements set forth in 40 CFR 257.81. This document has been placed in the operating record, posted to the publicly accessible website, and government notifications have been provided.

A Run-On and Run-Off Control System Plan must be prepared every 5 years from the completion date of this Plan.

The Plan must be amended whenever the periodic review period is reached or if changes in site conditions, either intentionally or unintentionally, occur that will sustainably impact the current written plan in effect.

4.0 Engineer's Certification

Pursuant to 40 CFR 257.81 and by means of this certification I attest that:

(i) I am familiar with the requirements of the federal CCR rule (40 CFR 257);

(ii) this Run-On and Run-Off Control System Plan has been prepared in accordance with good engineering practice; and

(iii) this Run-On and Run-Off Control System Plan meets the requirements of 40 CFR 257.81(c).

For the purpose of this document, "certify" and "certification" shall be interpreted and construed to be a "statement of professional opinion." The certification is understood and intended to be an expression of my professional opinion as a Wisconsin licensed professional engineer, based upon knowledge, information, and belief. The statement(s) of professional opinion are not and shall not be interpreted or construed to be a guarantee or a warranty of the analysis herein.

Signature of Registered Professional Engineer

Registration No. 42745-6 State: Wisconsin

Appendix A: Surface Water Run-On Control System Calculations

Note: For clarification purposes, these run-on calculations estimate "run-off" quantities from areas in and surrounding the Landfill that develop non-contact surface water that is managed to prevent run-on to the active Landfill areas.

- Surface Water Run-off Calculations
  - Purpose/Methodology/Assumptions/Results/References
  - Post-closure Run-off Calculations
  - Operational Run-off Calculations
  - Reference Information
- Diversion Berm, Perimeter Ditch, and Spillway Design Calculations
  - Purpose/Methodology/Assumptions/Results/References
  - Calculations – Post-closure Landfill Conditions
  - Calculations – Operational Landfill Conditions
  - Reference Information
- Culvert/Downslope Flume Design Calculations
  - Purpose/Methodology/Assumptions/Results/References
  - Calculations – Post-closure Landfill Conditions
  - Calculations – Temporary Culverts, Operational Conditions
- Vegetation Information

Surface Water Run-off Calculations

Purpose/Methodology/Assumptions/Results/References

RMT®

COMPUTATION SHEET

SHEET 1 OF 3

744 Heartland Trail (53717-8923) P. O. Box 8923 (53708-8923) Madison, WI (608) 831-4444 FAX: (608) 831-3334 VOICE: (608) 831-1989

PROJECT/PROPOSAL NAME	PREPARED		CHECKED		PROJECT/PROPOSAL NO.
	By:	Date:	By:	Date:	
Dairyland Power Cooperative	BJK	5/97	BLP	6/97	3081.40

SURFACE WATER RUNOFF CALCULATIONS

Purpose

The purpose of the surface water runoff calculations was to estimate the amount of surface water runoff and the peak discharge for the 25-year, 24-hour and 100-year, 24-hour storms at the proposed Dairyland Power Landfill. Calculations were performed for the pre- and post-development conditions. Calculations were also performed for operational conditions for the 25-year, 24-hour storm. Once determined, the surface water runoff quantities were compared to determine the effect of the proposed landfill on the existing drainage patterns. The runoff calculations were also used to size diversion ditches, sedimentation basins, culverts, and downslope flumes.

Methodologies

Surface water runoff calculations consist of delineating drainage areas (watersheds), as shown on the attached figures, estimating runoff characteristics, and calculating the peak and total runoff rate and volume for each drainage area. The methods for computing surface water runoff were based on the methodologies presented in the Technical Release No. 55 - "Urban Hydrology for Small Watersheds" by the United States Soil Conservation Service.

The calculations were performed using the QUICK TR-55 computer program developed by Haestad Methods (Haestad 1989). The program incorporates rainfall quantities, storm distributions, surface runoff characteristics, drainage areas, times of concentration, and travel times to generate a hydrograph from which the volume of surface water runoff and the peak discharge are obtained.

It is noted that the storm water control structures have been designed using a 100-year, 24-hour storm event and a TR-55 Type II storm distribution to determine peak flow rates. Rainfall distributions for the Type II storm event include "nested" higher intensity storm events within those needed for longer durations at the same probability. The resulting peak flows using this design method meet or exceed the peak flows obtained using a 25-year, time of concentration storm event (required by NR 504.09).

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Assumptions

The following assumptions were made in developing the hydrographs (Note: The figures and values referenced in these assumptions have been included in the references portion of this appendix):

- A 2-year, 24-hour storm event in the vicinity of the landfill is 2.8 inches based on rainfall maps prepared by the U.S. Weather Bureau.
- A 25-year, 24-hour storm event in the vicinity of the landfill equates to 4.9 inches based on rainfall maps prepared by the U.S. Weather Bureau.
- A 100-year, 24-hour storm event in the vicinity of the landfill equates to 6.1 inches based on rainfall maps prepared by the U.S. Weather Bureau.
- A Type II rainfall distribution was used, based on SCS storm distribution maps provided in the TR-55 manual.
- Cover types for the pre-development conditions, from which runoff curve numbers were determined, were based on USGS topographic maps and an aerial photograph.
- For the post-development landfill conditions, a runoff curve number of 74 was assumed, based on values provided in the TR-55 manual.
- Based on the USDA-SCS General Soil Map for Buffalo County, Wisconsin, the primary soil formations present include the Dubuque silt loam and the Fayette silt loam. These soils are a Type B soil, based on tables provided in the TR-55 manual.
- Runoff curve numbers for the non-landfill areas ranged from 55 to 86, based on values provided in the TR-55 manual. Refer to the attached calculations for the breakdown and description of each of the curve numbers used for the various drainage areas.

Results

The table below summarizes the results of the surface water runoff analyses and provides a comparison of the pre- and post-development conditions:

STORM	TOTAL RUNOFF (acre-ft)			PEAK DISCHARGE (cfs)		
	PRE-	POST-	Δ	PRE-	POST-	Δ
25-year	153	148	(5)	1,170	1,028	(142)
100-year	232	225	(7)	1,895	1,622	(273)

Based on the results of the surface water runoff calculations, the proposed landfill is not anticipated to have an adverse impact on the existing surface water at the site. Total runoff volumes to the existing drainageways are not anticipated to change in the pre- and post-development conditions. Peak runoff volumes to the existing drainageways for post-

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development conditions are slightly lower than the pre-development conditions. This is primarily due to the use of sedimentation basins to dissipate peak flows from the landfill to the surrounding areas. The reduced peak flows will result in reduced sediment transport from the site.

The results of these surface water runoff calculations have also been used in the attached diversion berm, perimeter ditch, spillway, and sedimentation basin calculations. These structures have been designed to handle the peak runoff from the 100-year, 24-hour storm event.

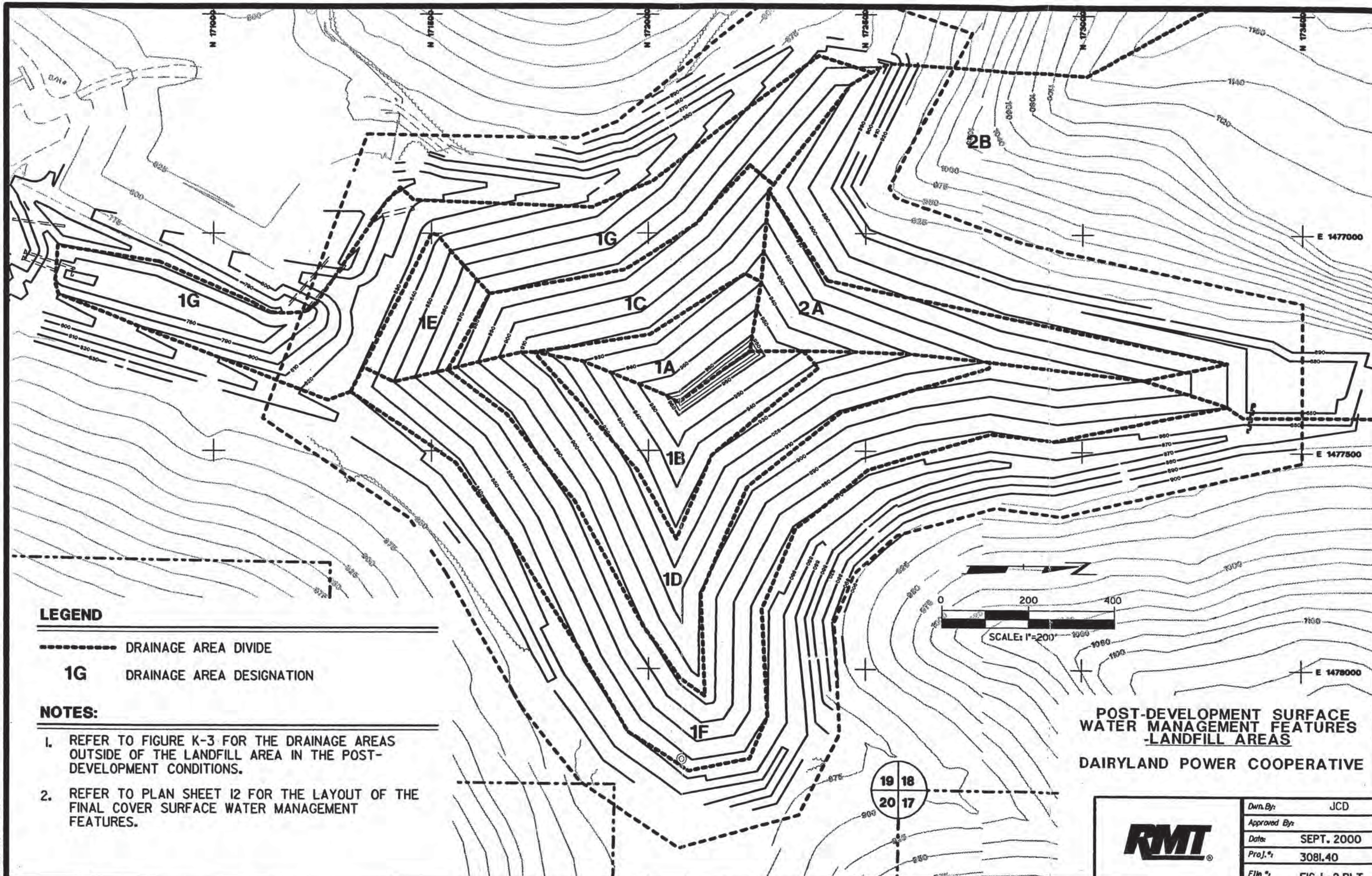
References

US Department of Agriculture, Soil Conservation Service. Urban Hydrology for Small Watersheds. Technical Release No. 55. 2nd Edition. June 1986.

US Department of Agriculture, Soil Conservation Service. 1986. Engineering Field Manual for Conservation Practices. November 1986.

Haestad Methods. Pond Pack, QUICK TR-55. Hydrology for Small Watersheds. December 1989.

Post-closure Run-off Calculations



RMT COMPUTER AIDED DESIGN & DRAFTING

FIGURE K-2

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RUNOFF CURVE NUMBER SUMMARY

::

Subarea Description	Area (acres)	CN (weighted)
1A	1.40	74
1B	2.20	74
1C	2.90	74
1D	5.30	74
1E	1.20	74
1F	9.50	74
1G	7.40	84

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RUNOFF CURVE NUMBER DATA

::

Composite Area: 1A

SURFACE DESCRIPTION	AREA (acres)	CN	
Landfill Cover	1.40	74 ✓	
COMPOSITE AREA --->	1.40	74.0	(74)

::

Composite Area: 1B

SURFACE DESCRIPTION	AREA (acres)	CN	
Landfill Cover	2.20	74 ✓	
COMPOSITE AREA --->	2.20	74.0	(74)

::

Composite Area: 1C

SURFACE DESCRIPTION	AREA (acres)	CN	
Landfill Cover	2.90	74 ✓	
COMPOSITE AREA --->	2.90	74.0	(74)

::

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Composite Area: 1D

SURFACE DESCRIPTION	AREA (acres)	CN	
Landfill Cover	5.30	74 ✓	
COMPOSITE AREA --->	5.30	74.0	(74)

Composite Area: 1E

SURFACE DESCRIPTION	AREA (acres)	CN	
Landfill Cover	1.20	74 ✓	
COMPOSITE AREA --->	1.20	74.0	(74)

Composite Area: 1F

SURFACE DESCRIPTION	AREA (acres)	CN	
Landfill Cover	9.50	74 ✓	
COMPOSITE AREA --->	9.50	74.0	(74)

Composite Area: 1G

SURFACE DESCRIPTION	AREA (acres)	CN	
Landfill Cover	4.40	74 ✓	
Sedimentation Basin	3.00	98 ✓	
COMPOSITE AREA --->	7.40	83.7	(84)

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RUNOFF CURVE NUMBER SUMMARY

::

Subarea Description	Area (acres)	CN (weighted)
2A	2.70	74
2B	21.50	69

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RUNOFF CURVE NUMBER DATA

Composite Area: 2A

SURFACE DESCRIPTION	AREA (acres)	CN	
Landfill Cover	2.70	74	
COMPOSITE AREA --->	2.70	74.0	(74)

Composite Area: 2B

SURFACE DESCRIPTION	AREA (acres)	CN	
Landfill Cover	2.70	74	
Graded/Grassed Area	2.00	61	
Woods/Brush	15.80	67	
Sedimentation Basin	1.00	98	
COMPOSITE AREA --->	21.50	68.8	(69)

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SUMMARY SHEET FOR Tc or Tt COMPUTATIONS
(Solved for Time using TR-55 Methods)

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Subarea descr.	Tc or Tt	Time (hrs)
1A	Tc	0.18
1B	Tc	0.23
1C	Tc	0.23
1D	Tc	0.35
1E	Tc	0.18
1F	Tc	0.45
1G	Tc	0.22

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Tc COMPUTATIONS FOR: 1A

SHEET FLOW (Applicable to Tc only)

Segment ID		1	
Surface description		Dense Grass	
Manning's roughness coeff., n		0.2400	
Flow length, L (total < or = 300)	ft	150.0	
Two-yr 24-hr rainfall, P2	in	2.800	
Land slope, s	ft/ft	0.2500	
$T = \frac{.007 * (n*L)^{0.8}}{P2^{0.5} * s^{0.4}}$	hrs	0.13	= 0.13

SHALLOW CONCENTRATED FLOW

Segment ID		2	
Surface (paved or unpaved)?		Unpaved	
Flow length, L	ft	420.0	
Watercourse slope, s	ft/ft	0.0200	
$Avg.V = Csf * (s)^{0.5}$	ft/s	2.2818	
where: Unpaved Csf = 16.1345			
Paved Csf = 20.3282			
T = L / (3600*V)	hrs	0.05	= 0.05

CHANNEL FLOW

Segment ID			
Cross Sectional Flow Area, a	sq.ft	0.00	
Wetted perimeter, Pw	ft	0.00	
Hydraulic radius, r = a/Pw	ft	0.000	
Channel slope, s	ft/ft	0.0000	
Manning's roughness coeff., n		0.0000	
$V = \frac{1.49 * r^{2/3} * s^{1/2}}{n}$	ft/s	0.0000	
Flow length, L	ft	0	
T = L / (3600*V)	hrs	0.00	= 0.00

::

TOTAL TIME (hrs)   0.18

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Tc COMPUTATIONS FOR: 1B

```
SHEET FLOW (Applicable to Tc only)
    Segment ID                                      1
    Surface description                       Dense Grass
    Manning's roughness coeff., n                 0.2400
    Flow length, L (total < or = 300)   ft       125.0
    Two-yr 24-hr rainfall, P2           in        2.800
    Land slope, s                       ft/ft    0.2500
                      0.8
         .007 * (n*L)
    T =  --------------                 hrs       0.11            = 0.11
             0.5    0.4
           P2   *  s

SHALLOW CONCENTRATED FLOW
    Segment ID                                      2
    Surface (paved or unpaved)?                 Unpaved
    Flow length, L                      ft        960.0
    Watercourse slope, s                ft/ft    0.0200

                        0.5
    Avg.V =  Csf *  (s)                 ft/s     2.2818
    where:   Unpaved Csf = 16.1345
             Paved   Csf = 20.3282

    T = L / (3600*V)                    hrs       0.12            = 0.12


CHANNEL FLOW
    Segment ID
    Cross Sectional Flow Area, a        sq.ft     0.00
    Wetted perimeter, Pw                ft        0.00
    Hydraulic radius, r = a/Pw          ft       0.000
    Channel slope, s                    ft/ft   0.0000
    Manning's roughness coeff., n               0.0000

                  2/3    1/2
        1.49  *  r   *  s
    V = --------------------            ft/s    0.0000
                  n

    Flow length, L                      ft           0

    T = L / (3600*V)                    hrs       0.00            = 0.00

::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                                         TOTAL TIME (hrs)          0.23
```

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Tc COMPUTATIONS FOR: 1C

SHEET FLOW (Applicable to Tc only)

Segment ID		1	
Surface description		Dense Grass	
Manning's roughness coeff., n		0.2400	
Flow length, L (total < or = 300)	ft	165.0	
Two-yr 24-hr rainfall, P2	in	2.800	
Land slope, s	ft/ft	0.2500	
$T = \frac{.007 * (n*L)^{0.8}}{P2^{0.5} * s^{0.4}}$	hrs	0.14	= 0.14

SHALLOW CONCENTRATED FLOW

Segment ID		2	
Surface (paved or unpaved)?		Unpaved	
Flow length, L	ft	720.0	
Watercourse slope, s	ft/ft	0.0200	
Avg.V = $Csf * (s)^{0.5}$	ft/s	2.2818	
where: Unpaved Csf = 16.1345			
Paved Csf = 20.3282			
T = L / (3600*V)	hrs	0.09	= 0.09

CHANNEL FLOW

Segment ID			
Cross Sectional Flow Area, a	sq.ft	0.00	
Wetted perimeter, Pw	ft	0.00	
Hydraulic radius, r = a/Pw	ft	0.000	
Channel slope, s	ft/ft	0.0000	
Manning's roughness coeff., n		0.0000	
$V = \frac{1.49 * r^{2/3} * s^{1/2}}{n}$	ft/s	0.0000	
Flow length, L	ft	0	
T = L / (3600*V)	hrs	0.00	= 0.00

::

TOTAL TIME (hrs) 0.23

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Tc COMPUTATIONS FOR: 1D

SHEET FLOW (Applicable to Tc only)

Segment ID		1	
Surface description		Dense Grass	
Manning's roughness coeff., n		0.2400	
Flow length, L (total < or = 300)	ft	160.0 ✓	
Two-yr 24-hr rainfall, P2	in	2.800	
Land slope, s	ft/ft	0.2500 ✓	
$T = \frac{.007 * (n*L)^{0.8}}{P2^{0.5} * s^{0.4}}$	hrs	0.13	= 0.13

SHALLOW CONCENTRATED FLOW

Segment ID		2	
Surface (paved or unpaved)?		Unpaved	
Flow length, L	ft	1770.0 ✓	
Watercourse slope, s	ft/ft	0.0200 ✓	
$Avg.V = Csf * (s)^{0.5}$	ft/s	2.2818	
where: Unpaved Csf = 16.1345			
Paved Csf = 20.3282			
T = L / (3600*V)	hrs	0.22	= 0.22

CHANNEL FLOW

Segment ID			
Cross Sectional Flow Area, a	sq.ft	0.00	
Wetted perimeter, Pw	ft	0.00	
Hydraulic radius, r = a/Pw	ft	0.000	
Channel slope, s	ft/ft	0.0000	
Manning's roughness coeff., n		0.0000	
$V = \frac{1.49 * r^{2/3} * s^{1/2}}{n}$	ft/s	0.0000	
Flow length, L	ft	0	
T = L / (3600*V)	hrs	0.00	= 0.00

::

TOTAL TIME (hrs) 0.35

```
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                    Tc COMPUTATIONS FOR: 1E

SHEET FLOW (Applicable to Tc only)
    Segment ID                                     1
    Surface description                      Dense Grass
    Manning's roughness coeff., n                0.2400
    Flow length, L (total < or = 300)    ft     175.0
    Two-yr 24-hr rainfall, P2            in     2.800
    Land slope, s                     ft/ft    0.2500
                          0.8
         .007 * (n*L)
    T =  --------------                  hrs     0.14              = 0.14
             0.5    0.4
           P2   *  s

SHALLOW CONCENTRATED FLOW
    Segment ID                                     2
    Surface (paved or unpaved)?                 Unpaved
    Flow length, L                       ft     250.0
    Watercourse slope, s              ft/ft    0.0200

                          0.5
    Avg.V =  Csf *  (s)               ft/s   2.2818
    where:   Unpaved Csf = 16.1345
             Paved   Csf = 20.3282

    T = L / (3600*V)                     hrs     0.03              = 0.03


CHANNEL FLOW
    Segment ID
    Cross Sectional Flow Area, a     sq.ft      0.00
    Wetted perimeter, Pw                ft      0.00
    Hydraulic radius, r = a/Pw          ft     0.000
    Channel slope, s                 ft/ft    0.0000
    Manning's roughness coeff., n             0.0000

                      2/3    1/2
         1.49  *  r   *  s
    V =  --------------------        ft/s   0.0000
                    n

    Flow length, L                      ft         0

    T = L / (3600*V)                    hrs      0.00              = 0.00

  ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                                        TOTAL TIME (hrs)       0.18
```

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Tc COMPUTATIONS FOR: 1F

SHEET FLOW (Applicable to Tc only)

Segment ID		1	
Surface description		Dense Grass	
Manning's roughness coeff., n		0.2400	
Flow length, L (total < or = 300)	ft	150.0	
Two-yr 24-hr rainfall, P2	in	2.800	
Land slope, s	ft/ft	0.2500	
$T = \frac{.007 * (n*L)^{0.8}}{P2^{0.5} * s^{0.4}}$	hrs	0.13	= 0.13

SHALLOW CONCENTRATED FLOW

Segment ID		2	
Surface (paved or unpaved)?		Unpaved	
Flow length, L	ft	2650.0	
Watercourse slope, s	ft/ft	0.0200	
$Avg.V = Csf * (s)^{0.5}$	ft/s	2.2818	
where: Unpaved Csf = 16.1345			
Paved Csf = 20.3282			
T = L / (3600*V)	hrs	0.32	= 0.32

CHANNEL FLOW

Segment ID			
Cross Sectional Flow Area, a	sq.ft	0.00	
Wetted perimeter, Pw	ft	0.00	
Hydraulic radius, r = a/Pw	ft	0.000	
Channel slope, s	ft/ft	0.0000	
Manning's roughness coeff., n		0.0000	
$V = \frac{1.49 * r^{2/3} * s^{1/2}}{n}$	ft/s	0.0000	
Flow length, L	ft	0	
T = L / (3600*V)	hrs	0.00	= 0.00

::

TOTAL TIME (hrs) 0.45

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Tc COMPUTATIONS FOR: 1G

```
SHEET FLOW (Applicable to Tc only)
    Segment ID                                      1
    Surface description                        Dense Grass
    Manning's roughness coeff., n                  0.2400
    Flow length, L (total < or = 300)     ft      170.0
    Two-yr 24-hr rainfall, P2             in      2.800
    Land slope, s                        ft/ft    0.2500
                    0.8
        .007 * (n*L)
    T = --------------                   hrs       0.14             = 0.14
           0.5    0.4
         P2   *  s

SHALLOW CONCENTRATED FLOW
    Segment ID                                      2         3
    Surface (paved or unpaved)?                  Unpaved   Unpaved
    Flow length, L                        ft      780.0     370.0
    Watercourse slope, s                 ft/ft    0.0600    0.0800

                        0.5
    Avg.V =  Csf *  (s)                  ft/s    3.9521    4.5635
    where:   Unpaved Csf = 16.1345
             Paved   Csf = 20.3282

    T = L / (3600*V)                     hrs       0.05  +   0.02   = 0.08


CHANNEL FLOW
    Segment ID
    Cross Sectional Flow Area, a        sq.ft      0.00
    Wetted perimeter, Pw                  ft       0.00
    Hydraulic radius, r = a/Pw            ft      0.000
    Channel slope, s                     ft/ft    0.0000
    Manning's roughness coeff., n                 0.0000

                 2/3    1/2
        1.49  *  r   *  s
    V = --------------------              ft/s    0.0000
                  n

    Flow length, L                        ft          0

    T = L / (3600*V)                     hrs       0.00             = 0.00

::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                                         TOTAL TIME (hrs)            0.22
```

Quick TR-55 Ver.5.46 S/N:
Executed: 08:57:44 06-18-1997 a:COVER2.TCT

SUMMARY SHEET FOR Tc or Tt COMPUTATIONS
(Solved for Time using TR-55 Methods)

Dairyland Power Coop.
Feasibility Report
Landfill Final Cover
BJK 3/97

Subarea descr.	Tc or Tt	Time (hrs)
2A	Tc	0.28
2B	Tc	0.18

Quick TR-55 Ver.5.46 S/N:
Executed: 08:57:44 06-18-1997 a:COVER2.TCT

Dairyland Power Coop.
Feasibility Report
Landfill Final Cover
BJK 3/97

√ BJG 6/13/97

Tc COMPUTATIONS FOR: 2A

SHEET FLOW (Applicable to Tc only)

Segment ID		1	
Surface description		Dense Grass	
Manning's roughness coeff., n		0.2400	
Flow length, L (total < or = 300)	ft	200.0 ✓	
Two-yr 24-hr rainfall, P2	in	2.800	
Land slope, s	ft/ft	0.2500 ✓	

$$T = \frac{.007 * (n*L)^{0.8}}{P2^{0.5} * s^{0.4}} \quad \text{hrs} \quad 0.16 \qquad = 0.16$$

SHALLOW CONCENTRATED FLOW

Segment ID		2	
Surface (paved or unpaved)?		Unpaved	
Flow length, L	ft	940.0 ✓	
Watercourse slope, s	ft/ft	0.0200 ✓	

$$Avg.V = Csf * (s)^{0.5} \quad \text{ft/s} \quad 2.2818$$

where: Unpaved Csf = 16.1345
Paved Csf = 20.3282

T = L / (3600*V) hrs 0.11 = 0.11

CHANNEL FLOW

Segment ID			
Cross Sectional Flow Area, a	sq.ft	0.00	
Wetted perimeter, Pw	ft	0.00	
Hydraulic radius, r = a/Pw	ft	0.000	
Channel slope, s	ft/ft	0.0000	
Manning's roughness coeff., n		0.0000	

$$V = \frac{1.49 * r^{2/3} * s^{1/2}}{n} \quad \text{ft/s} \quad 0.0000$$

Flow length, L ft 0

T = L / (3600*V) hrs 0.00 = 0.00

::

TOTAL TIME (hrs) 0.28

```
Quick TR-55 Ver.5.46   S/N:
Executed: 08:57:44   06-18-1997    a:COVER2.TCT

                        Dairyland Power Coop.
                         Feasibility Report
                        Landfill Final Cover
                             BJK 3/97

                    Tc COMPUTATIONS FOR: 2B

 SHEET FLOW (Applicable to Tc only)
    Segment ID                                   1
    Surface description                     Brush
    Manning's roughness coeff., n                0.1300
    Flow length, L (total < or = 300)   ft      300.0
    Two-yr 24-hr rainfall, P2           in      2.800
    Land slope, s                     ft/ft     0.2000
                      0.8
        .007 * (n*L)
    T = --------------                  hrs      0.15              = 0.15
           0.5   0.4
         P2   *  s

SHALLOW CONCENTRATED FLOW
    Segment ID                                  2         3
    Surface (paved or unpaved)?               Unpaved   Unpaved
    Flow length, L                      ft     560.0     300.0
    Watercourse slope, s              ft/ft    0.4400    0.0800

                        0.5
    Avg.V =  Csf *  (s)                ft/s   %10.7024  4.5635
    where:   Unpaved Csf = 16.1345
             Paved   Csf = 20.3282

    T = L / (3600*V)                   hrs     0.01  +   0.02   =  0.03


CHANNEL FLOW
    Segment ID
    Cross Sectional Flow Area, a      sq.ft    0.00
    Wetted perimeter, Pw                 ft    0.00
    Hydraulic radius, r = a/Pw           ft    0.000
    Channel slope, s                  ft/ft    0.0000
    Manning's roughness coeff., n              0.0000

                   2/3   1/2
        1.49  *  r    *  s
    V = --------------------           ft/s   0.0000
                  n

    Flow length, L                     ft        0

    T = L / (3600*V)                   hrs     0.00                = 0.00

 ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                                          TOTAL TIME (hrs)        0.18
```

Return Frequency: 25 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 09-18-2000 12:51:33
Watershed file: --> P:\DATA\PROJECTS\3081\40\SW\COVER1 .MOP
Hydrograph file: --> P:\DATA\PROJECTS\3081\40\SW\COVER125.HYD

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>>>> Input Parameters Used to Compute Hydrograph <<<<

Subarea Description	AREA (acres)	CN	Tc (hrs)	* Tt (hrs)	Precip. (in)	Runoff (in)	Ia/p input/used	
1A	1.40	74.0	0.20	0.00	4.90	2.28	I.14	.14
1B	2.20	74.0	0.20	0.00	4.90	2.28	I.14	.14
1C	2.90	74.0	0.20	0.00	4.90	2.28	I.14	.14
1D	5.30	74.0	0.40	0.00	4.90	2.28	I.14	.14
1E	1.20	74.0	0.20	0.00	4.90	2.28	I.14	.14
1F	9.50	74.0	0.50	0.00	4.90	2.28	I.14	.14
1G	7.40	84.0	0.20	0.00	4.90	3.18	I.08	.10

* Travel time from subarea outfall to composite watershed outfall point.
I -- Subarea where user specified interpolation between Ia/p tables.

Total area = 29.90 acres or 0.04672 sq.mi
Peak discharge = 67 cfs

WARNING: Drainage areas of two or more subareas
differ by a factor of 5 or greater.

Total Runoff =

$$\frac{22.5\text{ ac}(2.28") + 7.4\text{ ac}(3.18\text{ in})}{12}$$

= 6.2 ac-FT

>>>> Computer Modifications of Input Parameters <<<<<

Subarea Description	Input Values Tc (hr)	Input Values * Tt (hr)	Rounded Values Tc (hr)	Rounded Values * Tt (hr)	Ia/p Interpolated (Yes/No)	Ia/p Messages
1A	0.18	0.00	0.20	0.00	Yes	--
1B	0.23	0.00	0.20	0.00	Yes	--
1C	0.23	0.00	0.20	0.00	Yes	--
1D	0.35	0.00	0.40	0.00	Yes	--
1E	0.18	0.00	0.20	0.00	Yes	--
1F	0.45	0.00	0.50	0.00	Yes	--
1G	0.22	0.00	0.20	0.00	No	Computed Ia/p < .1

* Travel time from subarea outfall to composite watershed outfall point.

Return Frequency: 25 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 09-18-2000 12:51:33
Watershed file: --> P:\DATA\PROJECTS\3081\40\SW\COVER1 .MOP
Hydrograph file: --> P:\DATA\PROJECTS\3081\40\SW\COVER125.HYD

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>>>> Summary of Subarea Times to Peak <<<<

Subarea	Peak Discharge at Composite Outfall (cfs)	Time to Peak at Composite Outfall (hrs)
1A	4	12.2
1B	6	12.2
1C	8	12.2
1D	11	12.3
1E	3	12.1
1F	17	12.4
1G	29	12.2
Composite Watershed	67	12.2

Return Frequency: 25 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 09-18-2000 12:51:33
Watershed file: --> P:\DATA\PROJECTS\3081\40\SW\COVER1 .MOP
Hydrograph file: --> P:\DATA\PROJECTS\3081\40\SW\COVER125.HYD

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Composite Hydrograph Summary (cfs)

Subarea Description	11.0 hr	11.3 hr	11.6 hr	11.9 hr	12.0 hr	12.1 hr	12.2 hr	12.3 hr	12.4 hr
1A	0	0	0	1	2	3	4	2	1
1B	0	0	0	1	3	5	6	4	2
1C	0	0	0	2	4	7	8	5	3
1D	0	0	1	1	2	5	8	11	11
1E	0	0	0	1	2	3	3	2	1
1F	0	1	1	2	3	5	9	15	17
1G	1	1	2	8	15	27	29	18	9
Total (cfs)	1	2	4	16	31	55	67	57	44

Subarea Description	12.5 hr	12.6 hr	12.7 hr	12.8 hr	13.0 hr	13.2 hr	13.4 hr	13.6 hr	13.8 hr
1A	1	1	1	0	0	0	0	0	0
1B	1	1	1	1	1	1	0	0	0
1C	2	1	1	1	1	1	1	1	0
1D	8	6	4	3	2	2	1	1	1
1E	1	1	0	0	0	0	0	0	0
1F	17	13	10	8	5	3	3	2	2
1G	6	5	4	3	3	2	2	2	2
Total (cfs)	36	28	21	16	12	9	7	6	5

Return Frequency: 25 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 09-18-2000 12:51:33
Watershed file: --> P:\DATA\PROJECTS\3081\40\SW\COVER1 .MOP
Hydrograph file: --> P:\DATA\PROJECTS\3081\40\SW\COVER125.HYD

Dairyland Power Coop.
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Composite Hydrograph Summary (cfs)

Subarea Description	14.0 hr	14.3 hr	14.6 hr	15.0 hr	15.5 hr	16.0 hr	16.5 hr	17.0 hr	17.5 hr
1A	0	0	0	0	0	0	0	0	0
1B	0	0	0	0	0	0	0	0	0
1C	0	0	0	0	0	0	0	0	0
1D	1	1	1	1	1	1	0	0	0
1E	0	0	0	0	0	0	0	0	0
1F	2	1	1	1	1	1	1	1	1
1G	1	1	1	1	1	1	1	1	1
Total (cfs)	4	3	3	3	3	3	2	2	2

Subarea Description	18.0 hr	19.0 hr	20.0 hr	22.0 hr	26.0 hr
1A	0	0	0	0	0
1B	0	0	0	0	0
1C	0	0	0	0	0
1D	0	0	0	0	0
1E	0	0	0	0	0
1F	1	1	1	0	0
1G	1	1	0	0	0
Total (cfs)	2	2	1	0	0

Return Frequency: 100 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 07-30-1998 11:54:55
Watershed file: --> A:COVER1 .MOP
Hydrograph file: --> A:COVER100.HYD

Dairyland Power Coop.
Fesibility Study
Landfill Cover
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1BLB
8/20/98

>>>> Input Parameters Used to Compute Hydrograph <<<<

Subarea Description	AREA (acres)	CN	Tc (hrs)	* Tt (hrs)	Precip. (in)	Runoff (in)	Ia/p input/used	
1A	1.40	74.0	0.20	0.00	6.10	3.27	I.12	.12
1B	2.20	74.0	0.20	0.00	6.10	3.27	I.12	.12
1C	2.90	74.0	0.20	0.00	6.10	3.27	I.12	.12
1D	5.30	74.0	0.40	0.00	6.10	3.27	I.12	.12
1E	1.20	74.0	0.20	0.00	6.10	3.27	I.12	.12
1F	9.50	74.0	0.50	0.00	6.10	3.27	I.12	.12
1G	7.40	84.0	0.20	0.00	6.10	4.29	I.06	.10

* Travel time from subarea outfall to composite watershed outfall point.
I -- Subarea where user specified interpolation between Ia/p tables.

Total area = 29.90 acres or 0.04672 sq.mi
Peak discharge = 98 cfs

WARNING: Drainage areas of two or more subareas differ by a factor of 5 or greater.

Total Runoff =

$$\frac{22.5\text{ ac }(3.27") + 7.4\text{ ac }(4.29")}{12}$$

= 8.8 ac-FT

>>>> Computer Modifications of Input Parameters <<<<<

Subarea Description	Input Values Tc (hr)	Input Values * Tt (hr)	Rounded Values Tc (hr)	Rounded Values * Tt (hr)	Ia/p Interpolated (Yes/No)	Ia/p Messages
1A	0.18	0.00	0.20	0.00	Yes	--
1B	0.23	0.00	0.20	0.00	Yes	--
1C	0.23	0.00	0.20	0.00	Yes	--
1D	0.35	0.00	0.40	0.00	Yes	--
1E	0.18	0.00	0.20	0.00	Yes	--
1F	0.45	0.00	0.50	0.00	Yes	--
1G	0.22	0.00	0.20	0.00	No	Computed Ia/p < .1

* Travel time from subarea outfall to composite watershed outfall point.

Return Frequency: 100 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 07-30-1998 11:54:55
Watershed file: --> A:COVER1 .MOP
Hydrograph file: --> A:COVER100.HYD

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Fesibility Study
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BJK 3/97

>>>> Summary of Subarea Times to Peak <<<<

Subarea	Peak Discharge at Composite Outfall (cfs)	Time to Peak at Composite Outfall (hrs)
1A	6	12.2
1B	9	12.2
1C	12	12.2
1D	16	12.3
1E	5	12.2
1F	25	12.4
1G	40	12.2
Composite Watershed	98	12.2

Return Frequency: 100 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 07-30-1998 11:54:55
Watershed file: --> A:COVER1 .MOP
Hydrograph file: --> A:COVER100.HYD

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Composite Hydrograph Summary (cfs)

Subarea Description	11.0 hr	11.3 hr	11.6 hr	11.9 hr	12.0 hr	12.1 hr	12.2 hr	12.3 hr	12.4 hr
1A	0	0	0	1	3	5	6	3	2
1B	0	0	0	2	4	8	9	5	3
1C	0	0	1	3	6	11	12	7	4
1D	0	1	1	2	4	7	12	16	15
1E	0	0	0	1	2	4	5	3	2
1F	1	1	1	2	4	8	14	22	25
1G	1	2	2	10	20	37	40	24	12
Total (cfs)	2	4	5	21	43	80	98	80	63

Subarea Description	12.5 hr	12.6 hr	12.7 hr	12.8 hr	13.0 hr	13.2 hr	13.4 hr	13.6 hr	13.8 hr
1A	1	1	1	1	1	0	0	0	0
1B	2	1	1	1	1	1	1	1	1
1C	3	2	2	1	1	1	1	1	1
1D	12	8	6	4	3	2	2	2	1
1E	1	1	1	1	0	0	0	0	0
1F	24	19	14	11	7	5	4	3	3
1G	8	6	5	4	3	3	3	2	2
Total (cfs)	51	38	30	23	16	12	11	9	8

Return Frequency: 100 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 07-30-1998 11:54:55
Watershed file: --> A:COVER1 .MOP
Hydrograph file: --> A:COVER100.HYD

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Composite Hydrograph Summary (cfs)

Subarea Description	14.0 hr	14.3 hr	14.6 hr	15.0 hr	15.5 hr	16.0 hr	16.5 hr	17.0 hr	17.5 hr
1A	0	0	0	0	0	0	0	0	0
1B	0	0	0	0	0	0	0	0	0
1C	1	1	1	0	0	0	0	0	0
1D	1	1	1	1	1	1	1	1	1
1E	0	0	0	0	0	0	0	0	0
1F	2	2	2	2	1	1	1	1	1
1G	2	2	2	1	1	1	1	1	1
Total (cfs)	6	6	6	4	3	3	3	3	3

Subarea Description	18.0 hr	19.0 hr	20.0 hr	22.0 hr	26.0 hr
1A	0	0	0	0	0
1B	0	0	0	0	0
1C	0	0	0	0	0
1D	1	0	0	0	0
1E	0	0	0	0	0
1F	1	1	1	1	0
1G	1	1	1	1	0
Total (cfs)	3	2	2	2	0

Return Frequency: 25 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 09-18-2000 12:51:16
Watershed file: --> P:\DATA\PROJECTS\3081\40\SW\COVER2 .MOP
Hydrograph file: --> P:\DATA\PROJECTS\3081\40\SW\COVER225.HYD

Dairyland Power Coop.
Fesibility Study
Landfill Cover
BJK 3/97

>>>> Input Parameters Used to Compute Hydrograph <<<<

Subarea Description	AREA (acres)	CN	Tc (hrs)	* Tt (hrs)	Precip. (in)	Runoff (in)	Ia/p input/used
2A	2.70	74.0	0.30	0.00	4.90	2.28	I.14 .14
2B	21.50	69.0	0.20	0.00	4.90	1.89	I.18 .18

* Travel time from subarea outfall to composite watershed outfall point.
I -- Subarea where user specified interpolation between Ia/p tables.

Total area = 24.20 acres or 0.03781 sq.mi
Peak discharge = 54 cfs

WARNING: Drainage areas of two or more subareas differ by a factor of 5 or greater.

>>>> Computer Modifications of Input Parameters <<<<<

Subarea Description	Input Values Tc (hr)	Input Values * Tt (hr)	Rounded Values Tc (hr)	Rounded Values * Tt (hr)	Ia/p Interpolated (Yes/No)	Ia/p Messages
2A	0.28	0.00	0.30	0.00	Yes	--
2B	0.18	0.00	0.20	0.00	Yes	--

* Travel time from subarea outfall to composite watershed outfall point.

Return Frequency: 25 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 09-18-2000 12:51:16
Watershed file: --> P:\DATA\PROJECTS\3081\40\SW\COVER2 .MOP
Hydrograph file: --> P:\DATA\PROJECTS\3081\40\SW\COVER225.HYD

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>>>> Summary of Subarea Times to Peak <<<<

Subarea	Peak Discharge at Composite Outfall (cfs)	Time to Peak at Composite Outfall (hrs)
2A	6	12.2
2B	48	12.2
Composite Watershed	54	12.2

Return Frequency: 25 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 09-18-2000 12:51:16
Watershed file: --> P:\DATA\PROJECTS\3081\40\SW\COVER2 .MOP
Hydrograph file: --> P:\DATA\PROJECTS\3081\40\SW\COVER225.HYD

Dairyland Power Coop.
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Composite Hydrograph Summary (cfs)

Subarea Description	11.0 hr	11.3 hr	11.6 hr	11.9 hr	12.0 hr	12.1 hr	12.2 hr	12.3 hr	12.4 hr
2A	0	0	0	1	2	4	6	6	4
2B	1	1	2	9	20	42	48	31	17
Total (cfs)	1	1	2	10	22	46	54	37	21

Subarea Description	12.5 hr	12.6 hr	12.7 hr	12.8 hr	13.0 hr	13.2 hr	13.4 hr	13.6 hr	13.8 hr
2A	3	2	1	1	1	1	1	1	0
2B	11	9	7	6	5	4	4	4	3
Total (cfs)	14	11	8	7	6	5	5	5	3

Subarea Description	14.0 hr	14.3 hr	14.6 hr	15.0 hr	15.5 hr	16.0 hr	16.5 hr	17.0 hr	17.5 hr
2A	0	0	0	0	0	0	0	0	0
2B	3	3	2	2	2	2	2	2	1
Total (cfs)	3	3	2	2	2	2	2	2	1

Subarea Description	18.0 hr	19.0 hr	20.0 hr	22.0 hr	26.0 hr
2A	0	0	0	0	0
2B	1	1	1	1	0

Return Frequency: 100 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 10-01-1998 15:19:47
Watershed file: --> A:\COVER2 .MOP
Hydrograph file: --> A:\COVER200.HYD

Dairyland Power Coop.
Fesibility Study
Landfill Cover
BJK 3/97

>>>> Input Parameters Used to Compute Hydrograph <<<<

Subarea Description	AREA (acres)	CN	Tc (hrs)	* Tt (hrs)	Precip. (in)	Runoff (in)	Ia/p input/used	
2A	2.70	74.0	0.30	0.00	6.10	3.27	I.12	.12
2B	21.50	69.0	0.20	0.00	6.10	2.79	I.15	.15

* Travel time from subarea outfall to composite watershed outfall point.
I -- Subarea where user specified interpolation between Ia/p tables.

Total area = 24.20 acres or 0.03781 sq.mi
Peak discharge = 82 cfs

WARNING: Drainage areas of two or more subareas differ by a factor of 5 or greater.

>>>> Computer Modifications of Input Parameters <<<<<

Subarea Description	Input Values Tc (hr)	Input Values * Tt (hr)	Rounded Values Tc (hr)	Rounded Values * Tt (hr)	Ia/p Interpolated (Yes/No)	Ia/p Messages
2A	0.28	0.00	0.30	0.00	Yes	--
2B	0.18	0.00	0.20	0.00	Yes	--

* Travel time from subarea outfall to composite watershed outfall point.

Return Frequency: 100 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 10-01-1998 15:19:47
Watershed file: --> A:\COVER2 .MOP
Hydrograph file: --> A:\COVER200.HYD

Dairyland Power Coop.
Fesibility Study
Landfill Cover
BJK 3/97

>>>> Summary of Subarea Times to Peak <<<<

Subarea	Peak Discharge at Composite Outfall (cfs)	Time to Peak at Composite Outfall (hrs)
2A	9	12.2
2B	73	12.2
Composite Watershed	82	12.2

Return Frequency: 100 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 10-01-1998 15:19:47
Watershed file: --> A:\COVER2 .MOP
Hydrograph file: --> A:\COVER200.HYD

Dairyland Power Coop.
Fesibility Study
Landfill Cover
BJK 3/97

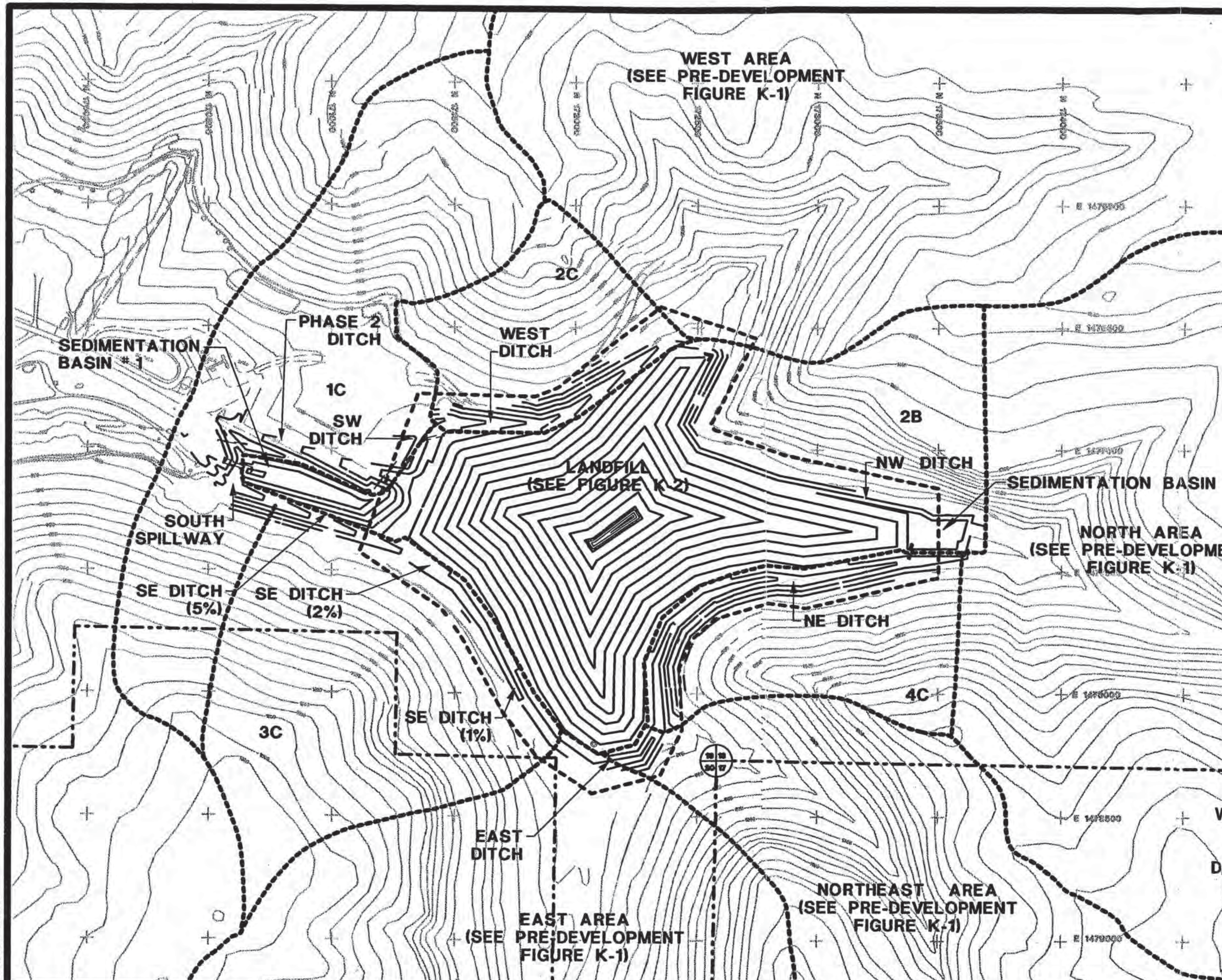
Composite Hydrograph Summary (cfs)

Subarea Description	11.0 hr	11.3 hr	11.6 hr	11.9 hr	12.0 hr	12.1 hr	12.2 hr	12.3 hr	12.4 hr
2A	0	0	1	1	3	6	9	9	6
2B	2	2	3	16	33	65	73	45	24
Total (cfs)	2	2	4	17	36	71	82	54	30

Subarea Description	12.5 hr	12.6 hr	12.7 hr	12.8 hr	13.0 hr	13.2 hr	13.4 hr	13.6 hr	13.8 hr
2A	4	3	2	2	1	1	1	1	1
2B	16	13	10	9	7	6	6	5	5
Total (cfs)	20	16	12	11	8	7	7	6	6

Subarea Description	14.0 hr	14.3 hr	14.6 hr	15.0 hr	15.5 hr	16.0 hr	16.5 hr	17.0 hr	17.5 hr
2A	1	1	0	0	0	0	0	0	0
2B	4	4	3	3	3	3	2	2	2
Total (cfs)	5	5	3	3	3	3	2	2	2

Subarea Description	18.0 hr	19.0 hr	20.0 hr	22.0 hr	26.0 hr
2A	0	0	0	0	0
2B	2	2	1	1	0



LEGEND

DRAINAGE AREA DIVIDE

3C — WEST AREA DRAINAGE AREA DESIGNATION

NOTES:

1. REFER TO FIGURE K-2 FOR DRAINAGE AREAS ALONG THE LANDFILL FINAL COVER.

0 400 800

SCALE: 1"=400'

POST-DEVELOPMENT SURFACE WATER MANAGEMENT FEATURES -EXTERIOR AREAS

DAIRYLAND POWER COOPERATIVE

RMT

Dwn. By:	JCD
Approved By:	
Date:	SEPT. 2000
Proj. #:	3081.40
File #:	FIG-L-3.PLT

RMT COMPUTER AIDED DESIGN & DRAFTING

FIGURE K-3

Quick TR-55 Ver.5.46 S/N:
Executed: 11:43:33 07-30-1998

Dairyland Power Coop.
Feasibility Report
PostDevelopment Conditions
BJK 5/97 rev 7/98

RUNOFF CURVE NUMBER SUMMARY

::

Subarea Description	Area (acres)	CN (weighted)
1C	42.00	67
2C	15.00	56
3C	33.00	58
4C	16.00	57
East	520.00	67
Northeast	80.00	63
North	236.00	63
West	100.00	71

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RUNOFF CURVE NUMBER DATA

Composite Area: 1C

SURFACE DESCRIPTION	AREA (acres)	CN	
Woods (35%)	15.00	55	
Existing Landfill (50%)	21.00	74	
Graded Areas (10%)	4.00	61	
Fallow - Bare Soil (5%)	2.00	86	
COMPOSITE AREA --->	42.00	66.5	(67)

Composite Area: 2C

SURFACE DESCRIPTION	AREA (acres)	CN	
Woods (85%)	12.80	55	
Graded Areas (15%)	2.20	61	
COMPOSITE AREA --->	15.00	55.9	(56)

Composite Area: 3C

SURFACE DESCRIPTION	AREA (acres)	CN	
Woods (80%)	27.00	55	
Graded Areas (10%)	3.00	61	
Fallow - Bare Soil (10%)	3.00	86	
COMPOSITE AREA --->	33.00	58.4	(58)

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Composite Area: 4C

SURFACE DESCRIPTION	AREA (acres)	CN	
Woods (75%)	12.00	55	
Graded Areas (25%)	4.00	61	
COMPOSITE AREA --->	16.00	56.5	(57)

Composite Area: East

SURFACE DESCRIPTION	AREA (acres)	CN	
Woods (60%)	312.00	55	
Fallow - Bare Soil (40%)	208.00	86	
COMPOSITE AREA --->	520.00	67.4	(67)

Composite Area: Northeast

SURFACE DESCRIPTION	AREA (acres)	CN	
Woods (75%)	60.00	55	
Fallow - Bare Soil (25%)	20.00	86	
COMPOSITE AREA --->	80.00	62.8	(63)

Composite Area: North

SURFACE DESCRIPTION	AREA (acres)	CN	
Woods (75%)	177.00	55	
Fallow - Bare Soil (25%)	59.00	86	
COMPOSITE AREA --->	236.00	62.8	(63)

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Composite Area: West

SURFACE DESCRIPTION	AREA (acres)	CN	
Woods (50%)	50.00	55	
Fallow - Bare Soil (50%)	50.00	86	
COMPOSITE AREA --->	100.00	70.5	(71)

Quick TR-55 Ver.5.46 S/N:
Executed: 09:21:09 05-09-1997 a:POSTDVTC.TCT

SUMMARY SHEET FOR Tc or Tt COMPUTATIONS
(Solved for Time using TR-55 Methods)

Dairyland Power Coop.
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PostDevelopment Conditions
BJK 5/97

Subarea descr.	Tc or Tt	Time (hrs)
1C	Tc	0.35
2C	Tc	0.32
3C	Tc	0.41
4C	Tc	0.38
East	Tc	0.68
Northeast	Tc	0.37
North	Tc	0.53
West	Tc	0.52

```
Quick TR-55 Ver.5.46   S/N:
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                    Dairyland Power Coop.
                     Feasibility Report
                 PostDevelopment Conditions
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                Tc COMPUTATIONS FOR: 1C

SHEET FLOW (Applicable to Tc only)
  Segment ID                                  1
  Surface description                     Woods
  Manning's roughness coeff., n                0.4000
  Flow length, L (total < or = 300)    ft      300.0
  Two-yr 24-hr rainfall, P2            in      2.800
  Land slope, s                        ft/ft   0.2700
                     0.8
       .007 * (n*L)
  T =  --------------                  hrs      0.33           = 0.33
           0.5   0.4
         P2   *  s

SHALLOW CONCENTRATED FLOW
  Segment ID                                   2
  Surface (paved or unpaved)?                  Unpaved
  Flow length, L                       ft      650.0
  Watercourse slope, s                 ft/ft   0.5000

                      0.5
  Avg.V =  Csf *  (s)                  ft/s   %11.4088
  where:   Unpaved Csf = 16.1345
           Paved   Csf = 20.3282

  T = L / (3600*V)                     hrs      0.02           = 0.02


CHANNEL FLOW
  Segment ID                                   3
  Cross Sectional Flow Area, a         sq.ft    42.00
  Wetted perimeter, Pw                 ft       28.00
  Hydraulic radius, r = a/Pw           ft       1.500
  Channel slope, s                     ft/ft    0.1500
  Manning's roughness coeff., n                 0.0450

               2/3    1/2
      1.49  *  r   *  s
  V = --------------------             ft/s   %16.8040
               n

  Flow length, L                       ft        500

  T = L / (3600*V)                     hrs      0.01           = 0.01

::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                                          TOTAL TIME (hrs)      0.35
```

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√ BAG 6/17/97

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Tc COMPUTATIONS FOR: 2C

SHEET FLOW (Applicable to Tc only)

Segment ID		1	
Surface description		Woods	
Manning's roughness coeff., n		0.4000	
Flow length, L (total < or = 300)	ft	300.0	
Two-yr 24-hr rainfall, P2	in	2.800	
Land slope, s	ft/ft	0.4200	
$T = \frac{.007 * (n*L)^{0.8}}{P2^{0.5} * s^{0.4}}$	hrs	0.27	= 0.27

SHALLOW CONCENTRATED FLOW

Segment ID		2	
Surface (paved or unpaved)?		Unpaved	
Flow length, L	ft	370.0	
Watercourse slope, s	ft/ft	0.4200	
$Avg.V = Csf * (s)^{0.5}$	ft/s	%10.4564	
where: Unpaved Csf = 16.1345 Paved Csf = 20.3282			
T = L / (3600*V)	hrs	0.01	= 0.01

CHANNEL FLOW

Segment ID		3	
Cross Sectional Flow Area, a	sq.ft	17.00	
Wetted perimeter, Pw	ft	17.00	
Hydraulic radius, r = a/Pw	ft	1.000	
Channel slope, s	ft/ft	0.0600	
Manning's roughness coeff., n		0.0450	
$V = \frac{1.49 * r^{2/3} * s^{1/2}}{n}$	ft/s	8.1105	
Flow length, L	ft	1050	
T = L / (3600*V)	hrs	0.04	= 0.04

::

TOTAL TIME (hrs) 0.32

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Tc COMPUTATIONS FOR: 3C

SHEET FLOW (Applicable to Tc only)

Segment ID		1	
Surface description		Row Crops	
Manning's roughness coeff., n		0.1700 ✓	
Flow length, L (total < or = 300)	ft	300.0 ✓	
Two-yr 24-hr rainfall, P2	in	2.800	
Land slope, s	ft/ft	0.0500 ✓	
$T = \frac{.007 * (n*L)^{0.8}}{P2^{0.5} * s^{0.4}}$	hrs	0.32	= 0.32

SHALLOW CONCENTRATED FLOW

Segment ID		2	
Surface (paved or unpaved)?		Unpaved	
Flow length, L	ft	1020.0 ✓	
Watercourse slope, s	ft/ft	0.3600 ✓	
Avg.V = $Csf * (s)^{0.5}$	ft/s	9.6807	
where: Unpaved Csf = 16.1345			
Paved Csf = 20.3282			
T = L / (3600*V)	hrs	0.03	= 0.03

CHANNEL FLOW

Segment ID		3	
Cross Sectional Flow Area, a	sq.ft	150.00 ✓	
Wetted perimeter, Pw	ft	45.00 ✓	
Hydraulic radius, r = a/Pw	ft	3.333	
Channel slope, s	ft/ft	0.0150 ✓	
Manning's roughness coeff., n		0.0600 ✓	
$V = \frac{1.49 * r^{2/3} * s^{1/2}}{n}$	ft/s	6.7868	
Flow length, L	ft	1450 ✓	
T = L / (3600*V)	hrs	0.06	= 0.06

::

TOTAL TIME (hrs) 0.41

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Tc COMPUTATIONS FOR: 4C

SHEET FLOW (Applicable to Tc only)

Segment ID		1	
Surface description		Woods	
Manning's roughness coeff., n		0.4000	
Flow length, L (total < or = 300)	ft	300.0	
Two-yr 24-hr rainfall, P2	in	2.800	
Land slope, s	ft/ft	0.3700	
$T = \frac{.007 * (n*L)^{0.8}}{P2^{0.5} * s^{0.4}}$	hrs	0.29	= 0.29

SHALLOW CONCENTRATED FLOW

Segment ID		2	
Surface (paved or unpaved)?		Unpaved	
Flow length, L	ft	390.0	
Watercourse slope, s	ft/ft	0.5000	
$Avg.V = Csf * (s)^{0.5}$	ft/s	X11.4088	
where: Unpaved Csf = 16.1345			
Paved Csf = 20.3282			
T = L / (3600*V)	hrs	0.01	= 0.01

CHANNEL FLOW

Segment ID		3	
Cross Sectional Flow Area, a	sq.ft	28.00	
Wetted perimeter, Pw	ft	20.00	
Hydraulic radius, r = a/Pw	ft	1.400	
Channel slope, s	ft/ft	0.0200	
Manning's roughness coeff., n		0.0500	
$V = \frac{1.49 * r^{2/3} * s^{1/2}}{n}$	ft/s	5.2741	
Flow length, L	ft	1670	
T = L / (3600*V)	hrs	0.09	= 0.09

::

TOTAL TIME (hrs) 0.38

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PostDevelopment Conditions
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Tc COMPUTATIONS FOR: East

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SHEET FLOW (Applicable to Tc only)
    Segment ID                                  1
    Surface description                    Row Crops
    Manning's roughness coeff., n             0.1700
    Flow length, L (total < or = 300)   ft    300.0
    Two-yr 24-hr rainfall, P2           in    2.800
    Land slope, s                      ft/ft  0.0500
                        0.8
         .007 * (n*L)
    T =  --------------                 hrs    0.32            = 0.32
             0.5    0.4
           P2   *  s

SHALLOW CONCENTRATED FLOW
    Segment ID                                  2
    Surface (paved or unpaved)?              Unpaved
    Flow length, L                      ft    2000.0
    Watercourse slope, s               ft/ft  0.0700

                        0.5
    Avg.V =  Csf *  (s)                ft/s   4.2688
    where:   Unpaved Csf = 16.1345
             Paved   Csf = 20.3282

    T = L / (3600*V)                    hrs    0.13            = 0.13


CHANNEL FLOW
    Segment ID                                  3        4
    Cross Sectional Flow Area, a      sq.ft   27.00    27.00
    Wetted perimeter, Pw                ft    16.40    16.40
    Hydraulic radius, r = a/Pw          ft    1.646    1.646
    Channel slope, s                   ft/ft  0.0700   0.0400
    Manning's roughness coeff., n             0.0700   0.0700

                 2/3    1/2
        1.49  *  r   *  s
    V = --------------------           ft/s   7.8521   5.9356
                 n

    Flow length, L                      ft     2500     3000

    T = L / (3600*V)                    hrs    0.09  +  0.14   = 0.23

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                                        TOTAL TIME (hrs)         0.68
```

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Tc COMPUTATIONS FOR: Northeast

SHEET FLOW (Applicable to Tc only)

Segment ID		1	
Surface description		Row Crops	
Manning's roughness coeff., n		0.1700	
Flow length, L (total < or = 300)	ft	300.0 ✓	
Two-yr 24-hr rainfall, P2	in	2.800	
Land slope, s	ft/ft	0.0800 ✓	

$$T = \frac{.007 * (n*L)^{0.8}}{P2^{0.5} * s^{0.4}}$$ hrs 0.27 = 0.27

SHALLOW CONCENTRATED FLOW

Segment ID		2	
Surface (paved or unpaved)?		Unpaved	
Flow length, L	ft	600.0 ✓	
Watercourse slope, s	ft/ft	0.0700 ✓	

$$Avg.V = Csf * (s)^{0.5}$$ ft/s 4.2688

where: Unpaved Csf = 16.1345
Paved Csf = 20.3282

T = L / (3600*V) hrs 0.04 = 0.04

CHANNEL FLOW

Segment ID		3	
Cross Sectional Flow Area, a	sq.ft	27.00	
Wetted perimeter, Pw	ft	16.40	
Hydraulic radius, r = a/Pw	ft	1.646	
Channel slope, s	ft/ft	0.1400 ✓	
Manning's roughness coeff., n		0.0700	

$$V = \frac{1.49 * r^{2/3} * s^{1/2}}{n}$$ ft/s %11.1045

Flow length, L ft 2400 ✓

T = L / (3600*V) hrs 0.06 = 0.06

::

TOTAL TIME (hrs) 0.37

```
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                           Feasibility Report
                      PostDevelopment Conditions
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                   Tc COMPUTATIONS FOR: North

 SHEET FLOW (Applicable to Tc only)
    Segment ID                                     1
    Surface description                        Row Crops
    Manning's roughness coeff., n                 0.1700
    Flow length, L (total < or = 300)    ft       300.0
    Two-yr 24-hr rainfall, P2            in       2.800
    Land slope, s                       ft/ft    0.0500
                         0.8
         .007 * (n*L)
    T =  --------------                  hrs       0.32              = 0.32
             0.5     0.4
           P2    *  s

SHALLOW CONCENTRATED FLOW
    Segment ID                                     2
    Surface (paved or unpaved)?                 Unpaved
    Flow length, L                       ft      1000.0
    Watercourse slope, s                ft/ft    0.0600

                         0.5
    Avg.V =  Csf *  (s)                 ft/s    3.9521
    where:   Unpaved Csf = 16.1345
             Paved   Csf = 20.3282

    T = L / (3600*V)                     hrs       0.07              = 0.07


CHANNEL FLOW
    Segment ID                                     3
    Cross Sectional Flow Area, a        sq.ft     27.00
    Wetted perimeter, Pw                 ft       16.40
    Hydraulic radius, r = a/Pw           ft       1.646
    Channel slope, s                    ft/ft    0.0830
    Manning's roughness coeff., n                0.0700

                   2/3    1/2
         1.49  *  r   *  s
    V =  --------------------           ft/s    8.5502
                   n

    Flow length, L                       ft       4200

    T = L / (3600*V)                     hrs       0.14              = 0.14

 ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                                         TOTAL TIME (hrs)             0.53
```

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Tc COMPUTATIONS FOR: West

SHEET FLOW (Applicable to Tc only)

Segment ID		1	
Surface description		Row Crops	
Manning's roughness coeff., n		0.1700	
Flow length, L (total < or = 300)	ft	300.0 ✓	
Two-yr 24-hr rainfall, P2	in	2.800	
Land slope, s	ft/ft	0.0500 ✓	
$T = \frac{.007 * (n*L)^{0.8}}{P2^{0.5} * s^{0.4}}$	hrs	0.32	= 0.32

SHALLOW CONCENTRATED FLOW

Segment ID		2	
Surface (paved or unpaved)?		Unpaved	
Flow length, L	ft	1600.0 ✓	
Watercourse slope, s	ft/ft	0.0850 ✓	
Avg.V = $Csf * (s)^{0.5}$	ft/s	4.7040	
where: Unpaved Csf = 16.1345			
Paved Csf = 20.3282			
T = L / (3600*V)	hrs	0.09	= 0.09

CHANNEL FLOW

Segment ID		3	
Cross Sectional Flow Area, a	sq.ft	17.00	
Wetted perimeter, Pw	ft	16.40	
Hydraulic radius, r = a/Pw	ft	1.037	
Channel slope, s	ft/ft	0.1000 ✓	
Manning's roughness coeff., n		0.0700	
$V = \frac{1.49 * r^{2/3} * s^{1/2}}{n}$	ft/s	6.8943	
Flow length, L	ft	2600 ✓	
T = L / (3600*V)	hrs	0.10	= 0.10

::

TOTAL TIME (hrs) 0.52

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Executed: 11:30:57 06-18-1997 a:POSTDVTT.TCT

SUMMARY SHEET FOR Tc or Tt COMPUTATIONS
(Solved for Time using TR-55 Methods)

Dairyland Power Coop.
Feasibility Report
PostDevelopment Conditions
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Subarea descr.	Tc or Tt	Time (hrs)
1C	Tt	0.00
2C	Tt	0.05
3C	Tt	0.01
4C	Tt	0.09
East	Tt	0.07
Northeast	Tt	0.09
North	Tt	0.18
West	Tt	0.08

Quick TR-55 Ver.5.46 S/N:
Executed: 09:24:17 05-09-1997 a:POSTDVTT.TCT

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BJB
6/17/97

Tt COMPUTATIONS FOR: 2C

SHEET FLOW (Applicable to Tc only)

Segment ID			
Surface description			
Manning's roughness coeff., n		0.0000	
Flow length, L (total < or = 300)	ft	0.0	
Two-yr 24-hr rainfall, P2	in	0.000	
Land slope, s	ft/ft	0.0000	
$T = \frac{.007 * (n*L)^{0.8}}{P2^{0.5} * s^{0.4}}$	hrs	0.00	= 0.00

SHALLOW CONCENTRATED FLOW

Segment ID			
Surface (paved or unpaved)?			
Flow length, L	ft	0.0	
Watercourse slope, s	ft/ft	0.0000	
$Avg.V = Csf * (s)^{0.5}$	ft/s	0.0000	
where: Unpaved Csf = 16.1345			
Paved Csf = 20.3282			
T = L / (3600*V)	hrs	0.00	= 0.00

CHANNEL FLOW

Segment ID		1	
Cross Sectional Flow Area, a	sq.ft	17.00	
Wetted perimeter, Pw	ft	17.00	
Hydraulic radius, r = a/Pw	ft	1.000	
Channel slope, s	ft/ft	0.0500 ✓	
Manning's roughness coeff., n		0.0450	
$V = \frac{1.49 * r^{2/3} * s^{1/2}}{n}$	ft/s	7.4039	
Flow length, L	ft	1200 ✓	
T = L / (3600*V)	hrs	0.05	= 0.05

::

TOTAL TIME (hrs) 0.05

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✓BAB 6/17/97

Tt COMPUTATIONS FOR: 3C

SHEET FLOW (Applicable to Tc only)

Segment ID			
Surface description			
Manning's roughness coeff., n		0.0000	
Flow length, L (total < or = 300)	ft	0.0	
Two-yr 24-hr rainfall, P2	in	0.000	
Land slope, s	ft/ft	0.0000	
$T = \dfrac{.007 * (n*L)^{0.8}}{P2^{0.5} * s^{0.4}}$	hrs	0.00	= 0.00

SHALLOW CONCENTRATED FLOW

Segment ID			
Surface (paved or unpaved)?			
Flow length, L	ft	0.0	
Watercourse slope, s	ft/ft	0.0000	
$Avg.V = Csf * (s)^{0.5}$	ft/s	0.0000	
where: Unpaved Csf = 16.1345			
Paved Csf = 20.3282			
T = L / (3600*V)	hrs	0.00	= 0.00

CHANNEL FLOW

Segment ID		1	
Cross Sectional Flow Area, a	sq.ft	42.00 ✓	
Wetted perimeter, Pw	ft	28.00 ✓	
Hydraulic radius, r = a/Pw	ft	1.500	
Channel slope, s	ft/ft	0.1500 ✓	
Manning's roughness coeff., n		0.0450	
$V = \dfrac{1.49 * r^{2/3} * s^{1/2}}{n}$	ft/s	%16.8040	
Flow length, L	ft	550 ✓	
T = L / (3600*V)	hrs	0.01	= 0.01

::

TOTAL TIME (hrs) 0.01

```
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                         Dairyland Power Coop.
                          Feasibility Report
                       PostDevelopment Conditions
                                BJK 5/97

                    Tt COMPUTATIONS FOR: 4C

SHEET FLOW (Applicable to Tc only)
   Segment ID
   Surface description
   Manning's roughness coeff., n                0.0000
   Flow length, L (total < or = 300)    ft        0.0
   Two-yr 24-hr rainfall, P2            in      0.000
   Land slope, s                      ft/ft    0.0000
                  0.8
       .007 * (n*L)
   T = --------------                  hrs      0.00                 = 0.00
            0.5   0.4
         P2   *  s

SHALLOW CONCENTRATED FLOW
   Segment ID
   Surface (paved or unpaved)?
   Flow length, L                       ft        0.0
   Watercourse slope, s               ft/ft    0.0000

                    0.5
   Avg.V =  Csf *  (s)                ft/s    0.0000
   where:   Unpaved Csf = 16.1345
            Paved   Csf = 20.3282

   T = L / (3600*V)                    hrs      0.00                 = 0.00


CHANNEL FLOW
   Segment ID                                    1          2
   Cross Sectional Flow Area, a      sq.ft   150.00      42.00
   Wetted perimeter, Pw                 ft    45.00      28.00
   Hydraulic radius, r = a/Pw           ft    3.333      1.500
   Channel slope, s                   ft/ft   0.0150✓    0.1500✓
   Manning's roughness coeff., n              0.0600     0.0450

               2/3   1/2
       1.49 *  r  *  s
   V = --------------------           ft/s   6.7868     X16.8040
                n

   Flow length, L                       ft     1950✓      550✓

   T = L / (3600*V)                    hrs     0.08  +   0.01    = 0.09

:::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                                        TOTAL TIME (hrs)           0.09
```

✓ BJG 6/17/97

Quick TR-55 Ver.5.46 S/N:
Executed: 09:24:17 05-09-1997 a:POSTDVTT.TCT

Dairyland Power Coop.
Feasibility Report
PostDevelopment Conditions
BJK 5/97

JBB 6/17/97

Tt COMPUTATIONS FOR: East

SHEET FLOW (Applicable to Tc only)

Segment ID			
Surface description			
Manning's roughness coeff., n		0.0000	
Flow length, L (total < or = 300)	ft	0.0	
Two-yr 24-hr rainfall, P2	in	0.000	
Land slope, s	ft/ft	0.0000	
$T = \frac{.007 * (n*L)^{0.8}}{P2^{0.5} * s^{0.4}}$	hrs	0.00	= 0.00

SHALLOW CONCENTRATED FLOW

Segment ID			
Surface (paved or unpaved)?			
Flow length, L	ft	0.0	
Watercourse slope, s	ft/ft	0.0000	
$Avg.V = Csf * (s)^{0.5}$	ft/s	0.0000	
where: Unpaved Csf = 16.1345			
Paved Csf = 20.3282			
T = L / (3600*V)	hrs	0.00	= 0.00

CHANNEL FLOW

Segment ID		1	2	
Cross Sectional Flow Area, a	sq.ft	150.00	42.00	
Wetted perimeter, Pw	ft	45.00	28.00	
Hydraulic radius, r = a/Pw	ft	3.333	1.500	
Channel slope, s	ft/ft	0.0150 ✓	0.1500 ✓	
Manning's roughness coeff., n		0.0600	0.0450	
$V = \frac{1.49 * r^{2/3} * s^{1/2}}{n}$	ft/s	6.7868	X16.8040	
Flow length, L	ft	1600 ✓	550 ✓	
T = L / (3600*V)	hrs	0.07 +	0.01	= 0.07

::

TOTAL TIME (hrs) 0.07

Quick TR-55 Ver.5.46 S/N:
Executed: 11:30:57 06-18-1997 a:POSTDVTT.TCT

Dairyland Power Coop.
Feasibility Report
PostDevelopment Conditions
BJK 5/97

BJB
6/17/97

Tt COMPUTATIONS FOR: Northeast

SHEET FLOW (Applicable to Tc only)

Segment ID			
Surface description			
Manning's roughness coeff., n		0.0000	
Flow length, L (total < or = 300)	ft	0.0	
Two-yr 24-hr rainfall, P2	in	0.000	
Land slope, s	ft/ft	0.0000	
$T = \frac{.007 * (n*L)^{0.8}}{P2^{0.5} * s^{0.4}}$	hrs	0.00	= 0.00

SHALLOW CONCENTRATED FLOW

Segment ID			
Surface (paved or unpaved)?			
Flow length, L	ft	0.0	
Watercourse slope, s	ft/ft	0.0000	
$Avg.V = Csf * (s)^{0.5}$	ft/s	0.0000	
where: Unpaved Csf = 16.1345			
Paved Csf = 20.3282			
T = L / (3600*V)	hrs	0.00	= 0.00

CHANNEL FLOW

Segment ID		1	2	
Cross Sectional Flow Area, a	sq.ft	150.00	42.00	
Wetted perimeter, Pw	ft	45.00	28.00	
Hydraulic radius, r = a/Pw	ft	3.333	1.500	
Channel slope, s	ft/ft	0.0150 ✓	0.1500 ✓	
Manning's roughness coeff., n		0.0600	0.0450	
$V = \frac{1.49 * r^{2/3} * s^{1/2}}{n}$	ft/s	6.7868	%16.8040	
Flow length, L	ft	1870 ✓	550 ✓	
T = L / (3600*V)	hrs	0.08 +	0.01	= 0.09

::

TOTAL TIME (hrs) 0.09

Quick TR-55 Ver.5.46 S/N:
Executed: 11:30:57 06-18-1997 a:POSTDVTT.TCT

Dairyland Power Coop.
Feasibility Report
PostDevelopment Conditions
BJK 5/97

✓ BLB 6/17/97

Tt COMPUTATIONS FOR: North

SHEET FLOW (Applicable to Tc only)

Segment ID			
Surface description			
Manning's roughness coeff., n		0.0000	
Flow length, L (total < or = 300)	ft	0.0	
Two-yr 24-hr rainfall, P2	in	0.000	
Land slope, s	ft/ft	0.0000	
$T = \frac{.007 * (n*L)^{0.8}}{P2^{0.5} * s^{0.4}}$	hrs	0.00	= 0.00

SHALLOW CONCENTRATED FLOW

Segment ID			
Surface (paved or unpaved)?			
Flow length, L	ft	0.0	
Watercourse slope, s	ft/ft	0.0000	
$Avg.V = Csf * (s)^{0.5}$	ft/s	0.0000	
where: Unpaved Csf = 16.1345			
Paved Csf = 20.3282			
T = L / (3600*V)	hrs	0.00	= 0.00

CHANNEL FLOW

Segment ID		1	2	
Cross Sectional Flow Area, a	sq.ft	28.00	150.00	
Wetted perimeter, Pw	ft	20.00	45.00	
Hydraulic radius, r = a/Pw	ft	1.400	3.333	
Channel slope, s	ft/ft	0.0200 ✓	0.0150 ✓	
Manning's roughness coeff., n		0.0500	0.0600	
$V = \frac{1.49 * r^{2/3} * s^{1/2}}{n}$	ft/s	5.2741	6.7868	
Flow length, L	ft	1670 ✓	2250 ✓	
T = L / (3600*V)	hrs	0.09 +	0.09	= 0.18

::

TOTAL TIME (hrs) 0.18

Quick TR-55 Ver.5.46 S/N:
Executed: 09:24:17 05-09-1997 a:POSTDVTT.TCT

1 BLB
6/17/97

Dairyland Power Coop.
Feasibility Report
PostDevelopment Conditions
BJK 5/97

Tt COMPUTATIONS FOR: West

SHEET FLOW (Applicable to Tc only)

Segment ID				
Surface description				
Manning's roughness coeff., n		0.0000		
Flow length, L (total < or = 300)	ft	0.0		
Two-yr 24-hr rainfall, P2	in	0.000		
Land slope, s	ft/ft	0.0000		
$T = \frac{.007 * (n*L)^{0.8}}{P2^{0.5} * s^{0.4}}$	hrs	0.00		= 0.00

SHALLOW CONCENTRATED FLOW

Segment ID				
Surface (paved or unpaved)?				
Flow length, L	ft	0.0		
Watercourse slope, s	ft/ft	0.0000		
$Avg.V = Csf * (s)^{0.5}$	ft/s	0.0000		
where: Unpaved Csf = 16.1345; Paved Csf = 20.3282				
T = L / (3600*V)	hrs	0.00		= 0.00

CHANNEL FLOW

Segment ID		1	2	
Cross Sectional Flow Area, a	sq.ft	17.00	17.00	
Wetted perimeter, Pw	ft	17.00	17.00	
Hydraulic radius, r = a/Pw	ft	1.000	1.000	
Channel slope, s	ft/ft	0.0600	0.0500	
Manning's roughness coeff., n		0.0450	0.0450	
$V = \frac{1.49 * r^{2/3} * s^{1/2}}{n}$	ft/s	8.1105	7.4039	
Flow length, L	ft	1050	1200	
T = L / (3600*V)	hrs	0.04 +	0.05	= 0.08

::

TOTAL TIME (hrs) 0.08

Return Frequency: 25 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 09-18-2000 12:58:17
Watershed file: --> P:\DATA\PROJECTS\3081\40\SW\POSTDV2 .MOP
Hydrograph file: --> P:\DATA\PROJECTS\3081\40\SW\POSTDV25.HYD

Dairyland Power Coop.
Feasibility Report
PostDevelopment Conditions
BJK 5/97 REV 9/98

>>>> Input Parameters Used to Compute Hydrograph <<<<

Subarea Description	AREA (acres)	CN	Tc (hrs)	* Tt (hrs)	Precip. (in)	Runoff (in)	Ia/p input/used	
1C	42.00	67.0	0.40	0.00	4.90	1.73	I.2	.20
2C	15.00	56.0	0.30	0.10	4.90	0.99	I.32	.32
3C	33.00	58.0	0.40	0.00	4.90	1.11	I.3	.30
4C	16.00	57.0	0.40	0.10	4.90	1.05	I.31	.31
East	520.00	67.0	0.75	0.00	4.90	1.73	I.2	.20
Northeast	80.00	63.0	0.40	0.10	4.90	1.45	I.24	.24
North	236.00	63.0	0.50	0.20	4.90	1.45	I.24	.24
West	100.00	71.0	0.50	0.10	4.90	2.04	I.17	.17

* Travel time from subarea outfall to composite watershed outfall point.
I -- Subarea where user specified interpolation between Ia/p tables.

Total Runoff
= 141.9 ac-ft

Total area = 1042.00 acres or 1.6281 sq.mi
Peak discharge = 1027 cfs

WARNING: Drainage areas of two or more subareas differ by a factor of 5 or greater.

>>>> Computer Modifications of Input Parameters <<<<<

Subarea Description	Input Values Tc (hr)	Input Values * Tt (hr)	Rounded Values Tc (hr)	Rounded Values * Tt (hr)	Ia/p Interpolated (Yes/No)	Ia/p Messages
1C	0.35	0.00	0.40	0.00	Yes	--
2C	0.32	0.05	0.30	0.10	Yes	--
3C	0.41	0.01	0.40	0.00	Yes	--
4C	0.38	0.09	0.40	0.10	Yes	--
East	0.68	0.07	0.75	0.00	Yes	--
Northeast	0.37	0.09	0.40	0.10	Yes	--
North	0.53	0.18	0.50	0.20	Yes	--
West	0.52	0.08	0.50	0.10	Yes	--

* Travel time from subarea outfall to composite watershed outfall point.

Return Frequency: 25 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 09-18-2000 12:58:17
Watershed file: --> P:\DATA\PROJECTS\3081\40\SW\POSTDV2 .MOP
Hydrograph file: --> P:\DATA\PROJECTS\3081\40\SW\POSTDV25.HYD

Dairyland Power Coop.
Feasibility Report
PostDevelopment Conditions
BJK 5/97 REV 9/98

>>>> Summary of Subarea Times to Peak <<<<

Subarea	Peak Discharge at Composite Outfall (cfs)	Time to Peak at Composite Outfall (hrs)
1C	61	12.3
2C	11	12.4
3C	28	12.4
4C	12	12.5
East	533	12.7
Northeast	84	12.5
North	219	12.6
West	145	12.5
Composite Watershed	1027	12.6

Return Frequency: 25 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 09-18-2000 12:58:17
Watershed file: --> P:\DATA\PROJECTS\3081\40\SW\POSTDV2 .MOP
Hydrograph file: --> P:\DATA\PROJECTS\3081\40\SW\POSTDV25.HYD

Dairyland Power Coop.
Feasibility Report
PostDevelopment Conditions
BJK 5/97 REV 9/98

Composite Hydrograph Summary (cfs)

Subarea Description	11.0 hr	11.3 hr	11.6 hr	11.9 hr	12.0 hr	12.1 hr	12.2 hr	12.3 hr	12.4 hr
1C	1	1	2	5	9	22	43	61	61
2C	0	0	0	0	0	1	4	9	11
3C	0	0	0	0	1	6	17	27	28
4C	0	0	0	0	0	0	2	6	10
East	9	13	17	25	33	52	102	197	329
Northeast	1	1	2	4	7	14	31	57	80
North	2	3	4	6	8	13	28	66	126
West	3	5	6	11	17	30	56	95	128
Total (cfs)	16	23	31	51	75	138	283	518	773

Subarea Description	12.5 hr	12.6 hr	12.7 hr	12.8 hr	13.0 hr	13.2 hr	13.4 hr	13.6 hr	13.8 hr
1C	48	34	26	20	13	10	8	7	7
2C	10	8	6	5	3	2	2	2	2
3C	24	18	13	11	7	6	5	4	4
4C	12	11	9	7	4	3	3	2	2
East	454	527	533	490	350	248	183	143	117
Northeast	84	74	58	45	28	20	16	14	12
North	187	219	217	191	130	86	62	49	41
West	145	136	115	92	58	39	29	24	20
Total (cfs)	964	1027	977	861	593	414	308	245	205

Return Frequency: 25 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 09-18-2000 12:58:17
Watershed file: --> P:\DATA\PROJECTS\3081\40\SW\POSTDV2 .MOP
Hydrograph file: --> P:\DATA\PROJECTS\3081\40\SW\POSTDV25.HYD

Dairyland Power Coop.
Feasibility Report
PostDevelopment Conditions
BJK 5/97 REV 9/98

Composite Hydrograph Summary (cfs)

Subarea Description	14.0 hr	14.3 hr	14.6 hr	15.0 hr	15.5 hr	16.0 hr	16.5 hr	17.0 hr	17.5 hr
1C	6	5	5	4	4	4	3	3	3
2C	1	1	1	1	1	1	1	1	1
3C	3	3	3	3	2	2	2	2	2
4C	2	2	1	1	1	1	1	1	1
East	98	81	69	59	53	47	42	38	36
Northeast	11	9	8	8	7	6	6	5	5
North	35	30	26	23	21	19	17	16	14
West	18	15	13	12	11	10	9	8	7
Total (cfs)	174	146	126	111	100	90	81	74	69

Subarea Description	18.0 hr	19.0 hr	20.0 hr	22.0 hr	26.0 hr
1C	3	2	2	2	0
2C	1	1	1	0	0
3C	2	1	1	1	0
4C	1	1	1	1	0
East	34	30	27	22	0
Northeast	5	4	4	3	0
North	14	12	10	9	0
West	7	6	5	5	0
Total (cfs)	67	57	51	43	0

Return Frequency: 100 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 10-01-1998 11:25:28
Watershed file: --> A:\POSTDV2 .MOP
Hydrograph file: --> A:\POSTDV00.HYD

Dairyland Power Coop.
Feasibility Report
PostDevelopment Conditions
BJK 5/97 REV 9/98

>>>> Input Parameters Used to Compute Hydrograph <<<<

Subarea Description	AREA (acres)	CN	Tc (hrs)	* Tt (hrs)	Precip. (in)	Runoff (in)	Ia/p input/used	
1C	42.00	67.0	0.40	0.00	6.10	2.61	I.16	.16
2C	15.00	56.0	0.30	0.10	6.10	1.66	I.26	.26
3C	33.00	58.0	0.40	0.00	6.10	1.82	I.24	.24
4C	16.00	57.0	0.40	0.10	6.10	1.74	I.25	.25
East	520.00	67.0	0.75	0.00	6.10	2.61	I.16	.16
Northeast	80.00	63.0	0.40	0.10	6.10	2.25	I.19	.19
North	236.00	63.0	0.50	0.20	6.10	2.25	I.19	.19
West	100.00	71.0	0.50	0.10	6.10	2.98	I.13	.13

* Travel time from subarea outfall to composite watershed outfall point.
I -- Subarea where user specified interpolation between Ia/p tables.

Total Runoff = 215.7 ac-ft

Total area = 1042.00 acres or 1.6281 sq.mi
Peak discharge = 1618 cfs

WARNING: Drainage areas of two or more subareas differ by a factor of 5 or greater.

>>>> Computer Modifications of Input Parameters <<<<<

Subarea Description	Input Values Tc (hr)	Input Values * Tt (hr)	Rounded Values Tc (hr)	Rounded Values * Tt (hr)	Ia/p Interpolated (Yes/No)	Ia/p Messages
1C	0.35	0.00	0.40	0.00	Yes	--
2C	0.32	0.05	0.30	0.10	Yes	--
3C	0.41	0.01	0.40	0.00	Yes	--
4C	0.38	0.09	0.40	0.10	Yes	--
East	0.68	0.07	0.75	0.00	Yes	--
Northeast	0.37	0.09	0.40	0.10	Yes	--
North	0.53	0.18	0.50	0.20	Yes	--
West	0.52	0.08	0.50	0.10	Yes	--

* Travel time from subarea outfall to composite watershed outfall point.

Return Frequency: 100 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 10-01-1998 11:25:28
Watershed file: --> A:\POSTDV2 .MOP
Hydrograph file: --> A:\POSTDV00.HYD

Dairyland Power Coop.
Feasibility Report
PostDevelopment Conditions
BJK 5/97 REV 9/98

>>>> Summary of Subarea Times to Peak <<<<

Subarea	Peak Discharge at Composite Outfall (cfs)	Time to Peak at Composite Outfall (hrs)
1C	96	12.3
2C	20	12.4
3C	49	12.4
4C	20	12.5
East	837	12.6
Northeast	136	12.4
North	360	12.6
West	223	12.5
Composite Watershed	1618	12.6

Return Frequency: 100 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 10-01-1998 11:25:28
Watershed file: --> A:\POSTDV2 .MOP
Hydrograph file: --> A:\POSTDV00.HYD

Dairyland Power Coop.
Feasibility Report
PostDevelopment Conditions
BJK 5/97 REV 9/98

Composite Hydrograph Summary (cfs)

Subarea Description	11.0 hr	11.3 hr	11.6 hr	11.9 hr	12.0 hr	12.1 hr	12.2 hr	12.3 hr	12.4 hr
1C	2	3	4	9	18	38	71	96	94
2C	0	0	0	1	2	4	10	18	20
3C	1	1	1	2	6	15	33	48	49
4C	0	0	0	1	1	3	7	13	19
East	19	27	36	53	69	105	190	343	547
Northeast	3	4	5	10	18	36	70	109	136
North	6	9	11	17	22	33	63	127	224
West	6	9	12	20	32	56	102	165	209
Total (cfs)	37	53	69	113	168	290	546	919	1298

Subarea Description	12.5 hr	12.6 hr	12.7 hr	12.8 hr	13.0 hr	13.2 hr	13.4 hr	13.6 hr	13.8 hr
1C	73	51	38	29	19	14	12	10	9
C	18	13	10	7	5	4	3	3	3
C	39	28	21	17	11	9	7	6	6
C	20	18	14	11	7	5	4	3	3
ast	733	837	830	756	531	370	270	208	168
ortheast	132	110	85	65	40	28	23	19	17
orth	315	360	350	303	200	130	92	71	59
est	223	201	163	128	79	53	40	32	27
otal (cfs)	1553	1618	1511	1316	892	613	451	352	292

Return Frequency: 100 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 10-01-1998 11:25:28
Watershed file: --> A:\POSTDV2 .MOP
Hydrograph file: --> A:\POSTDV00.HYD

Dairyland Power Coop.
Feasibility Report
PostDevelopment Conditions
BJK 5/97 REV 9/98

Composite Hydrograph Summary (cfs)

Subarea Description	14.0 hr	14.3 hr	14.6 hr	15.0 hr	15.5 hr	16.0 hr	16.5 hr	17.0 hr	17.5 hr
1C	8	7	7	6	5	5	4	4	4
2C	2	2	2	2	1	1	1	1	1
3C	5	5	4	4	3	3	3	3	2
4C	3	2	2	2	2	2	1	1	1
East	141	115	97	83	74	66	59	53	49
Northeast	15	13	12	11	10	9	8	7	7
North	51	44	38	33	30	27	24	22	20
West	24	21	18	16	14	13	12	11	10
Total (cfs)	249	209	180	157	139	126	112	102	94

Subarea Description	18.0 hr	19.0 hr	20.0 hr	22.0 hr	26.0 hr
1C	4	3	3	2	0
2C	1	1	1	1	0
3C	2	2	2	2	0
4C	1	1	1	1	0
East	47	42	37	30	0
Northeast	6	6	5	4	0
North	19	17	15	13	0
West	10	8	7	6	0
Total (cfs)	90	80	71	59	0

Executed 09-18-2000 13:11:11

Data directory: p:\data\projects\3081\40\sw*.HYD

File Summary for Composite Hydrograph

Time (hrs)	POSTDV25 (cfs)	BSN1OUT1 (cfs)	BSN2OUT1 (cfs)	TPTPST25 (Total)
11.00	16.0	0.0	0.0	16.0
11.10	18.0	0.2	0.2	18.4
11.20	21.0	0.2	0.2	21.4
11.30	23.0	0.3	0.2	23.5
11.40	26.0	0.3	0.2	26.5
11.50	28.0	0.3	0.2	28.5
11.60	31.0	0.4	0.2	31.6
11.70	38.0	0.4	0.3	38.7
11.80	44.0	0.4	0.3	44.7
11.90	51.0	0.5	0.3	51.8
12.00	75.0	0.5	0.4	75.9
12.10	138.0	0.6	0.4	139.0
12.20	283.0	0.6	0.5	284.1
12.30	518.0	0.7	0.5	519.2
12.40	773.0	0.7	0.5	774.2
12.50	964.0	0.7	0.6	965.3
12.60	1027.0	0.7	0.6	1028.3 ← Peak
12.70	977.0	0.7	0.6	978.3
12.80	861.0	0.7	0.6	862.3
12.90	727.0	0.7	0.6	728.3
13.00	593.0	0.8	0.6	594.3
13.10	503.0	0.8	0.6	504.4
13.20	414.0	0.8	0.6	415.4
13.30	361.0	0.8	0.6	362.4
13.40	308.0	0.8	0.6	309.4
13.50	277.0	0.8	0.6	278.4
13.60	245.0	0.8	0.6	246.4
13.70	225.0	0.8	0.6	226.4
13.80	205.0	0.8	0.6	206.4
13.90	190.0	0.8	0.6	191.4
14.00	174.0	0.8	0.6	175.4
14.10	165.0	0.8	0.6	166.4
14.20	155.0	0.8	0.6	156.4
14.30	146.0	0.9	0.6	147.5
14.40	139.0	1.2	0.6	140.8
14.50	133.0	1.5	0.6	135.1
14.60	126.0	1.8	0.6	128.4
14.70	122.0	2.0	0.6	124.6
14.80	118.0	2.2	0.6	120.8
14.90	115.0	2.3	0.6	117.9

Combined Post-Development Hydrograph 25yr storm

Basin 1 +
Basin 2 +
Surrounding watershed.

Executed 09-18-2000 13:11:11

Data directory: p:\data\projects\3081\40\sw*.HYD

File Summary for Composite Hydrograph

Time (hrs)	POSTDV25 (cfs)	BSN1OUT1 (cfs)	BSN2OUT1 (cfs)	TPTPST25 (Total)
15.00	111.0	2.4	0.6	114.0
15.10	109.0	2.5	0.6	112.1
15.20	107.0	2.6	0.6	110.2
15.30	104.0	2.7	0.6	107.3
15.40	102.0	2.7	0.6	105.3
15.50	100.0	2.8	0.6	103.4
15.60	98.0	2.8	0.6	101.4
15.70	96.0	2.8	0.6	99.4
15.80	94.0	2.9	0.6	97.5
15.90	92.0	2.9	0.6	95.5
16.00	90.0	2.9	0.6	93.5
16.10	88.0	2.9	0.6	91.5
16.20	86.0	2.9	0.6	89.5
16.30	85.0	2.9	0.6	88.5
16.40	83.0	2.7	0.6	86.3
16.50	81.0	2.6	0.6	84.2
16.60	80.0	2.5	0.6	83.1
16.70	78.0	2.4	0.6	81.0
16.80	77.0	2.3	0.6	79.9
16.90	75.0	2.3	0.6	77.9
17.00	74.0	2.2	0.6	76.8
17.10	73.0	2.2	0.6	75.8
17.20	72.0	2.2	0.6	74.8
17.30	71.0	2.1	0.6	73.7
17.40	70.0	2.1	0.6	72.7
17.50	69.0	2.1	0.6	71.7
17.60	69.0	2.1	0.6	71.7
17.70	68.0	2.1	0.6	70.7
17.80	68.0	2.0	0.6	70.7
17.90	67.0	2.0	0.6	69.6
18.00	67.0	2.0	0.6	69.6
18.10	66.0	2.0	0.6	68.6
18.20	65.0	2.0	0.6	67.6
18.30	64.0	2.0	0.6	66.6
18.40	63.0	2.0	0.6	65.6
18.50	62.0	2.0	0.6	64.6
18.60	61.0	2.0	0.6	63.6
18.70	60.0	2.0	0.6	62.6
18.80	59.0	2.0	0.7	61.7
18.90	58.0	2.0	0.7	60.8
19.00	57.0	2.0	0.8	59.8

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Data directory: p:\data\projects\3081\40\sw*.HYD

File Summary for Composite Hydrograph

Time (hrs)	POSTDV25 (cfs)	BSN1OUT1 (cfs)	BSN2OUT1 (cfs)	TPTPST25 (Total)
19.10	56.0	2.0	0.8	58.8
19.20	56.0	2.0	0.9	58.9
19.30	55.0	2.0	0.9	57.9
19.40	55.0	2.0	0.9	57.9
19.50	54.0	2.0	0.9	56.9
19.60	53.0	1.9	0.9	55.9
19.70	53.0	1.8	0.9	55.7
19.80	52.0	1.6	1.0	54.6
19.90	52.0	1.5	1.0	54.5
20.00	51.0	1.4	1.0	53.4
20.10	51.0	1.4	1.0	53.3
20.20	50.0	1.3	1.0	52.3
20.30	50.0	1.2	1.0	52.2
20.40	49.0	1.2	1.0	51.2
20.50	49.0	1.2	1.0	51.2
20.60	49.0	1.1	1.0	51.1
20.70	48.0	1.1	1.0	50.1
20.80	48.0	1.1	1.0	50.1
20.90	47.0	1.1	1.0	49.1
21.00	47.0	1.0	1.0	49.0
21.10	47.0	0.8	1.0	48.8
21.20	46.0	0.8	1.0	47.8
21.30	46.0	0.8	1.0	47.8
21.40	45.0	0.8	1.0	46.8
21.50	45.0	0.8	1.0	46.8
21.60	45.0	0.8	1.0	46.8
21.70	44.0	0.8	1.0	45.8
21.80	44.0	0.8	1.0	45.8
21.90	43.0	0.8	1.0	44.8
22.00	43.0	0.8	1.0	44.8
22.10	42.0	0.8	1.0	43.8
22.20	41.0	0.8	1.0	42.8
22.30	40.0	0.8	1.0	41.8
22.40	39.0	0.8	1.0	40.8
22.50	38.0	0.8	1.0	39.8
22.60	37.0	0.8	1.0	38.8
22.70	35.0	0.8	1.0	36.8
22.80	34.0	0.8	1.0	35.8
22.90	33.0	0.8	1.0	34.8
23.00	32.0	0.8	1.0	33.8
23.10	31.0	0.8	1.0	32.8

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Data directory: p:\data\projects\3081\40\sw*.HYD

File Summary for Composite Hydrograph

Time (hrs)	POSTDV25 (cfs)	BSN1OUT1 (cfs)	BSN2OUT1 (cfs)	TPTPST25 (Total)
23.20	30.0	0.8	1.0	31.8
23.30	29.0	0.8	1.0	30.8
23.40	28.0	0.8	1.0	29.8
23.50	27.0	0.8	1.0	28.8
23.60	26.0	0.8	1.0	27.8
23.70	25.0	0.8	1.0	26.8
23.80	24.0	0.8	1.0	25.8
23.90	23.0	0.8	1.0	24.8
24.00	22.0	0.8	0.9	23.7
24.10	20.0	0.8	0.7	21.5
24.20	19.0	0.8	0.6	20.4
24.30	18.0	0.8	0.6	19.4
24.40	17.0	0.8	0.6	18.4
24.50	16.0	0.8	0.6	17.4
24.60	15.0	0.8	0.6	16.4
24.70	14.0	0.8	0.6	15.4
24.80	13.0	0.8	0.6	14.4
24.90	12.0	0.8	0.6	13.4
25.00	11.0	0.8	0.6	12.4
25.10	10.0	0.8	0.6	11.4
25.20	9.0	0.8	0.6	10.4
25.30	8.0	0.8	0.6	9.4
25.40	6.0	0.8	0.6	7.4
25.50	5.0	0.8	0.6	6.4

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File Summary for Composite Hydrograph

Combined Post - Development Hydrograph - 100 yr Storm
Basin 1 +
Basin 2 +
Surrounding Watershed.

Time (hrs)	POSTDV00 (cfs)	BSN1OUT2 (cfs)	BSN2OUT2 (cfs)	TOTPST00 (Total)
11.00	37.0	0.0	0.0	37.0
11.10	42.0	0.2	0.2	42.4
11.20	48.0	0.3	0.2	48.5
11.30	53.0	0.3	0.2	53.5
11.40	58.0	0.4	0.3	58.6
11.50	64.0	0.4	0.3	64.7
11.60	69.0	0.4	0.3	69.7
11.70	84.0	0.4	0.3	84.7
11.80	98.0	0.5	0.3	98.8
11.90	113.0	0.5	0.4	113.9
12.00	168.0	0.6	0.4	169.0
12.10	290.0	0.6	0.5	291.1
12.20	546.0	0.7	0.5	547.2
12.30	919.0	0.7	0.6	920.3
12.40	1298.0	0.7	0.6	1299.3
12.50	1553.0	0.8	0.6	1554.4
12.60	1618.0	2.8	1.2	1622.0 ← Peak
12.70	1511.0	8.2	3.7	1522.9
12.80	1316.0	12.2	5.2	1333.4
12.90	1104.0	14.8	6.1	1124.9
13.00	892.0	15.7	6.6	914.3
13.10	752.0	15.5	6.9	774.4
13.20	613.0	14.8	7.0	634.8
13.30	532.0	14.0	7.0	553.0
13.40	451.0	13.3	7.0	471.3
13.50	402.0	12.5	7.0	421.5
13.60	352.0	11.7	6.9	370.6
13.70	322.0	10.8	6.7	339.5
13.80	292.0	10.0	6.6	308.6
13.90	270.0	9.6	6.5	286.0
14.00	249.0	9.1	6.3	264.3
14.10	236.0	8.5	6.0	250.6
14.20	222.0	8.1	5.8	235.9
14.30	209.0	7.7	5.7	222.4
14.40	199.0	7.4	5.4	211.9
14.50	190.0	7.2	5.2	202.3
14.60	180.0	7.0	4.8	191.8
14.70	174.0	6.8	4.5	185.3
14.80	168.0	6.6	4.2	178.8
14.90	163.0	6.2	4.0	173.2

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File Summary for Composite Hydrograph

Time (hrs)	POSTDV00 (cfs)	BSN1OUT2 (cfs)	BSN2OUT2 (cfs)	TOTPST00 (Total)
15.00	157.0	5.8	3.8	166.6
15.10	153.0	5.5	3.6	162.1
15.20	150.0	5.3	3.5	158.8
15.30	146.0	5.0	3.4	154.4
15.40	143.0	4.6	3.3	150.9
15.50	139.0	4.3	3.3	146.6
15.60	136.0	4.1	3.2	143.3
15.70	134.0	3.9	3.2	141.1
15.80	131.0	3.8	3.1	137.9
15.90	129.0	3.6	3.1	135.7
16.00	126.0	3.5	3.1	132.6
16.10	123.0	3.4	3.1	129.5
16.20	120.0	3.4	3.1	126.4
16.30	118.0	3.3	3.0	124.2
16.40	115.0	3.2	2.8	121.0
16.50	112.0	3.2	2.6	117.8
16.60	110.0	3.2	2.5	115.7
16.70	108.0	3.1	2.4	113.5
16.80	106.0	3.1	2.3	111.4
16.90	104.0	3.1	2.3	109.3
17.00	102.0	3.1	2.2	107.3
17.10	100.0	3.1	2.2	105.2
17.20	99.0	3.0	2.1	104.2
17.30	97.0	3.0	2.1	102.2
17.40	96.0	3.0	2.1	101.1
17.50	94.0	3.0	2.1	99.1
17.60	93.0	3.0	2.1	98.1
17.70	92.0	3.0	2.0	97.1
17.80	92.0	3.0	2.0	97.1
17.90	91.0	3.0	2.0	96.0
18.00	90.0	3.0	2.0	95.0
18.10	89.0	3.0	2.0	94.0
18.20	88.0	3.0	2.0	93.0
18.30	87.0	3.0	2.0	92.0
18.40	86.0	3.0	2.0	91.0
18.50	85.0	2.9	2.0	89.9
18.60	84.0	2.8	2.0	88.8
18.70	83.0	2.6	2.0	87.6
18.80	82.0	2.5	2.0	86.5
18.90	81.0	2.4	2.0	85.4
19.00	80.0	2.4	2.0	84.4

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Data directory: p:\data\projects\3081\40\sw*.HYD

File Summary for Composite Hydrograph

Time (hrs)	POSTDV00 (cfs)	BSN1OUT2 (cfs)	BSN2OUT2 (cfs)	TOTPST00 (Total)
19.10	79.0	2.3	2.0	83.3
19.20	78.0	2.2	2.0	82.2
19.30	77.0	2.2	2.0	81.2
19.40	76.0	2.2	2.0	80.2
19.50	76.0	2.1	2.0	80.1
19.60	75.0	2.1	1.9	79.0
19.70	74.0	2.1	1.7	77.8
19.80	73.0	2.1	1.6	76.7
19.90	72.0	2.1	1.5	75.5
20.00	71.0	2.0	1.4	74.4
20.10	70.0	2.0	1.3	73.3
20.20	70.0	2.0	1.3	73.3
20.30	69.0	2.0	1.2	72.2
20.40	69.0	2.0	1.2	72.2
20.50	68.0	2.0	1.1	71.1
20.60	67.0	2.0	1.1	70.1
20.70	67.0	2.0	1.1	70.1
20.80	66.0	2.0	1.1	69.1
20.90	66.0	2.0	1.0	69.1
21.00	65.0	2.0	1.0	68.1
21.10	64.0	2.0	1.0	67.0
21.20	64.0	2.0	1.0	67.0
21.30	63.0	2.0	1.0	66.0
21.40	63.0	2.0	1.0	66.0
21.50	62.0	2.0	1.0	65.0
21.60	61.0	2.0	1.0	64.0
21.70	61.0	2.0	1.0	64.0
21.80	60.0	2.0	1.0	63.0
21.90	60.0	2.0	1.0	63.0
22.00	59.0	2.0	1.0	62.0
22.10	58.0	2.0	1.0	61.0
22.20	56.0	2.0	1.0	59.0
22.30	55.0	2.0	1.0	58.0
22.40	53.0	2.0	1.0	56.0
22.50	52.0	2.0	1.0	55.0
22.60	50.0	2.0	1.0	53.0
22.70	49.0	2.0	1.0	52.0
22.80	47.0	2.0	1.0	50.0
22.90	46.0	2.0	1.0	49.0
23.00	44.0	2.0	1.0	47.0
23.10	43.0	1.9	1.0	45.9

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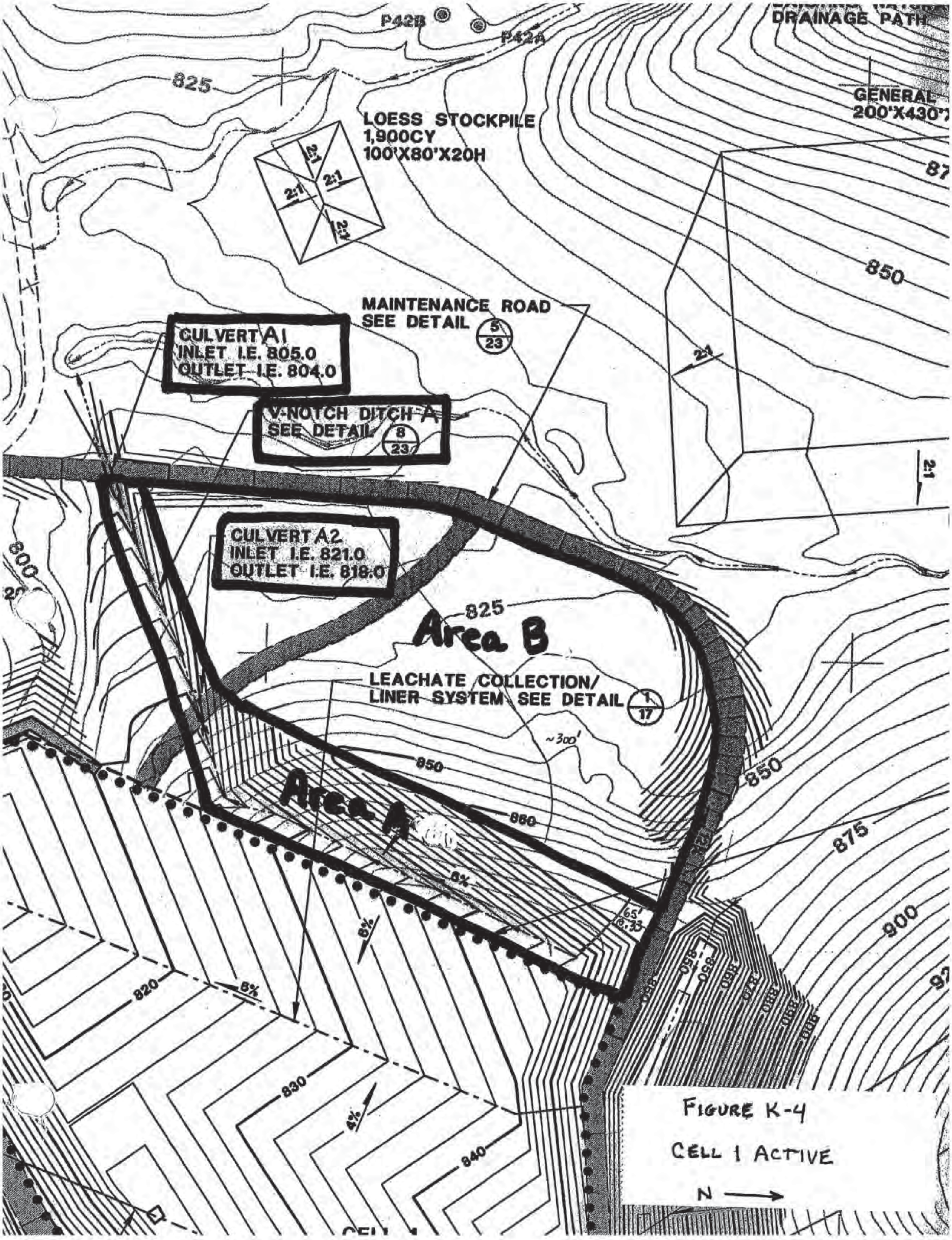
Data directory: p:\data\projects\3081\40\sw*.HYD

File Summary for Composite Hydrograph

Time (hrs)	POSTDV00 (cfs)	BSN1OUT2 (cfs)	BSN2OUT2 (cfs)	TOTPST00 (Total)
23.20	41.0	1.8	1.0	43.8
23.30	40.0	1.6	1.0	42.6
23.40	38.0	1.5	1.0	40.5
23.50	37.0	1.4	1.0	39.4
23.60	35.0	1.4	1.0	37.3
23.70	34.0	1.3	1.0	36.3
23.80	32.0	1.2	1.0	34.2
23.90	31.0	1.2	1.0	33.2
24.00	30.0	1.2	0.9	32.1
24.10	28.0	1.1	0.7	29.9
24.20	27.0	1.1	0.6	28.7
24.30	25.0	1.1	0.6	26.7
24.40	24.0	1.1	0.6	25.7
24.50	22.0	1.1	0.6	23.7
24.60	21.0	1.0	0.6	22.6
24.70	19.0	1.0	0.6	20.6
24.80	18.0	1.0	0.6	19.6
24.90	16.0	1.0	0.6	17.6
25.00	15.0	0.9	0.6	16.5
25.10	13.0	0.8	0.6	14.4
25.20	12.0	0.8	0.6	13.4
25.30	10.0	0.8	0.6	11.4
25.40	9.0	0.8	0.6	10.4
25.50	7.0	0.8	0.6	8.4

Operational Run-off Calculations



DRAINAGE PATH
P42B
P42A
825
GENERAL
200'X430'
LOESS STOCKPILE
1,900CY
100'X80'X20H
2:1
850
MAINTENANCE ROAD
SEE DETAIL 5/23
CULVERT A1
INLET I.E. 805.0
OUTLET I.E. 804.0
V-NOTCH DITCH A
SEE DETAIL 8/23
CULVERT A2
INLET I.E. 821.0
OUTLET I.E. 818.0
800
825
Area B
LEACHATE COLLECTION/
LINER SYSTEM SEE DETAIL 1/17
~300'
850
Area A
860
875
900
8%
820
830
4%
840
FIGURE K-4
CELL 1 ACTIVE
N

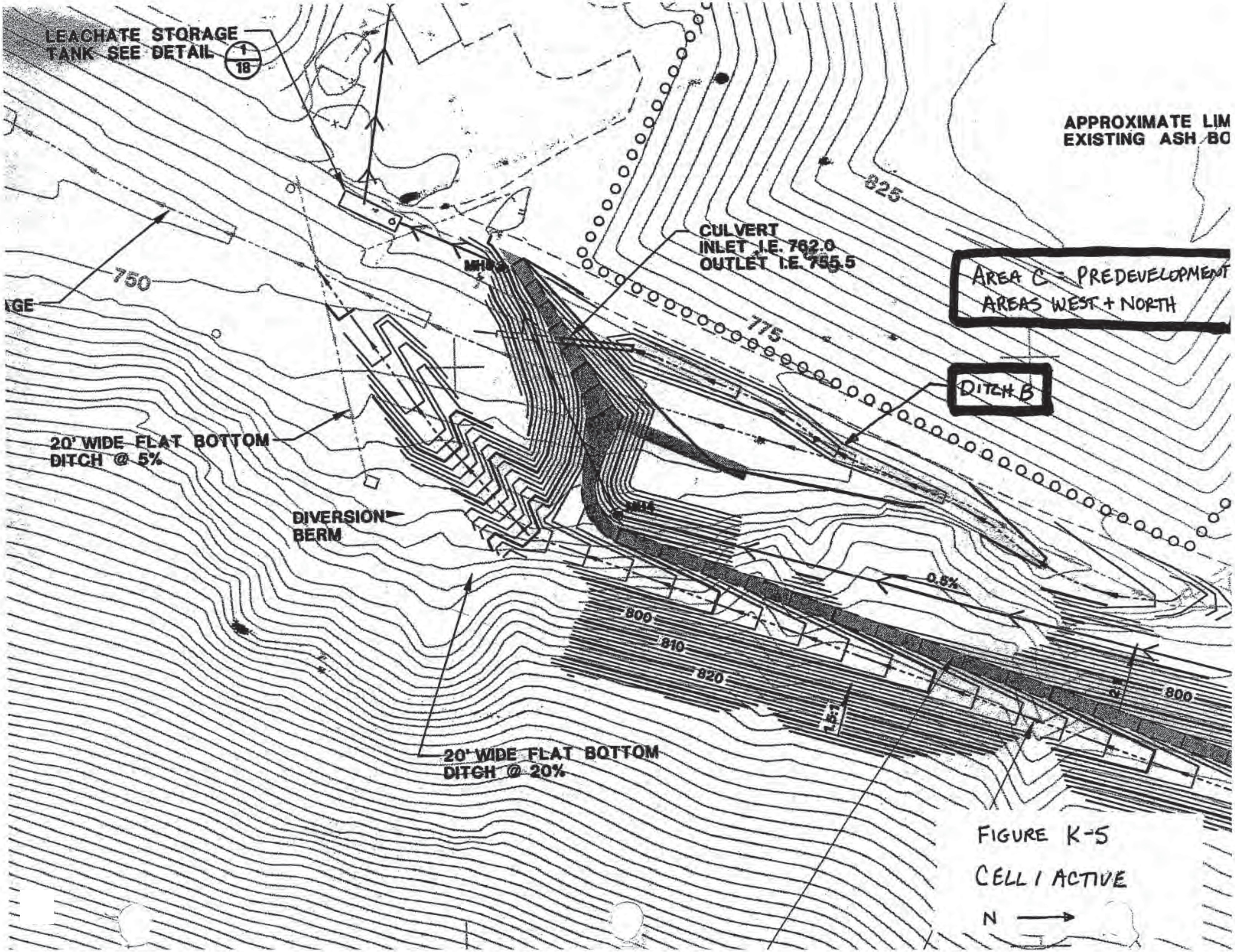
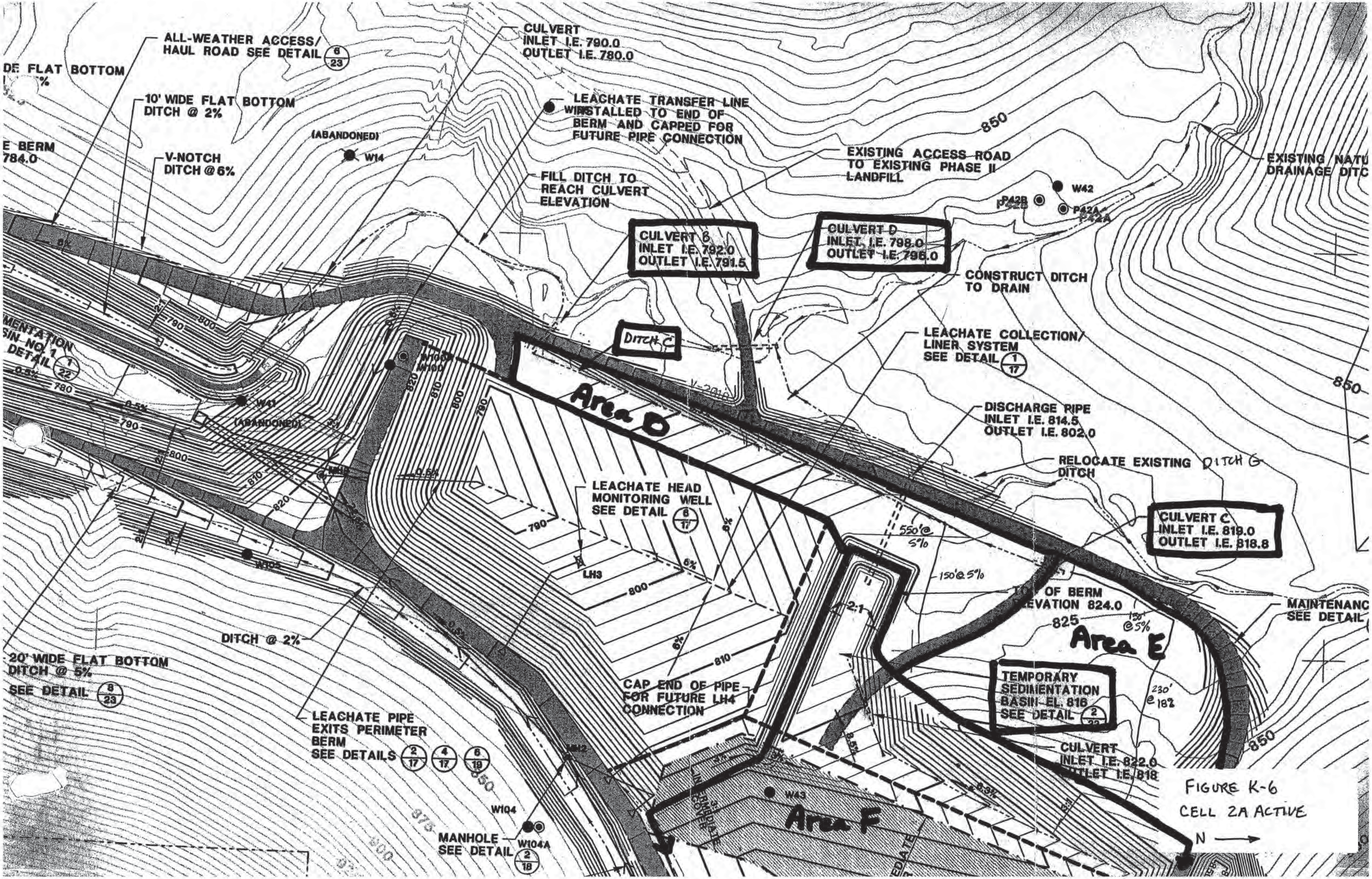


FIGURE K-5
CELL I ACTIVE


ALL-WEATHER ACCESS/
HAUL ROAD SEE DETAIL 6/23
CULVERT
INLET I.E. 790.0
OUTLET I.E. 780.0
10' WIDE FLAT BOTTOM
DITCH @ 2%
LEACHATE TRANSFER LINE
INSTALLED TO END OF
BERM AND CAPPED FOR
FUTURE PIPE CONNECTION
(ABANDONED)
W14
V-NOTCH
DITCH @ 6%
850
FILL DITCH TO
REACH CULVERT
ELEVATION
EXISTING ACCESS ROAD
TO EXISTING PHASE II
LANDFILL
EXISTING NATU
DRAINAGE DITC
W42
P42B
P42A
CULVERT B
INLET I.E. 792.0
OUTLET I.E. 791.5
CULVERT D
INLET I.E. 798.0
OUTLET I.E. 796.0
CONSTRUCT DITCH
TO DRAIN
DITCH C
LEACHATE COLLECTION/
LINER SYSTEM
SEE DETAIL 1/17
Area D
W41
(ABANDONED)
DISCHARGE PIPE
INLET I.E. 814.5
OUTLET I.E. 802.0
RELOCATE EXISTING DITCH G
DITCH
LEACHATE HEAD
MONITORING WELL
SEE DETAIL 6/17
CULVERT C
INLET I.E. 819.0
OUTLET I.E. 818.8
550' @ 5%
150' @ 5%
TOP OF BERM
ELEVATION 824.0
825
Area E
MAINTENANC
SEE DETAIL
LH3
DITCH @ 2%
20' WIDE FLAT BOTTOM
DITCH @ 5%
SEE DETAIL 8/23
CAP END OF PIPE
FOR FUTURE LH4
CONNECTION
TEMPORARY
SEDIMENTATION
BASIN EL. 816
SEE DETAIL 2/22
LEACHATE PIPE
EXITS PERIMETER
BERM
SEE DETAILS 2/17 4/17 6/19
CULVERT
INLET I.E. 822.0
OUTLET I.E. 818
W43
Area F
W104
MANHOLE
SEE DETAIL 2/18
W104A
850
FIGURE K-6
CELL 2A ACTIVE
N →

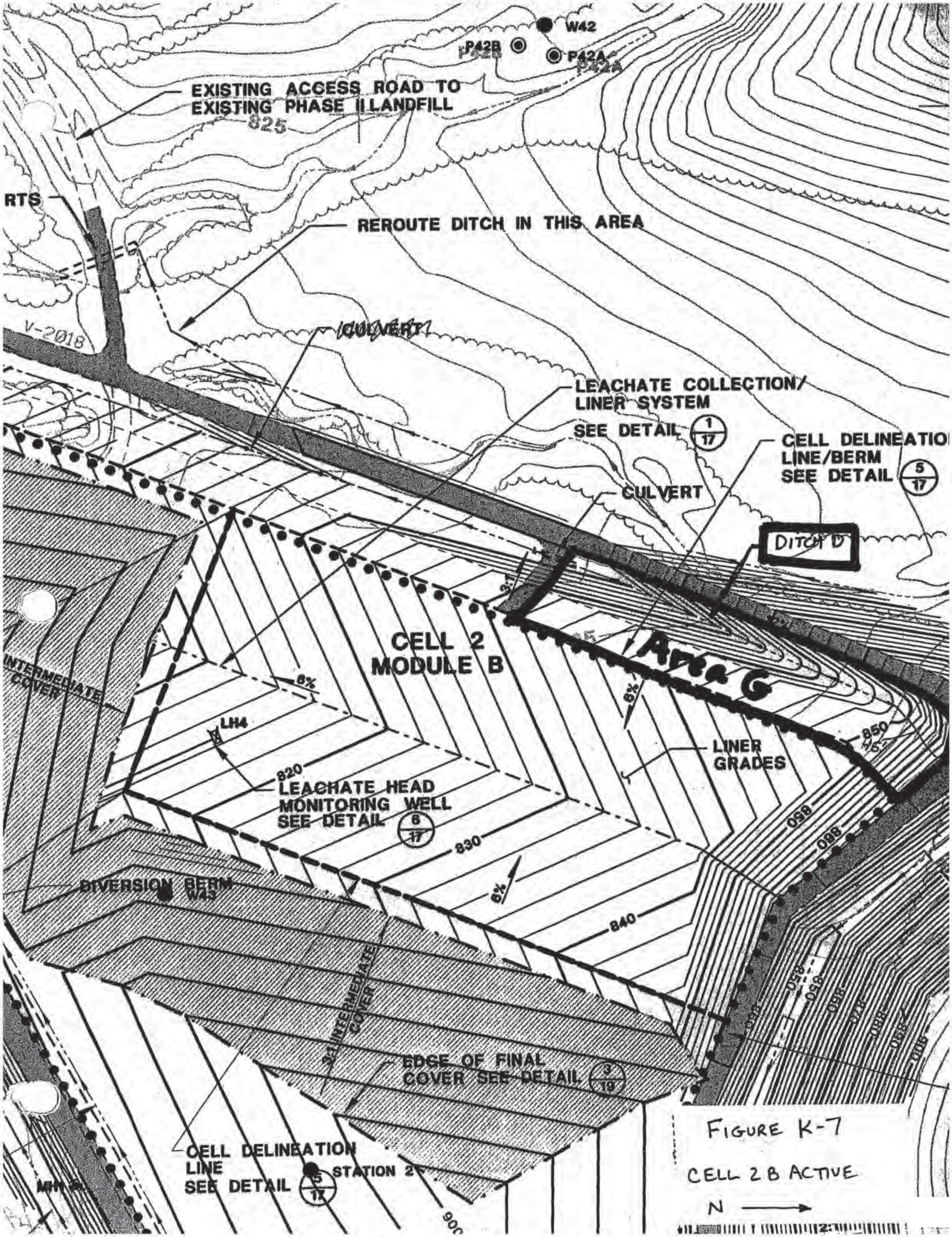


FIGURE K-7

CELL 2B ACTIVE

N →

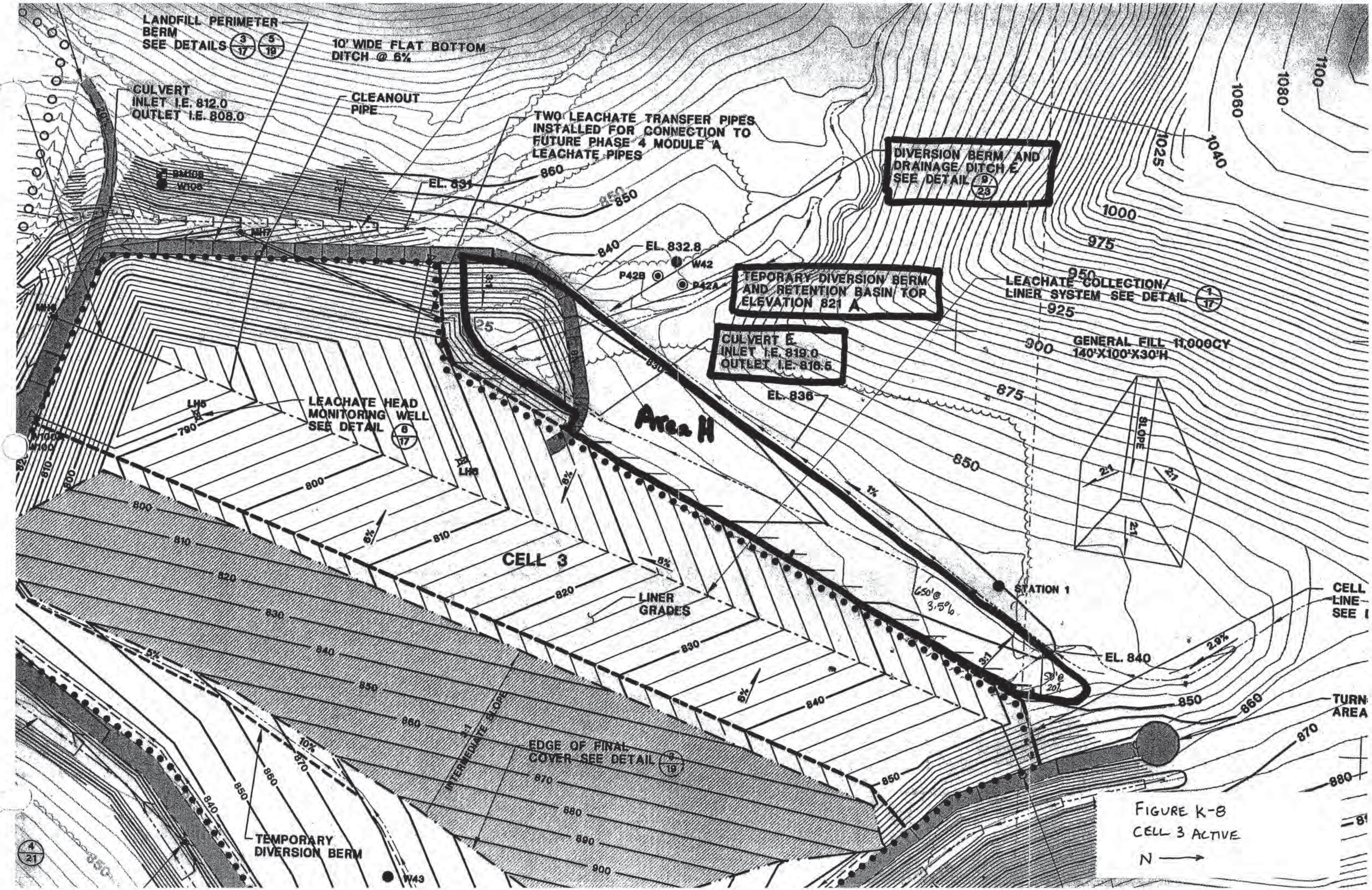


FIGURE K-8
CELL 3 ACTIVE
N →

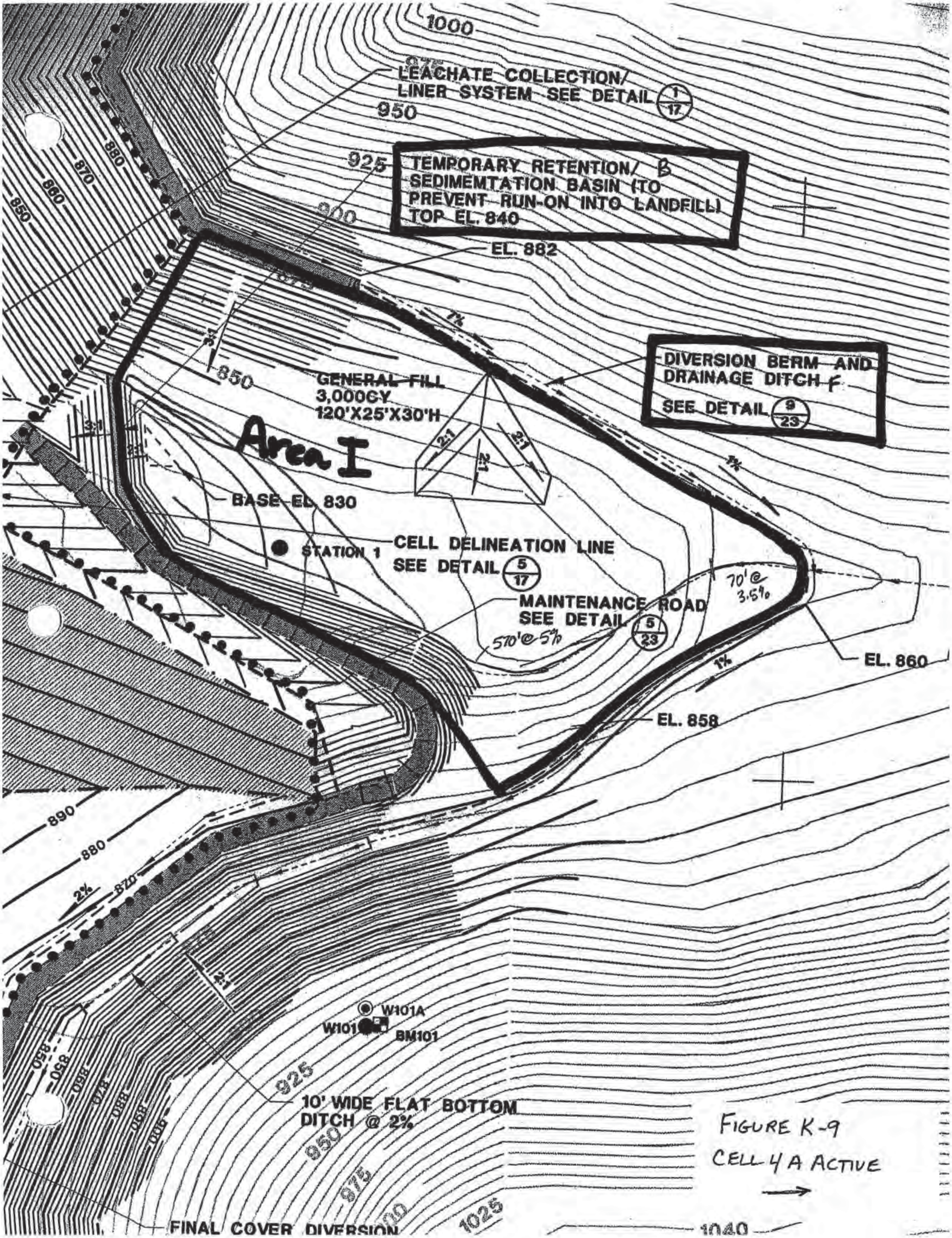


FIGURE K-9
CELL 4A ACTIVE

Quick TR-55 Ver.5.46 S/N:
Executed: 19:42:40 10-12-2000 p:\data\projects\3081\40\sw\op\OPERAT.TCT

SUMMARY SHEET FOR Tc or Tt COMPUTATIONS
(Solved for Time using TR-55 Methods)

Dairyland Power Coop.
Plan of Operation
Operational Conditions

Subarea descr.	Tc or Tt	Time (hrs)
Area A	Tc	0.08
Area B	Tc	0.21
Area D	Tc	0.06 – Round to 0.10
Area E	Tc	0.15
Area F	Tc	0.24
Area G	Tc	0.05 – Round to 0.10
Area H	Tc	0.10
Area I	Tc	0.15

```
Quick TR-55 Ver.5.46   S/N:
Executed: 19:42:40   10-12-2000    p:\data\projects\3081\40\sw\op\OPERAT.TCT

                         Dairyland Power Coop.
                           Plan of Operation
                        Operational Conditions


                  Tc COMPUTATIONS FOR: Area A

 SHEET FLOW (Applicable to Tc only)
     Segment ID                                  1
     Surface description                    grass
     Manning's roughness coeff., n                 0.1500
     Flow length, L (total < or = 300)      ft     65.0
     Two-yr 24-hr rainfall, P2              in     2.800
     Land slope, s                         ft/ft   0.3330
                         0.8
          .007 * (n*L)
     T =  --------------                    hrs     0.04              =  0.04
              0.5    0.4
            P2   *  s

 SHALLOW CONCENTRATED FLOW
     Segment ID                                  2
     Surface (paved or unpaved)?                 Unpaved
     Flow length, L                         ft    625.0
     Watercourse slope, s                  ft/ft   0.0600

                          0.5
     Avg.V =  Csf *  (s)                   ft/s   3.9521
     where:   Unpaved Csf = 16.1345
              Paved   Csf = 20.3282

     T = L / (3600*V)                       hrs     0.04              =  0.04


 CHANNEL FLOW
     Segment ID
     Cross Sectional Flow Area, a         sq.ft     0.00
     Wetted perimeter, Pw                    ft     0.00
     Hydraulic radius, r = a/Pw              ft    0.000
     Channel slope, s                     ft/ft   0.0000
     Manning's roughness coeff., n                0.0000

                     2/3    1/2
          1.49  *  r    *  s
     V =  --------------------             ft/s   0.0000
                    n

     Flow length, L                          ft        0

     T = L / (3600*V)                       hrs     0.00              =  0.00

   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                                          TOTAL TIME (hrs)        0.08
```

```
Quick TR-55 Ver.5.46   S/N:
Executed: 19:42:40   10-12-2000    p:\data\projects\3081\40\sw\op\OPERAT.TCT

                         Dairyland Power Coop.
                           Plan of Operation
                        Operational Conditions


                 Tc COMPUTATIONS FOR: Area B

 SHEET FLOW (Applicable to Tc only)
    Segment ID                                 1
    Surface description               grass
    Manning's roughness coeff., n              0.1500
    Flow length, L (total < or = 300)   ft     300.0
    Two-yr 24-hr rainfall, P2           in     2.800
    Land slope, s                     ft/ft    0.1700
                      0.8
        .007 * (n*L)
    T = --------------                 hrs      0.18              = 0.18
           0.5    0.4
         P2   *  s

 SHALLOW CONCENTRATED FLOW
    Segment ID                                2
    Surface (paved or unpaved)?               Unpaved
    Flow length, L                      ft     220.0
    Watercourse slope, s              ft/ft    0.0200

                       0.5
    Avg.V =  Csf *  (s)               ft/s    2.2818
    where:   Unpaved Csf = 16.1345
             Paved   Csf = 20.3282

    T = L / (3600*V)                   hrs      0.03              = 0.03


 CHANNEL FLOW
    Segment ID
    Cross Sectional Flow Area, a      sq.ft     0.00
    Wetted perimeter, Pw                ft      0.00
    Hydraulic radius, r = a/Pw          ft     0.000
    Channel slope, s                  ft/ft    0.0000
    Manning's roughness coeff., n              0.0000

                    2/3    1/2
        1.49  *  r   *  s
    V = --------------------           ft/s    0.0000
                  n

    Flow length, L                      ft          0

    T = L / (3600*V)                   hrs      0.00              = 0.00

    ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                                          TOTAL TIME (hrs)          0.21
```

```
Quick TR-55 Ver.5.46   S/N:
Executed: 19:42:40   10-12-2000    p:\data\projects\3081\40\sw\op\OPERAT.TCT

                        Dairyland Power Coop.
                         Plan of Operation
                       Operational Conditions


                  Tc COMPUTATIONS FOR: Area D

 SHEET FLOW (Applicable to Tc only)
    Segment ID                                   1
    Surface description                   soil
    Manning's roughness coeff., n               0.0110
    Flow length, L (total < or = 300)     ft     150.0
    Two-yr 24-hr rainfall, P2             in     2.800
    Land slope, s                        ft/ft  0.0500
                     0.8
        .007 * (n*L)
    T = --------------                    hrs     0.02              =  0.02
           0.5    0.4
         P2   *  s

 SHALLOW CONCENTRATED FLOW
    Segment ID                                   2
    Surface (paved or unpaved)?                 Unpaved
    Flow length, L                        ft     550.0
    Watercourse slope, s                 ft/ft  0.0500

                      0.5
    Avg.V =  Csf *  (s)                   ft/s  3.6078
    where:   Unpaved Csf = 16.1345
             Paved   Csf = 20.3282

    T = L / (3600*V)                      hrs     0.04              =  0.04


 CHANNEL FLOW
    Segment ID
    Cross Sectional Flow Area, a        sq.ft     0.00
    Wetted perimeter, Pw                  ft      0.00
    Hydraulic radius, r = a/Pw            ft     0.000
    Channel slope, s                     ft/ft  0.0000
    Manning's roughness coeff., n               0.0000

                  2/3    1/2
        1.49  *  r    *  s
    V = --------------------              ft/s  0.0000
                   n

    Flow length, L                        ft         0

    T = L / (3600*V)                      hrs     0.00              =  0.00

   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                                        TOTAL TIME (hrs)        0.06
```

```
Quick TR-55 Ver.5.46   S/N:
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                        Dairyland Power Coop.
                         Plan of Operation
                       Operational Conditions


                 Tc COMPUTATIONS FOR: Area E

 SHEET FLOW (Applicable to Tc only)
    Segment ID                                   1
    Surface description                      grass
    Manning's roughness coeff., n                0.1500
    Flow length, L (total < or = 300)    ft     230.0
    Two-yr 24-hr rainfall, P2            in     2.800
    Land slope, s                      ft/ft    0.1800
                      0.8
         .007 * (n*L)
    T = --------------                 hrs       0.14            = 0.14
             0.5    0.4
           P2   *  s

 SHALLOW CONCENTRATED FLOW
    Segment ID                                   2
    Surface (paved or unpaved)?                 Unpaved
    Flow length, L                       ft     150.0
    Watercourse slope, s               ft/ft    0.0500

                       0.5
    Avg.V =  Csf *  (s)                ft/s     3.6078
    where:   Unpaved Csf = 16.1345
             Paved   Csf = 20.3282

    T = L / (3600*V)                   hrs       0.01            = 0.01


 CHANNEL FLOW
    Segment ID
    Cross Sectional Flow Area, a      sq.ft      0.00
    Wetted perimeter, Pw                 ft      0.00
    Hydraulic radius, r = a/Pw           ft     0.000
    Channel slope, s                   ft/ft    0.0000
    Manning's roughness coeff., n               0.0000

                   2/3    1/2
         1.49  *  r   *  s
    V = --------------------           ft/s     0.0000
                   n

    Flow length, L                       ft         0

    T = L / (3600*V)                   hrs       0.00            = 0.00

   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                                          TOTAL TIME (hrs)        0.15
```

```
Quick TR-55 Ver.5.46   S/N:
Executed: 19:42:40   10-12-2000    p:\data\projects\3081\40\sw\op\OPERAT.TCT

                         Dairyland Power Coop.
                          Plan of Operation
                        Operational Conditions


                    Tc COMPUTATIONS FOR: Area F

 SHEET FLOW (Applicable to Tc only)
    Segment ID                                  1
    Surface description                    grass
    Manning's roughness coeff., n              0.1500
    Flow length, L (total < or = 300)   ft     185.0
    Two-yr 24-hr rainfall, P2           in     2.800
    Land slope, s                      ft/ft   0.2500
                   0.8
        .007 * (n*L)
    T = --------------                 hrs      0.10            = 0.10
           0.5    0.4
         P2   *  s

 SHALLOW CONCENTRATED FLOW
    Segment ID                                  2
    Surface (paved or unpaved)?               Unpaved
    Flow length, L                      ft     1370.0
    Watercourse slope, s               ft/ft   0.0300

                    0.5
    Avg.V =  Csf *  (s)                ft/s    2.7946
    where:   Unpaved Csf = 16.1345
             Paved   Csf = 20.3282

    T = L / (3600*V)                   hrs      0.14            = 0.14


 CHANNEL FLOW
    Segment ID
    Cross Sectional Flow Area, a      sq.ft     0.00
    Wetted perimeter, Pw                ft      0.00
    Hydraulic radius, r = a/Pw          ft      0.000
    Channel slope, s                   ft/ft    0.0000
    Manning's roughness coeff., n               0.0000

                  2/3    1/2
        1.49  *  r    *  s
    V = --------------------           ft/s    0.0000
                 n

    Flow length, L                      ft          0

    T = L / (3600*V)                   hrs      0.00            = 0.00

  ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                                              TOTAL TIME (hrs)      0.24
```

```
Quick TR-55 Ver.5.46   S/N:
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                          Dairyland Power Coop.
                            Plan of Operation
                         Operational Conditions


                     Tc COMPUTATIONS FOR: Area G

 SHEET FLOW (Applicable to Tc only)
    Segment ID                                  1
    Surface description                     grass
    Manning's roughness coeff., n              0.1500
    Flow length, L (total < or = 300)    ft     45.0
    Two-yr 24-hr rainfall, P2            in    2.800
    Land slope, s                       ft/ft  0.3300
                     0.8
        .007 * (n*L)
    T = --------------                  hrs     0.03               = 0.03
           0.5    0.4
         P2   *  s

 SHALLOW CONCENTRATED FLOW
    Segment ID                                 2
    Surface (paved or unpaved)?              Unpaved
    Flow length, L                       ft    320.0
    Watercourse slope, s                ft/ft  0.1200

                       0.5
    Avg.V =  Csf *  (s)                 ft/s   5.5892
    where:   Unpaved Csf = 16.1345
             Paved   Csf = 20.3282

    T = L / (3600*V)                    hrs     0.02               = 0.02


 CHANNEL FLOW
    Segment ID
    Cross Sectional Flow Area, a       sq.ft    0.00
    Wetted perimeter, Pw                 ft     0.00
    Hydraulic radius, r = a/Pw           ft    0.000
    Channel slope, s                    ft/ft  0.0000
    Manning's roughness coeff., n              0.0000

                   2/3    1/2
        1.49  *  r   *  s
    V = --------------------            ft/s   0.0000
                  n

    Flow length, L                       ft        0

    T = L / (3600*V)                    hrs     0.00               = 0.00

   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                                            TOTAL TIME (hrs)       0.05
```

```
Quick TR-55 Ver.5.46   S/N:
Executed: 19:42:40   10-12-2000    p:\data\projects\3081\40\sw\op\OPERAT.TCT

                         Dairyland Power Coop.
                           Plan of Operation
                        Operational Conditions


                  Tc COMPUTATIONS FOR: Area H

SHEET FLOW (Applicable to Tc only)
    Segment ID                                  1
    Surface description                     grass
    Manning's roughness coeff., n              0.1500
    Flow length, L (total < or = 300)    ft     50.0
    Two-yr 24-hr rainfall, P2            in    2.800
    Land slope, s                       ft/ft  0.2000
                      0.8
         .007 * (n*L)
    T =  --------------                 hrs     0.04              = 0.04
            0.5    0.4
          P2   *  s

SHALLOW CONCENTRATED FLOW
    Segment ID                                  2
    Surface (paved or unpaved)?                Unpaved
    Flow length, L                       ft    650.0
    Watercourse slope, s                ft/ft  0.0350

                        0.5
    Avg.V =  Csf *  (s)                 ft/s   3.0185
    where:   Unpaved Csf = 16.1345
             Paved   Csf = 20.3282

    T = L / (3600*V)                    hrs     0.06              = 0.06


CHANNEL FLOW
    Segment ID
    Cross Sectional Flow Area, a       sq.ft    0.00
    Wetted perimeter, Pw                 ft     0.00
    Hydraulic radius, r = a/Pw           ft    0.000
    Channel slope, s                    ft/ft  0.0000
    Manning's roughness coeff., n              0.0000

                    2/3    1/2
         1.49  *  r    *  s
    V =  --------------------           ft/s   0.0000
                   n

    Flow length, L                       ft        0

    T = L / (3600*V)                    hrs     0.00              = 0.00

  ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                                         TOTAL TIME (hrs)         0.10
```

Quick TR-55 Ver.5.46 S/N:
Executed: 19:42:40 10-12-2000 p:\data\projects\3081\40\sw\op\OPERAT.TCT

Dairyland Power Coop.
Plan of Operation
Operational Conditions

Tc COMPUTATIONS FOR: Area I

SHEET FLOW (Applicable to Tc only)

Segment ID		1	
Surface description		grass	
Manning's roughness coeff., n		0.1500	
Flow length, L (total < or = 300)	ft	70.0	
Two-yr 24-hr rainfall, P2	in	2.800	
Land slope, s	ft/ft	0.0350	
$T = \frac{.007 * (n*L)^{0.8}}{P2^{0.5} * s^{0.4}}$	hrs	0.10	= 0.10

SHALLOW CONCENTRATED FLOW

Segment ID		2	
Surface (paved or unpaved)?		Unpaved	
Flow length, L	ft	570.0	
Watercourse slope, s	ft/ft	0.0500	
$Avg.V = Csf * (s)^{0.5}$	ft/s	3.6078	
where: Unpaved Csf = 16.1345			
Paved Csf = 20.3282			
T = L / (3600*V)	hrs	0.04	= 0.04

CHANNEL FLOW

Segment ID			
Cross Sectional Flow Area, a	sq.ft	0.00	
Wetted perimeter, Pw	ft	0.00	
Hydraulic radius, r = a/Pw	ft	0.000	
Channel slope, s	ft/ft	0.0000	
Manning's roughness coeff., n		0.0000	
$V = \frac{1.49 * r^{2/3} * s^{1/2}}{n}$	ft/s	0.0000	
Flow length, L	ft	0	
T = L / (3600*V)	hrs	0.00	= 0.00

::

TOTAL TIME (hrs) 0.15

TR-55 TABULAR HYDROGRAPH METHOD
Type II Distribution
(24 hr. Duration Storm)

Executed: 10-12-2000 20:11:42
Watershed file: --> p:\data\projects\3081\40\sw\op\CELL1 .WSD
Hydrograph file: --> p:\data\projects\3081\40\sw\op\CELL1 .HYD

Dairyland Power Coop.
Plan of Operation
Operational Conditions
Cell 1

>>>> Input Parameters Used to Compute Hydrograph <<<<

Subarea Description	AREA (acres)	CN	Tc (hrs)	* Tt (hrs)	Precip. (in)	Runoff (in)	Ia/p input/used	
Area A	1.10	69.0	0.10	0.00	6.10	2.79	.15	.10
Area B	2.70	69.0	0.20	0.00	6.10	2.79	.15	.10

* Travel time from subarea outfall to composite watershed outfall point.
Total area = 3.80 acres or 0.00594 sq.mi
Peak discharge = 14 cfs

>>>> Computer Modifications of Input Parameters <<<<<

	Input Values		Rounded Values		Ia/p	
Subarea Description	Tc (hr)	* Tt (hr)	Tc (hr)	* Tt (hr)	Interpolated (Yes/No)	Ia/p Messages
Area A	0.10	0.00	**	**	No	--
Area B	0.21	0.00	0.20	0.00	No	--

* Travel time from subarea outfall to composite watershed outfall point.
** Tc & Tt are available in the hydrograph tables.

TR-55 TABULAR HYDROGRAPH METHOD
Type II Distribution
(24 hr. Duration Storm)

Executed: 10-12-2000 20:11:42
Watershed file: --> p:\data\projects\3081\40\sw\op\CELL1 .WSD
Hydrograph file: --> p:\data\projects\3081\40\sw\op\CELL1 .HYD

Dairyland Power Coop.
Plan of Operation
Operational Conditions
Cell 1

>>>> Summary of Subarea Times to Peak <<<<

Subarea	Peak Discharge at Composite Outfall (cfs)	Time to Peak at Composite Outfall (hrs)
Area A	5	12.1
Area B	9	12.1
Composite Watershed	14	12.1

TR-55 TABULAR HYDROGRAPH METHOD
Type II Distribution
(24 hr. Duration Storm)

Executed: 10-12-2000 20:11:49
Watershed file: --> p:\data\projects\3081\40\sw\op\CELL2A .WSD
Hydrograph file: --> p:\data\projects\3081\40\sw\op\CELL2A .HYD

Dairyland Power Coop.
Plan of Opertaion
Operational Conditions
Cell 2A

>>>> Input Parameters Used to Compute Hydrograph <<<<

Subarea Description	AREA (acres)	CN	Tc (hrs)	* Tt (hrs)	Precip. (in)	Runoff (in)	Ia/p input/used
Area D	1.30	69.0	0.10	0.00	6.10	2.79	.15 .10
Area E	1.60	69.0	0.20	0.00	6.10	2.79	.15 .10

* Travel time from subarea outfall to composite watershed outfall point.
Total area = 2.90 acres or 0.00453 sq.mi
Peak discharge = 11 cfs

>>>> Computer Modifications of Input Parameters <<<<<

Subarea Description	Input Values Tc (hr)	Input Values * Tt (hr)	Rounded Values Tc (hr)	Rounded Values * Tt (hr)	Ia/p Interpolated (Yes/No)	Ia/p Messages
Area D	0.10	0.00	**	**	No	--
Area E	0.15	0.00	0.20	0.00	No	--

* Travel time from subarea outfall to composite watershed outfall point.
** Tc & Tt are available in the hydrograph tables.

TR-55 TABULAR HYDROGRAPH METHOD
Type II Distribution
(24 hr. Duration Storm)

Executed: 10-12-2000 20:11:49
Watershed file: --> p:\data\projects\3081\40\sw\op\CELL2A .WSD
Hydrograph file: --> p:\data\projects\3081\40\sw\op\CELL2A .HYD

Dairyland Power Coop.
Plan of Opertaion
Operational Conditions
Cell 2A

>>>> Summary of Subarea Times to Peak <<<<

Subarea	Peak Discharge at Composite Outfall (cfs)	Time to Peak at Composite Outfall (hrs)
Area D	6	12.1
Area E	6	12.2
Composite Watershed	11	12.1

TR-55 TABULAR HYDROGRAPH METHOD
Type II Distribution
(24 hr. Duration Storm)

Executed: 10-12-2000 20:11:57
Watershed file: --> p:\data\projects\3081\40\sw\op\TEMPBAS .WSD
Hydrograph file: --> p:\data\projects\3081\40\sw\op\TEMPBAS .HYD

Dairyland Power Coop.
Plan of Opertaion
Operational Conditions
Cell 2A Temporary Basin

>>>> Input Parameters Used to Compute Hydrograph <<<<

Subarea Description	AREA (acres)	CN	Tc (hrs)	* Tt (hrs)	Precip. (in)	Runoff (in)	Ia/p input/used
Area F	7.60	69.0	0.20	0.00	6.10	2.79	.15 .10

* Travel time from subarea outfall to composite watershed outfall point.

Total area = 7.60 acres or 0.01187 sq.mi
Peak discharge = 27 cfs

>>>> Computer Modifications of Input Parameters <<<<<

Subarea Description	Input Values Tc (hr)	Input Values * Tt (hr)	Rounded Values Tc (hr)	Rounded Values * Tt (hr)	Ia/p Interpolated (Yes/No)	Ia/p Messages
Area F	0.24	0.00	0.20	0.00	No	--

* Travel time from subarea outfall to composite watershed outfall point.

TR-55 TABULAR HYDROGRAPH METHOD
Type II Distribution
(24 hr. Duration Storm)

Executed: 10-12-2000 20:11:57
Watershed file: --> p:\data\projects\3081\40\sw\op\TEMPBAS .WSD
Hydrograph file: --> p:\data\projects\3081\40\sw\op\TEMPBAS .HYD

Dairyland Power Coop.
Plan of Opertaion
Operational Conditions
Cell 2A Temporary Basin

>>>> Summary of Subarea Times to Peak <<<<

Subarea	Peak Discharge at Composite Outfall (cfs)	Time to Peak at Composite Outfall (hrs)
Area F	27	12.2
Composite Watershed	27	12.2

TR-55 TABULAR HYDROGRAPH METHOD
Type II Distribution
(24 hr. Duration Storm)

Executed: 10-12-2000 20:12:03
Watershed file: --> p:\data\projects\3081\40\sw\op\CELL2B .WSD
Hydrograph file: --> p:\data\projects\3081\40\sw\op\CELL2B .HYD

Dairyland Power Coop.
Plan of Opertaion
Operational Conditions
Cell 2B

>>>> Input Parameters Used to Compute Hydrograph <<<<

Subarea Description	AREA (acres)	CN	Tc (hrs)	* Tt (hrs)	Precip. (in)	Runoff (in)	Ia/p input/used	
Area G	0.60	69.0	0.10	0.00	6.10	2.79	.15	.10

* Travel time from subarea outfall to composite watershed outfall point.
Total area = 0.60 acres or 0.00094 sq.mi
Peak discharge = 3 cfs

>>>> Computer Modifications of Input Parameters <<<<<

Subarea Description	Input Values Tc (hr)	Input Values * Tt (hr)	Rounded Values Tc (hr)	Rounded Values * Tt (hr)	Ia/p Interpolated (Yes/No)	Ia/p Messages
Area G	0.10	0.00	**	**	No	--

* Travel time from subarea outfall to composite watershed outfall point.
** Tc & Tt are available in the hydrograph tables.

TR-55 TABULAR HYDROGRAPH METHOD
Type II Distribution
(24 hr. Duration Storm)

Executed: 10-12-2000 20:12:03
Watershed file: --> p:\data\projects\3081\40\sw\op\CELL2B .WSD
Hydrograph file: --> p:\data\projects\3081\40\sw\op\CELL2B .HYD

Dairyland Power Coop.
Plan of Opertaion
Operational Conditions
Cell 2B

>>>> Summary of Subarea Times to Peak <<<<

Subarea	Peak Discharge at Composite Outfall (cfs)	Time to Peak at Composite Outfall (hrs)
Area G	3	12.1
Composite Watershed	3	12.1

TR-55 TABULAR HYDROGRAPH METHOD
Type II Distribution
(24 hr. Duration Storm)

Executed: 10-12-2000 20:12:08
Watershed file: --> p:\data\projects\3081\40\sw\op\CELL3 .WSD
Hydrograph file: --> p:\data\projects\3081\40\sw\op\CELL3 .HYD

Dairyland Power Coop.
Plan of Operation
Operational Conditions
Cell 3

>>>> Input Parameters Used to Compute Hydrograph <<<<

Subarea Description	AREA (acres)	CN	Tc (hrs)	* Tt (hrs)	Precip. (in)	Runoff (in)	Ia/p input/used
Area H	1.70	69.0	0.10	0.00	6.10	2.79	.15 .10

* Travel time from subarea outfall to composite watershed outfall point.
Total area = 1.70 acres or 0.00266 sq.mi
Peak discharge = 7 cfs

>>>> Computer Modifications of Input Parameters <<<<<

	Input Values		Rounded Values		Ia/p	
Subarea Description	Tc (hr)	* Tt (hr)	Tc (hr)	* Tt (hr)	Interpolated (Yes/No)	Ia/p Messages
Area H	0.10	0.00	**	**	No	--

* Travel time from subarea outfall to composite watershed outfall point.
** Tc & Tt are available in the hydrograph tables.

TR-55 TABULAR HYDROGRAPH METHOD
Type II Distribution
(24 hr. Duration Storm)

Executed: 10-12-2000 20:12:08
Watershed file: --> p:\data\projects\3081\40\sw\op\CELL3 .WSD
Hydrograph file: --> p:\data\projects\3081\40\sw\op\CELL3 .HYD

Dairyland Power Coop.
Plan of Operation
Operational Conditions
Cell 3

>>>> Summary of Subarea Times to Peak <<<<

Subarea	Peak Discharge at Composite Outfall (cfs)	Time to Peak at Composite Outfall (hrs)
Area H	7	12.1
Composite Watershed	7	12.1

TR-55 TABULAR HYDROGRAPH METHOD
Type II Distribution
(24 hr. Duration Storm)

Executed: 10-12-2000 20:21:09
Watershed file: --> p:\data\projects\3081\40\sw\op\CELL4A .WSD
Hydrograph file: --> p:\data\projects\3081\40\sw\op\CELL4A .HYD

Dairyland Power Coop.
Plan of Operation
Operational Conditions
Cell 4A

>>>> Input Parameters Used to Compute Hydrograph <<<<

Subarea Description	AREA (acres)	CN	Tc (hrs)	* Tt (hrs)	Precip. (in)	Runoff (in)	Ia/p input/used
Area I	3.60	69.0	0.20	0.00	6.10	2.79	.15 .10

* Travel time from subarea outfall to composite watershed outfall point.
Total area = 3.60 acres or 0.00562 sq.mi
Peak discharge = 13 cfs

>>>> Computer Modifications of Input Parameters <<<<<

Subarea Description	Input Values Tc (hr)	* Tt (hr)	Rounded Values Tc (hr)	* Tt (hr)	Ia/p Interpolated (Yes/No)	Ia/p Messages
Area I	0.15	0.00	0.20	0.00	No	--

* Travel time from subarea outfall to composite watershed outfall point.

TR-55 TABULAR HYDROGRAPH METHOD
Type II Distribution
(24 hr. Duration Storm)

Executed: 10-12-2000 20:21:09
Watershed file: --> p:\data\projects\3081\40\sw\op\CELL4A .WSD
Hydrograph file: --> p:\data\projects\3081\40\sw\op\CELL4A .HYD

Dairyland Power Coop.
Plan of Operation
Operational Conditions
Cell 4A

>>>> Summary of Subarea Times to Peak <<<<

Subarea	Peak Discharge at Composite Outfall (cfs)	Time to Peak at Composite Outfall (hrs)
Area I	13	12.2
Composite Watershed	13	12.2

Reference Information

Table 2-2a.—Runoff curve numbers for urban areas[1]

Cover description		Curve numbers for hydrologic soil group—			
Cover type and hydrologic condition	Average percent impervious area[2]	A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.)[3]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only)[4]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation)[5]		77	86	91	94
Idle lands (CN's are determined using cover types similar to those in table 2-2c).					

[1]Average runoff condition, and $I_a = 0.2S$.
[2]The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.
[3]CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.
[4]Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.
[5]Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4, based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.

Table 2-2b.—Runoff curve numbers for cultivated agricultural lands[1]

Cover description			Curve numbers for hydrologic soil group—			
Cover type	Treatment[2]	Hydrologic condition[3]	A	B	C	D
Fallow	Bare soil	—	77	86	91	94
	Crop residue cover (CR)	Poor	76	85	90	93
		Good	74	83	88	90
Row crops	Straight row (SR)	Poor	72	81	88	91
		Good	67	78	85	89
	SR + CR	Poor	71	80	87	90
		Good	64	75	82	85
	Contoured (C)	Poor	70	79	84	88
		Good	65	75	82	86
	C + CR	Poor	69	78	83	87
		Good	64	74	81	85
	Contoured & terraced (C&T)	Poor	66	74	80	82
		Good	62	71	78	81
	C&T + CR	Poor	65	73	79	81
		Good	61	70	77	80
Small grain	SR	Poor	65	76	84	88
		Good	63	75	83	87
	SR + CR	Poor	64	75	83	86
		Good	60	72	80	84
	C	Poor	63	74	82	85
		Good	61	73	81	84
	C + CR	Poor	62	73	81	84
		Good	60	72	80	83
	C&T	Poor	61	72	79	82
		Good	59	70	78	81
	C&T + CR	Poor	60	71	78	81
		Good	58	69	77	80
Close-seeded or broadcast legumes or rotation meadow	SR	Poor	66	77	85	89
		Good	58	72	81	85
	C	Poor	64	75	83	85
		Good	55	69	78	83
	C&T	Poor	63	73	80	83
		Good	51	67	76	80

[1]Average runoff condition, and $I_a = 0.2S$.
[2]*Crop residue cover* applies only if residue is on at least 5% of the surface throughout the year.
[3]Hydrologic condition is based on combination of factors that affect infiltration and runoff, including (a) density and canopy of vegetative areas, (b) amount of year-round cover, (c) amount of grass or close-seeded legumes in rotations, (d) percent of residue cover on the land surface (good ≥ 20%), and (e) degree of surface roughness.
Poor: Factors impair infiltration and tend to increase runoff.
Good: Factors encourage average and better than average infiltration and tend to decrease runoff.

Table 2-2c.—Runoff curve numbers for other agricultural lands[1]

Cover description		Curve numbers for hydrologic soil group—			
Cover type	Hydrologic condition	A	B	C	D
Pasture, grassland, or range—continuous forage for grazing.[2]	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Meadow—continuous grass, protected from grazing and generally mowed for hay.	—	30	58	71	78
Brush—brush-weed-grass mixture with brush the major element.[3]	Poor	48	67	77	83
	Fair	35	56	70	77
	Good	[4]30	48	65	73
Woods—grass combination (orchard or tree farm).[5]	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods.[6]	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	[4]30	55	70	77
Farmsteads—buildings, lanes, driveways, and surrounding lots.	—	59	74	82	86

[1]Average runoff condition, and $I_a = 0.2S$.

[2]*Poor:* <50% ground cover or heavily grazed with no mulch.
Fair: 50 to 75% ground cover and not heavily grazed.
Good: >75% ground cover and lightly or only occasionally grazed.

[3]*Poor:* <50% ground cover.
Fair: 50 to 75% ground cover.
Good: >75% ground cover.

[4]Actual curve number is less than 30; use CN = 30 for runoff computations.

[5]CN's shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CN's for woods and pasture.

[6]*Poor:* Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.
Fair: Woods are grazed but not burned, and some forest litter covers the soil.
Good: Woods are protected from grazing, and litter and brush adequately cover the soil.

Sheet flow

Sheet flow is flow over plane surfaces. It usually occurs in the headwater of streams. With sheet flow, the friction value (Manning's n) is an effective roughness coefficient that includes the effect of raindrop impact; drag over the plane surface; obstacles such as litter, crop ridges, and rocks; and erosion and transportation of sediment. These n values are for very shallow flow depths of about 0.1 foot or so. Table 3-1 gives Manning's n values for sheet flow for various surface conditions.

For sheet flow of less than 300 feet, use Manning's kinematic solution (Overton and Meadows 1976) to compute T_t:

$$T_t = \frac{0.007\ (nL)^{0.8}}{(P_2)^{0.5}\ s^{0.4}} \qquad \text{[Eq. 3-3]}$$

Table 3-1.—Roughness coefficients (Manning's n) for sheet flow

Surface description	n[1]
Smooth surfaces (concrete, asphalt, gravel, or bare soil)	0.011
Fallow (no residue)	0.05
Cultivated soils:	
Residue cover ≤20%	0.06
Residue cover >20%	0.17
Grass:	
Short grass prairie	0.15
Dense grasses[2]	0.24
Bermudagrass	0.41
Range (natural)	0.13
Woods:[3]	
Light underbrush	0.40
Dense underbrush	0.80

[1]The n values are a composite of information compiled by Engman (1986).
[2]Includes species such as weeping lovegrass, bluegrass, buffalo grass, blue grama grass, and native grass mixtures.
[3]When selecting n, consider cover to a height of about 0.1 ft. This is the only part of the plant cover that will obstruct sheet flow.

where

- T_t = travel time (hr),
- n = Manning's roughness coefficient (table 3-1),
- L = flow length (ft),
- P_2 = 2-year, 24-hour rainfall (in), and
- s = slope of hydraulic grade line (land slope, ft/ft).

This simplified form of the Manning's kinematic solution is based on the following: (1) shallow steady uniform flow, (2) constant intensity of rainfall excess (that part of a rain available for runoff), (3) rainfall duration of 24 hours, and (4) minor effect of infiltration on travel time. Rainfall depth can be obtained from appendix B.

Shallow concentrated flow

After a maximum of 300 feet, sheet flow usually becomes shallow concentrated flow. The average velocity for this flow can be determined from figure 3-1, in which average velocity is a function of watercourse slope and type of channel. For slopes less than 0.005 ft/ft, use equations given in appendix F for figure 3-1. Tillage can affect the direction of shallow concentrated flow. Flow may not always be directly down the watershed slope if tillage runs across the slope.

After determining average velocity in figure 3-1, use equation 3-1 to estimate travel time for the shallow concentrated flow segment.

Open channels

Open channels are assumed to begin where surveyed cross section information has been obtained, where channels are visible on aerial photographs, or where blue lines (indicating streams) appear on United States Geological Survey (USGS) quadrangle sheets. Manning's equation or water surface profile information can be used to estimate average flow velocity. Average flow velocity is usually determined for bank-full elevation.

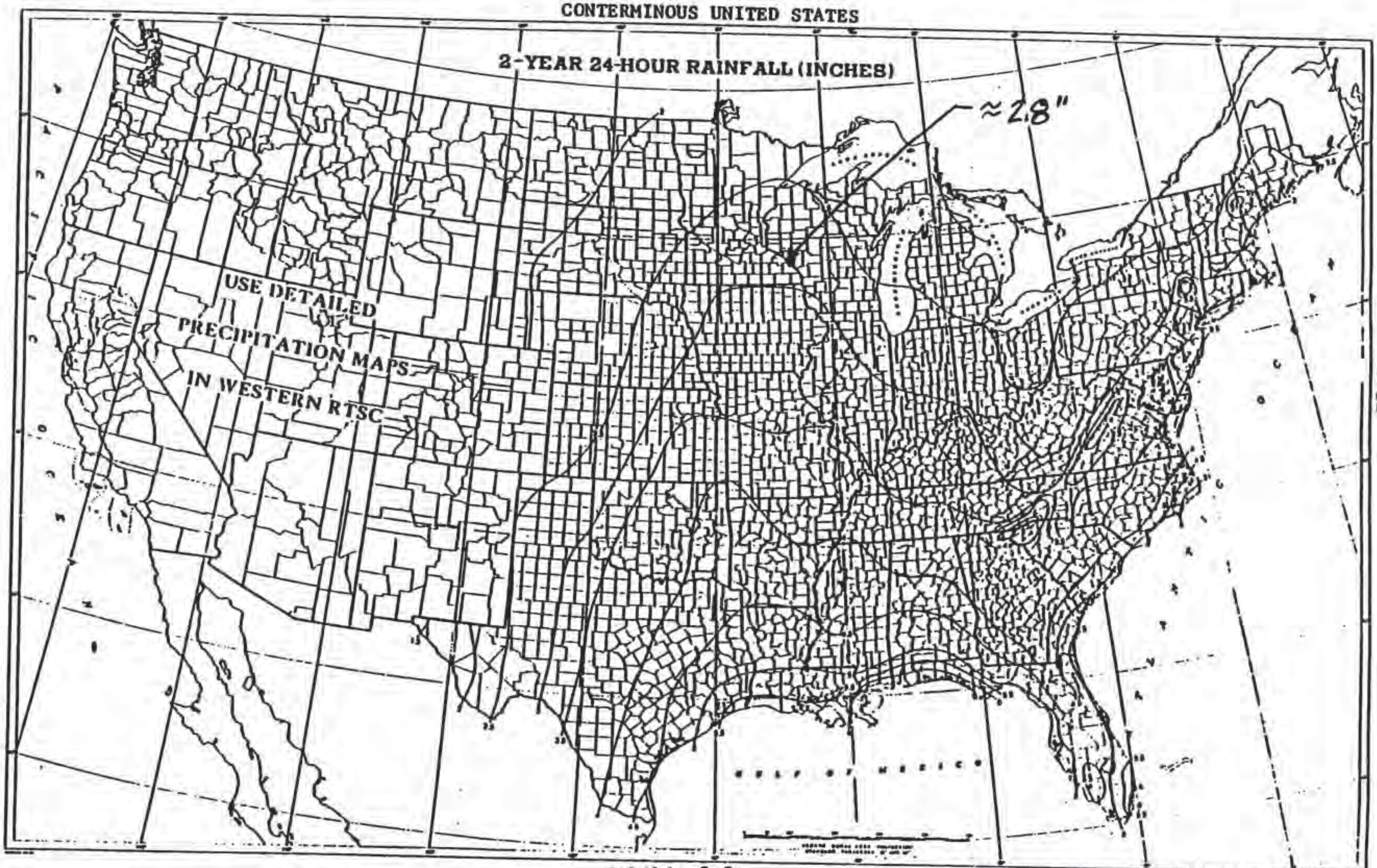
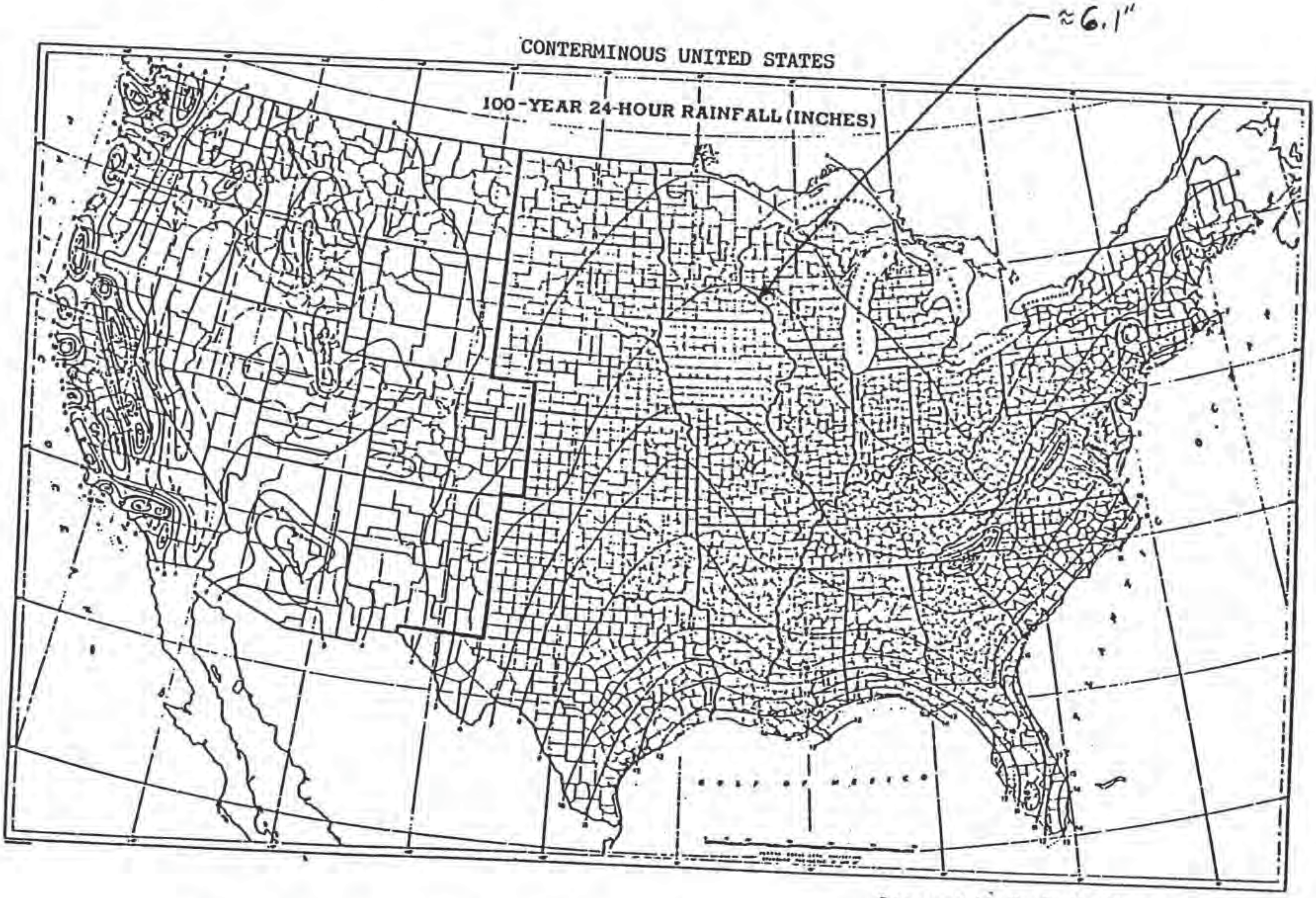


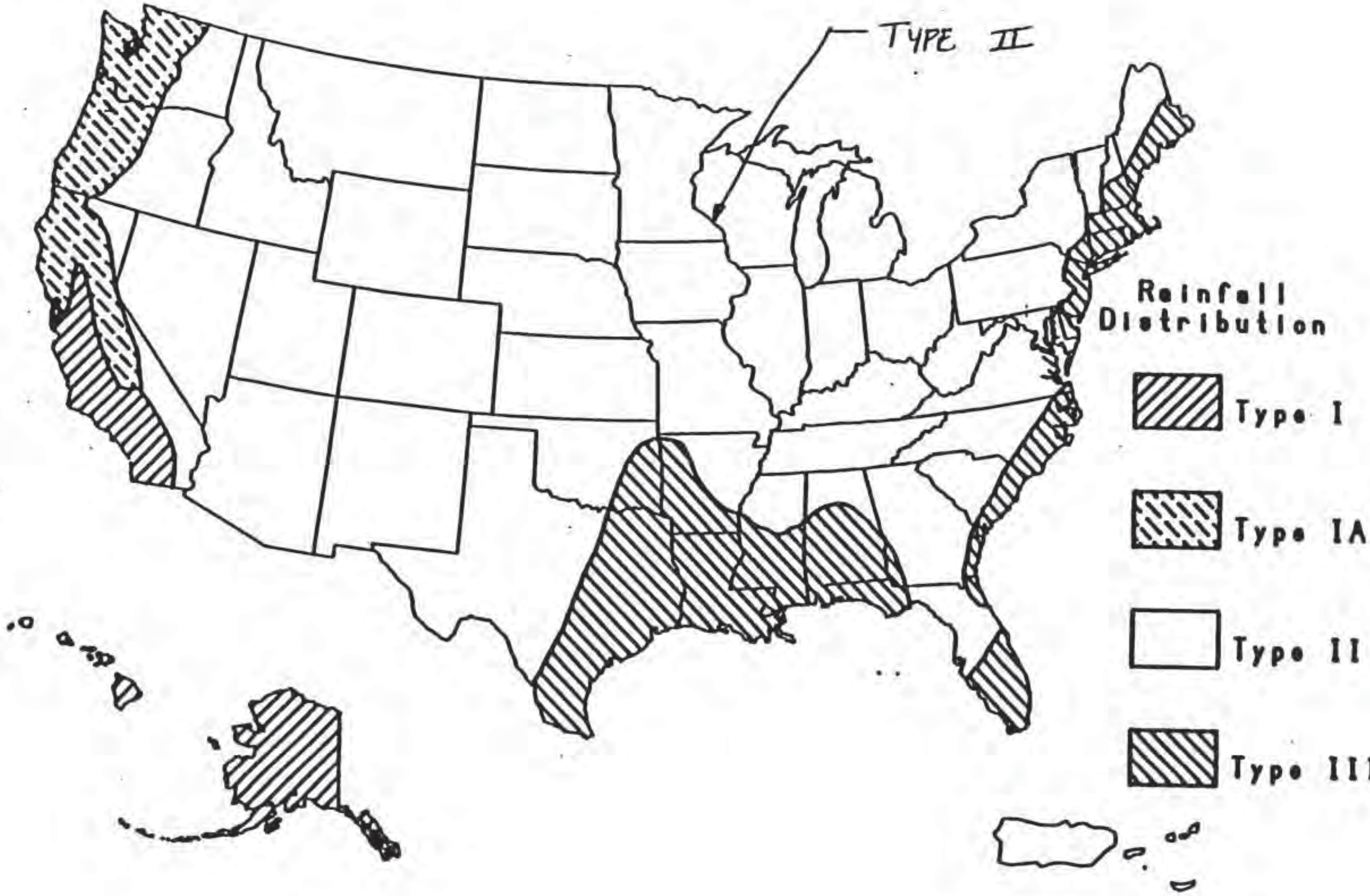
Exhibit 2-3
Sheet 1 of 5

Prepared by U. S. Weather Bureau



Prepared by U. S. Weather Bureau

FROM: Urban Hydrology for Small Watersheds. [n.p.]: U.S. Department of Agriculture. Soil Conservation Service Engineering Division, (Technical Release No. 55). 1975, as revised 1981.



—Approximate geographic boundaries for SCS rainfall distributions.

Diversion Berm, Perimeter Ditch, and Spillway Design Calculations

Purpose/Methodology/Assumptions/Results/References

744 Heartland Trail (53717-8923) P. O. Box 8923 (53708-8923) Madison, WI (608) 831-4444 FAX: (608) 831-3334 VOICE: (608) 831-1989

PROJECT/PROPOSAL NAME	PREPARED By:	Date:	CHECKED By:	Date:	PROJECT/PROPOSAL NO.
Dairyland Power Cooperative	BJK	9/00			3081.40

DIVERSION BERM, PERIMETER DITCH, AND SPILLWAY DESIGN CALCULATIONS

Purpose

To size the diversion berms, perimeter ditches and spillway at the proposed Dairyland Power Cooperative Landfill to adequately handle the surface water runoff from a 100-year, 24-hour storm.

Methodologies

Ditches, diversion berms and spillways were designed to channel the surface water runoff from the landfill drainage areas to the sedimentation basins, receiving ditches, or spillways. The direction of surface water runoff from the drainage areas surrounding the proposed landfill is towards the proposed landfill. Perimeter drainage ditches were therefore incorporated into the design to route the surface water runoff from outside the proposed landfill limits along the perimeter of the landfill area to the existing main channel at the south end of the landfill. These ditches are labeled as the NW, NE, West, SE, and SW ditches. The perimeter ditches sized in this subsection of the appendix, then, include ditches to collect runoff from the landfill drainage areas as well as ditches to collect surface water run-on from the drainage areas surrounding the landfill.

The adequacy of the diversion berms and ditches in handling the surface water runoff and run-on and in limiting the amount of erosion is based on the depth of flow and velocity, respectively, in the ditch. An in-house RMT spreadsheet incorporating Manning's equation was used to assist in the design of the diversion berms and ditches. This program allows the user to input the ditch geometry, the peak flow (as determined by the surface water runoff calculation), and the vegetative retardance factor (Chow, 1959). The program then begins an iterative process which adjusts the flow depth and Manning's coefficient until the trial velocity and the resultant velocity are within 0.002 feet per second (fps) of each other. The end result is the peak flow depth and peak velocity for the geometry and peak flow entered. Design software provided by Synthetic Industries was also used to select erosion control matting for ditches and grouted riprap for spillways.

Permanent ditches, diversion berms, and spillways will be constructed as early in the site development as practicable. Where temporary ditching is required, these temporary ditches have been designed to the same standards as the permanent ditches. Calculations for the sizing of the temporary ditches are also attached.

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	By:	Date:	By:	Date:	
Dairyland Power Cooperative	BJK	9/00			3081.40

It is noted that the storm water control structures have been designed using a 100-year, 24-hour storm event and a TR-55 Type II storm distribution. As noted in the surface water runoff calculations, the peak flows calculated using this method meet or exceed the peak flows calculated using a 25-year, time of concentration storm event (required by NR 504.09).

Assumptions

The following assumptions were used to design the diversion berms and perimeter ditches:

- Diversion berms, perimeter ditches and the spillway were designed to handle the runoff from the 100-year, 24-hour storm event.
- Diversion berm ditches were designed as V-notch ditches with a minimum 0.5 foot of freeboard for the 25-year, 24-hour storm. Diversion berm ditches were designed to convey the 100-year, 24-hour storm without overtopping.
- Perimeter ditches were designed as both V-notch and flat bottom (10-foot and 20-foot-wide) ditches with a minimum 0.5 foot of freeboard for the 25-year, 24-hour storm. Perimeter ditches were designed to convey the 100-year, 24-hour storm without overtopping.
- Grass-lined diversion berm and perimeter ditches were designed for a maximum velocity of 4 fps. Ditches with velocities exceeding 4 fps were designed to be lined with erosion mat or riprap, as appropriate.
- The spillway was designed as 20-foot-wide, flat-bottom spillway with a minimum 0.5 foot of freeboard.
- The peak flows in the diversion berms, perimeter ditches and the spillway were obtained from the hydrographs generated in the "Surface Water Runoff Calculations" subsection of this appendix.
- Manning's numbers were selected for both "low" retardance (Type "D") and "moderate" retardance (Type "C") as given by the U.S. Soil and Conservation Service. Type "D" is typical of spring conditions while Type "C" is typical of summer conditions. For ditches lined with erosion matting, default Manning numbers from the Synthetic Industries design software were utilized.

Results

The diversion berms and perimeter ditches were adequately sized to handle the surface water runoff from a 100-year, 24-hour storm event. The diversion berms at a 2 percent slope will be grass-lined. To limit erosion, permanent erosion matting will be placed in the diversion berms at a 6 percent slope, as well as in most of the perimeter ditching. Grouted riprap will be constructed in the spillways. The attached figure highlights the ditch sizing results.

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PROJECT/PROPOSAL NAME	PREPARED		CHECKED		PROJECT/PROPOSAL NO.
	By:	Date:	By:	Date:	
Dairyland Power Cooperative	BJK	9/00			3081.40

References

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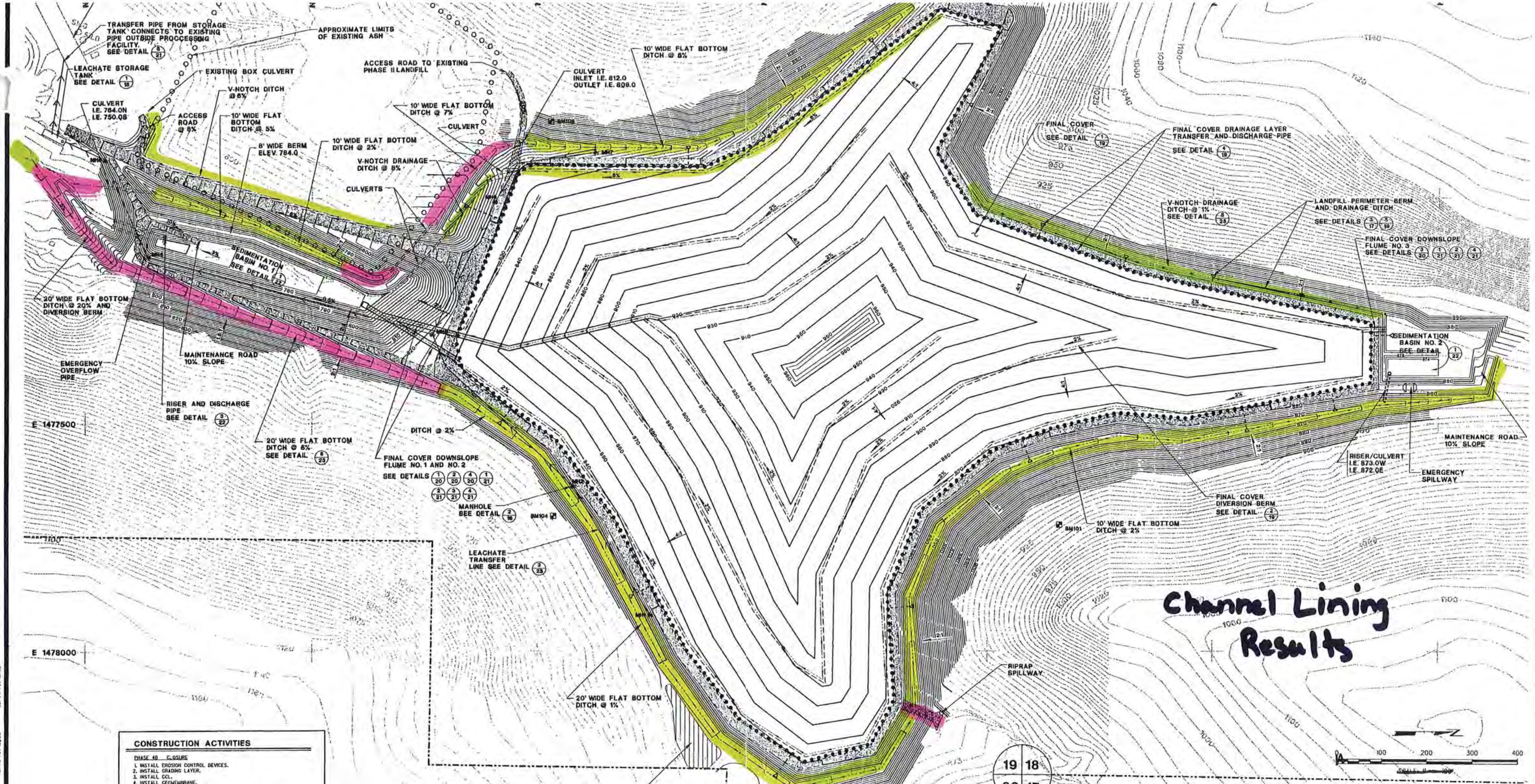

CONSTRUCTION ACTIVITIES

PHASE 4B CLOSURE

1. INSTALL EROSION CONTROL DEVICES.
2. INSTALL GRADING LAYER.
3. INSTALL GCL.
4. INSTALL GEOMEMBRANE.
5. INSTALL DOWNSLOPE FLUME.
6. INSTALL SELECT GRANULAR FILL, DRAINAGE PIPING, GEOTEXTILE, ROOTING ZONE LAYER, AND TOPSOIL.
7. INSTALL DIVERSION BERMS.
8. SEED, FERTILIZE, AND MULCH.

CONSTRUCTION QUANTITIES

PHASE 4B CLOSURE	VOLUME / AREA
TOPSOIL PLACED	
GRADING LAYER SOIL	9,800 CY
GENERAL FILL	8,800 CY
SELECT GRANULAR FILL	19,600 CY
GEOTEXTILE	19,600 CY
GCL	64,700 SY
GEOMEMBRANE	58,600 SY
SEED, FERTILIZER, MULCH	58,600 SY
DOWNSLOPE FLUME	12.1 ACRES
4-INCH DIA. HDPE CORRUGATED PIPE	1 EACH
W/ SMOOTH INTERIOR	3,150 LF
SELECT AGGREGATE FILL	470 CY

NOTE: THESE PLANS ARE ACCOMPANIED BY A REPORT OF THE SAME TITLE. THESE DOCUMENTS ARE INTERRELATED AND ARE INTENDED TO BE USED AND REVIEWED TOGETHER. THESE DOCUMENTS ARE INTENDED TO BE USED FOR REGULATORY PURPOSES ONLY.
(NOT FOR CONSTRUCTION)

NO.	BY	DATE	REVISION	APP'D.
3.				
2.				
1.				

PROJECT: DAIRYLAND POWER COOPERATIVE
PLAN OF OPERATION
BUFFALO COUNTY, WISCONSIN

SHEET TITLE: PROPOSED FINAL GRADES

DRAWN BY: STORMERL	SCALE: 1"=100'	PROJ. NO. 3081.40
CHECKED BY: DM		FILE NO. FGRADES.PLT
APPROVED BY: BJK	DATE PRINTED:	SHEET 12 OF 23
DATE: OCTOBER 2000		

RMT
744 Heartland Trail Madison, WI 53717-1934
P.O. Box 8923 Madison, WI 53708-8923 Phone: 608-831-4444

RMT COMPUTER AIDED DESIGN & DRAFTING

FIGURE K-10

Calculations – Post-closure Landfill Conditions

RMT, Inc.
Grass Channel Sizing Calculations

Site:	Dairyland Power Cooperative	Date:	10/1/98
Project #:	3081.33	User:	BLP
Channel:	Diversion Berm (2%) - worst case flow		
	Area 1F		VBH 10/98

==

I. Input Parameters.

A. Side slope, Z1 (hor/vert) =	4.000 ft/ft	✓
B. Side slope, Z2 (hor/vert) =	2.000 ft/ft	✓
C. Bottom width, B =	0.000 ft	✓
D. Design channel slope, S =	0.020 ft/ft	✓
E. Channel Peak Flow, Q =	25.000 cfs	✓
F. Enter - 1 - for Type "C" Veg. Retardence - 2 - for Type "D" Veg. Retardence	1	← Summer Conditions

II. Peak Flow Calculations.

A. Trial flow depth, D = (Bisection method until Va=Vb)	1.570 ft	0.4' freeboard
B. Channel flow area, Ac = (.5*Z1*D^2) + (B*D) + (.5*Z2*D^2)	7.390 sq ft	
C. Wetted Perimeter, Pw = (D*(Z1^2+1)^.5) + B + (D*(Z2^2+1)^.5)	9.981 ft	
D. Hydraulic radius, Rh = (Ac/Pw)	0.740 ft	
E. Velocity and hydraulic radius, VR = (Va * Rh)	2.505 sfps	
F. Channel flow Manning's coeff, nc = 0	0.051	
G. Trial velocity, Va = (Q/Ac)	3.383 fps	
H. Resultant velocity, Vb = (1.49/nc) * (Rh^.667) * (S^.5)	3.383 fps	< 4 fps

Invoke Solution Macro by typing - 'ctrl' D

h:\data\common\template\sc-51\grasscha.xls

RMT, Inc.
Grass Channel Sizing Calculations

Site:	Dairyland Power Cooperative	Date:	10/1/98
Project #:	3081.33	User:	BLP
Channel:	Diversion Berm (2%) - worst case flow		✓ BQK
	Area 1F		10/98

==

I. Input Parameters.

A. Side slope, Z1 (hor/vert) =	4.000	ft/ft ✓
B. Side slope, Z2 (hor/vert) =	2.000	ft/ft ✓
C. Bottom width, B =	0.000	ft ✓
D. Design channel slope, S =	0.020	ft/ft ✓
E. Channel Peak Flow, Q =	25.000	cfs ✓
F. Enter - 1 - for Type "C" Veg. Retardence - 2 - for Type "D" Veg. Retardence	2	← Spring Conditions ✓

II. Peak Flow Calculations.

A. Trial flow depth, D = (Bisection method until Va=Vb)	1.456	ft 0.5' freeboard
B. Channel flow area, Ac = (.5*Z1*D^2) + (B*D) + (.5*Z2*D^2)	6.357	sq ft
C. Wetted Perimeter, Pw = (D*(Z1^2+1)^.5) + B + (D*(Z2^2+1)^.5)	9.257	ft
D. Hydraulic radius, Rh = (Ac/Pw)	0.687	ft
E. Velocity and hydraulic radius, VR = (Va * Rh)	2.701	sfps
F. Channel flow Manning's coeff, nc = 0	0.042	
G. Trial velocity, Va = (Q/Ac)	3.933	fps
H. Resultant velocity, Vb = (1.49/nc) * (Rh^.667) * (S^.5)	3.933	fps < 4 fps ✓

Invoke Solution Macro by typing - 'ctrl' D

h:\data\common\template\sc-51\grasscha.xls

RMT, Inc.
Grass Channel Sizing Calculations

Site:	Dairyland Power Corp.	Date:	31-July-98
Project #:	3081.33	User:	SRC
Channel:	Ditch (8%)		
	Area 1G - Flow From Landfill Portion - 15 cfs		✓ 10/14 10/98

==

I. Input Parameters.

A. Side slope, Z1 (hor/vert) =	3.000	ft/ft ✓
B. Side slope, Z2 (hor/vert) =	2.000	ft/ft
C. Bottom width, B =	0.000	ft
D. Design channel slope, S =	0.080	ft/ft ✓
E. Channel Peak Flow, Q =	15.000	cfs ✓
F. Enter - 1 - for Type "C" Veg. Retardence - 2 - for Type "D" Veg. Retardence	1	← summer conditions

II. Peak Flow Calculations.

A. Trial flow depth, D = **(Bisection method until Va=Vb)**	**1.071**	**ft** 0.9' freeboard
B. Channel flow area, Ac = (.5*Z1*D^2) + (B*D) + (.5*Z2*D^2)	2.870	sq ft
C. Wetted Perimeter, Pw = (D*(Z1^2+1)^.5) + B + (D*(Z2^2+1)^.5)	5.784	ft
D. Hydraulic radius, Rh = (Ac/Pw)	0.496	ft
E. Velocity and hydraulic radius, VR = (Va * Rh)	2.593	sfps
F. Channel flow Manning's coeff, nc = 0	0.051	
G. Trial velocity, Va = (Q/Ac)	5.226	fps
H. Resultant velocity, Vb = **(1.49/nc) * (Rh^.667) * (S^.5)**	**5.226**	**fps** > 4fps

use permanent erosion

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RMT, Inc.
Grass Channel Sizing Calculations

Site:	Dairyland Power Corp.	Date:	31-July-98
Project #:	3081.33	User:	SRC
Channel:	Ditch (8%)		
	Area 1G - Flow From Landfill Portion - 15 cfs		VPJJR 10/98

==

I. Input Parameters.

A. Side slope, Z1 (hor/vert) =	3.000	ft/ft
B. Side slope, Z2 (hor/vert) =	2.000	ft/ft
C. Bottom width, B =	0.000	ft
D. Design channel slope, S =	0.080	ft/ft
E. Channel Peak Flow, Q =	15.000	cfs
F. Enter - 1 - for Type "C" Veg. Retardence - 2 - for Type "D" Veg. Retardence	2	← Spring conditions

II. Peak Flow Calculations.

A. Trial flow depth, D = (Bisection method until Va=Vb)	0.992	ft 1' freeboard
B. Channel flow area, Ac = (.5*Z1*D^2) + (B*D) + (.5*Z2*D^2)	2.459	sq ft
C. Wetted Perimeter, Pw = (D*(Z1^2+1)^.5) + B + (D*(Z2^2+1)^.5)	5.353	ft
D. Hydraulic radius, Rh = (Ac/Pw)	0.459	ft
E. Velocity and hydraulic radius, VR = (Va * Rh)	2.802	sfps
F. Channel flow Manning's coeff, nc = 0	0.041	
G. Trial velocity, Va = (Q/Ac)	6.101	fps
H. Resultant velocity, Vb = (1.49/nc) * (Rh^.667) * (S^.5)	6.101	fps > 4 fps

use permanent erosion matting

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/BLG 10/6/98

****

NORTH AMERICAN GREEN - ECMDS VER.IV - CHANNEL PROTECTION - ENGLISH

USER SPECIFIED CHANNEL LINING ANALYSIS

****

PROJECT NAME: Dairyland Power | PROJECT NO.: 3081.33
COMPUTED BY: BJK | DATE: 10-06-1998
FROM STATION/REACH: Area 1G - Fl | TO STATION/REACH:
DRAINAGE AREA: | DESIGN FREQUENCY: 100

Channel Bottom Width (ft)	Side Slope Lt. (Horz. to 1)	Side Slope Rt. (Horz. to 1)	Channel Slope (ft/ft)	
0.00	3.0	2.0	0.080	✓

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (ft/sec)	Area (ft^2)	Hydraulic Radius (ft)	Normal Depth (ft)	
15.0	2.0	5.34	2.81	0.49	1.06	ok

Lining Type	Growth Habit	Veg. Den	Manning Coefficient	Permissible Shear (lb/sf)	Calculated Shear (lb/sf)	Safety Factor	Remark	
P300			0.049	8.00	5.29	1.51	STABLE	✓

Staple E
Phase 3 (Mature Vegetation)

RMT, Inc.
Grass Channel Sizing Calculations

Site:	Dairyland Power Corp.	Date:	31-July-98
Project #:	3081.33	User:	SRC
Channel:	Ditch (1%)		
	Area 2B		VDL 10K8

==

I. Input Parameters.

A. Side slope, Z1 (hor/vert) =	3.000	ft/ft
B. Side slope, Z2 (hor/vert) =	2.000	ft/ft
C. Bottom width, B =	0.000	ft
D. Design channel slope, S =	0.010	ft/ft
E. Channel Peak Flow, Q =	73.000	cfs
F. Enter - 1 - for Type "C" Veg. Retardence - 2 - for Type "D" Veg. Retardence	1	← Summer conditions

II. Peak Flow Calculations.

A. Trial flow depth, D = (Bisection method until Va=Vb)	2.593	ft 0.4' freeboard
B. Channel flow area, Ac = (.5*Z1*D^2) + (B*D) + (.5*Z2*D^2)	16.814	sq ft
C. Wetted Perimeter, Pw = (D*(Z1^2+1)^.5) + B + (D*(Z2^2+1)^.5)	14.000	ft
D. Hydraulic radius, Rh = (Ac/Pw)	1.201	ft
E. Velocity and hydraulic radius, VR = (Va * Rh)	5.214	sfps
F. Channel flow Manning's coeff, nc = 0	0.039	
G. Trial velocity, Va = (Q/Ac)	4.342	fps
H. Resultant velocity, Vb = (1.49/nc) * (Rh^.667) * (S^.5)	4.341	fps > 4 fps

use permanent erosion matting

H:\data\common\src\Grassch7.xls

RMT, Inc.
Grass Channel Sizing Calculations

Site:	Dairyland Power Corp.	Date:	31-July-98
Project #:	3081.33	User:	SRC
Channel:	Ditch (1%)		
	Area 2B		√ 10/98

==

I. Input Parameters.

A. Side slope, Z1 (hor/vert) = 3.000 ft/ft

B. Side slope, Z2 (hor/vert) = 2.000 ft/ft

C. Bottom width, B = 0.000 ft

D. Design channel slope, S = 0.010 ft/ft

E. Channel Peak Flow, Q = 73.000 cfs

F. Enter - 1 - for Type "C" Veg. Retardence
- 2 - for Type "D" Veg. Retardence
2 ← Spring conditions

II. Peak Flow Calculations.

A. Trial flow depth, D = 2.512 ft 0.5' freeboard
(Bisection method until Va=Vb)

B. Channel flow area, Ac = 15.774 sq ft
(.5*Z1*D^2) + (B*D) + (.5*Z2*D^2)

C. Wetted Perimeter, Pw = 13.560 ft
(D*(Z1^2+1)^.5) + B + (D*(Z2^2+1)^.5)

D. Hydraulic radius, Rh = 1.163 ft
(Ac/Pw)

E. Velocity and hydraulic radius, VR = 5.383 sfps
(Va * Rh)

F. Channel flow Manning's coeff, nc = 0.036
0

G. Trial velocity, Va = 4.628 fps
(Q/Ac)

H. Resultant velocity, Vb = 4.627 fps > 4 fps
(1.49/nc) * (Rh^.667) * (S^.5)

use permanent erosion matting

√BJB
10/6/98

****

NORTH AMERICAN GREEN - ECMDS VER.IV - CHANNEL PROTECTION - ENGLISH
USER SPECIFIED CHANNEL LINING ANALYSIS

****

PROJECT NAME: Dairyland Paower Coop. PROJECT NO.: 3081.33
COMPUTED BY: BJK DATE: 10-06-1998
FROM STATION/REACH: Area 2B TO STATION/REACH:
DRAINAGE AREA: DESIGN FREQUENCY: 100

Channel Bottom Width (ft)	Side Slope Lt. (Horz. to 1)	Side Slope Rt. (Horz. to 1)	Channel Slope (ft/ft)	
0.00	3.0	2.0	0.010	✓

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (ft/sec)	Area (ft^2)	Hydraulic Radius (ft)	Normal Depth (ft)	
73.0	2.0	3.64	20.08	1.31	2.83	ok

Lining Type	Growth Habit	Veg. Den	Manning Coefficient	Permissible Shear (lb/sf)	Calculated Shear (lb/sf)	Safety Factor	Remark	
P300 Staple E Phase 3 (Mature Vegetation)			0.049	8.00	1.77	4.52	STABLE	✓

COMPUTATION SHEET

RMT INC.
744 Heartland Trail P.O. Box 8923 Madison, WI 53708-8923 (608) 831-4444 FAX: (608) 831-3334 VOICE: (608) 831-1989

PROJECT / PROPOSAL NAME	PREPARED		CHECKED		PROJECT / PROPOSAL NO.
DAIRYLAND POWER COOP.	By: BJK	Date: 5/9/97	By: [illegible]	Date: 6/17/97	3081.24

Rev BLP/BJK 10/98
Rev BJK 9/00

DITCH DESIGN CALCULATIONS - DESIGN INFORMATION (25 YR - 24 HR STORM)

SOUTH SPILLWAY

WIDTH = 20'
SLOPE = 20%
MIN DEPTH = 4'

PEAK FLOW - CONTRIBUTING DRAINAGE AREAS
3C + 4C + EAST + NORTHEAST + NORTH + BASIN 2 OUTFLOW ✓

18 + 11 + 445 + 68 + 194 + 10 = 746 cfs (25-YEAR)
↳ Round to 750 For Calc's

28 + 18 + 837 + 110 + 360 + 21 = 1,374 cfs (100-year) ✓

Note: All Flows @ 12.6 HRS (25 year)
and @ 12.5 HRS (100-YR Fallow)

SE DITCH (2%) & (5%)

WIDTH = 20'
SLOPE: 2%
MIN DEPTH = 5'

PEAK FLOW - CONTRIBUTING DRAINAGE AREAS
3C + 4C + EAST + NORHEAST + NORTH + BASIN 2 OUTFLOW ✓

see above = 750 cfs (25-YEAR)
= 1,374 (100-yr Fallow)

SE DITCH (1%)

SAME FLOWS AS ABOVE

WIDTH - 20'
SLOPE - 1%
MIN DEPTH - 6'

NE DITCH

WIDTH = 10'
SLOPE = 2%
MIN DEPTH = 10+'

PEAK FLOW - CONTRIBUTING DRAINAGE AREAS

4 C + NORTH + BASIN 2 OUT ✓

11 + 194 + 10 = 215 CFS (25-YEAR) ✓

18 + 360 + 21 = 399 cfs (100-YEAR FALLOW)

- ALL FLOWS AT 12.6 HRS (25 yr) and AT
12.5 HRS (100-YR FALLOW)

E Ditch

width = 10'
Slope = 2%
Min Depth: 10'+

Peak Flow - Contributing Drainage Areas
4C + Northeast + North + Basin 2 out
= 18 + 110 + 360 + 21 = 509 cfs (100 yr)

COMPUTATION SHEET

RMT

744 Heartland Trail P.O. Box 8923 Madison, WI 53708-8923 (608) 831-4444 FAX: (608) 831-3334 VOICE: (608) 831-1989

PROJECT / PROPOSAL NAME	PREPARED		CHECKED		PROJECT / PROPOSAL NO.
DAIRYLAND POWER COOP	By: BJK	Date:	By: [illegible]	Date: 6/17/97	3081.24

NW DITCH

WIDTH - 0' (V-NOTCH)
SLOPE - 1%
MIN DEPTH - 4 FT

PEAK FLOW - CONTRIBUTING DRAINAGE AREAS

2B - 48 CFS (25 YR) ✓

73 CFS (100 YR FALLOW)

WEST DITCH

WIDTH = 10'
SLOPE = 6%
MIN DEPTH = 6'

PEAK FLOW - CONTRIBUTING DRAINAGE AREAS

2C + WEST AREA ✓

10 + 111 = 121 CFS (25-YEAR) ✓

18 + 223 = 241 CFS (100 YEAR - FALLOW) ✓

- FLOWS @ 12.5 HRS (25-YEAR) AND AT 12.5 HRS (100-YEAR FALLOW)

SW DITCH

WIDTH = 10'
SLOPE = 2%, 5%, 7.1%
MIN DEPTH = 4' +

PEAK FLOW - CONTRIBUTING DRAINAGE AREAS

1C + 2C + WEST AREA ✓

46 + 10 + 111 = 167 CFS (25-YEAR) ✓

94 + 20 + 209 = 323 cfs (100-YEAR FALLOW) ✓

FLOWS @ 12.5 HRS (25-YEAR) AND @ 12.4 HRS (100-YEAR FALLOW)

MAIN CHANNEL

WIDTH ~ 20' MIN
SLOPE ~ 1.3%
MIN DEPTH ~ 6'

PEAK FLOW - CONTRIBUTING DRAINAGE AREAS

1C + 2C + 3C + 4C + EAST + NE + NORTH + WEST + BASIN 1 + BASIN 2 ✓

887 CFS + 8 + 10 = 905 CFS (25 YR)

1618 cfs + 21 + 21 = 1660 cfs (100-YR FALLOW) ✓

FLOWS @ 12.6 HRS (25-YEAR) AND @ 12.6 HRS (100-YEAR FALLOW)

RMT
744 Heartland Trail
Madison, WI 53717-1934
Tel. (608) 831-4444 • Fax (608) 831-3334

PROJECT / PROPOSAL NAME / LOCATION:		PROJECT / PROPOSAL NO.
SUBJECT: Dairyland Power Coop		3081.40
PREPARED BY: [initials]	DATE: 9/00	FINAL ☒
CHECKED BY:	DATE:	REVISION ☐

AREA 1G DITCH

WIDTH - V-NOTCH
SLOPE - 8%
MIN DEPTH = 4'

PEAK FLOW - CONTRIBUTING DRAINAGE AREA

= 15 CFS FLOW FROM LF.

PHASE 2 DITCH

WIDTH: V-NOTCH
SLOPE: 6%
MIN DEPTH: 2'

PEAK FLOW - CONTRIBUTING DRAINAGE AREA

~1.5 ACRES OF PHASE 2 COVER
DRAINAGE AREA 1C = 42 ACRES

$\frac{1.5}{42}(96 \text{ cfs}) = 3.4 \text{ cfs}$

USE 4 CFS

EC-Design 2000 Channel Analysis Report

Analysis By:

User Information:	Generated by EC-Design:
Bernie Krantz **RMT, Inc.** **744 Heartland Trail** **Madison, WI 53717**	**SYNTHETIC INDUSTRIES** *Geosynthetic Products Division* 4019 Industry Drive • Chattanooga, TN 37416 • USA (423) 899-0444 • (800) FIX-SOIL www.fixsoil.com

General Information:

Project Details:		Project Notes:
Project Name:	**DPC Plan of Operation**	
Description:	**Channel Lining**	
State\Country:	**WI**	
City:	**La Crosse**	
Units:	**English**	
Created:	**01/19/99 @ 10:43**	

Disclaimer:

The information presented herein is for general information only. While every effort has been made to ensure its accuracy, this information should not be used for a specific application without independent professional examination and verification of its suitability, applicability and accuracy.

EC-Design 2000 Channel Analysis Report

Channel Analysis Information:

Name:

Channel Analysis Name: **South Spillway**

Channel Geometry & Hydraulics:

Design By:

Designed By: **FLOW**

Channel Side Slopes:

Left Slope (xH:1V): **2.00**
Right Slope (xH:1V): **2.00**

Flow\Velocity:

Discharge (cfs): **1374.00**
Flow Duration (hrs): **1.00**
Average Velocity (ft/s): **0.00**

Channel Geometry:

Bed Slope (ft/ft): **0.20000**
Req. Freeboard (ft): **0.00**
Channel Length (ft): **270.00**
Bottom Width (ft): **20.00**
Channel Depth (ft): **4.00**

Channel Bend:

Channel Bend: **No**
Bend Radius (ft): **1.00**
Outside Bend:

Vegetation:

Vegetated: **Yes**
Vegetation Class: **C**

Soil Filled:

Soil Filled: **No**

Factor of Safety: **1.10**

Functional Longevity: **999**

Analysis Results:

	Side	Lining Type	Manning's "n"	Velocity (ft/s) Actual	Max. Allowed	Safety Factor	Shear Stress (lbs/sqft) Actual	Max. Allowed	Safety Factor	Flow Depth (ft)	Discharge (cfs)	OK?
Analysis #1	Left:	PYRAMAT	0.0280	24.0	23.3	1.0	20.2	9.4	0.5	2.0857	1374.0	No
	Bottom:	PYRAMAT	0.0280	27.3	23.3	0.9	26.0	9.4	0.4			
	Right:	PYRAMAT	0.0280	24.0	23.3	1.0	20.2	9.4	0.5			
Analysis #2	Left:	GABIONS	0.0270	28.6	17.0	0.6	17.3	35.0	2.0	1.7968	1374.0	No
	Bottom:	GABIONS	0.0270	32.6	17.0	0.5	22.4	35.0	1.6			
	Right:	GABIONS	0.0270	28.6	17.0	0.6	17.3	35.0	2.0			
Analysis #3	Left:	ROCK RIPRAP	0.0300	26.6	50.0	1.9	18.3	45.0	2.5	1.9093	1374.0	Yes
	Bottom:	ROCK RIPRAP	0.0300	30.4	50.0	1.6	23.8	45.0	1.9			
	Right:	ROCK RIPRAP	0.0300	26.6	50.0	1.9	18.3	45.0	2.5			

Channel Calculation Results:

	Flow Area (sq ft)	Hydraulic Radius (ft)	Composite 'n'	Left Wetted Perimeter(ft)	Right Wetted Perimeter(ft)	Total Wetted Perimeter(ft)	Average Veleocity (ft/s)	Average Discharge (cfs)	Froude
Analysis #1	50.4146	1.7190	0.0351	4.6638	4.6638	29.3276	27.2540	1374.0	3.06
Analysis #2	42.3935	1.5121	0.0270	4.0178	4.0178	28.0356	32.4106	1374.0	3.94
Analysis #3	45.4772	1.5935	0.0300	4.2694	4.2694	28.5387	30.2130	1374.0	3.55

EC-Design 2000 Channel Analysis Report

Channel Analysis Information:

Name:

Channel Analysis Name: **SE Ditch (2%)**

Channel Geometry & Hydraulics:

Design By:

Designed By: **FLOW**

Channel Side Slopes:

Left Slope (xH:1V): **2.00**
Right Slope (xH:1V): **2.00**

Flow\Velocity:

Discharge (cfs): **1374.00**
Flow Duration (hrs): **1.00**
Average Velocity (ft/s): **0.00**

Channel Geometry:

Bed Slope (ft/ft): **0.02000**
Req. Freeboard (ft): **0.00**
Channel Length (ft): **200.00**
Bottom Width (ft): **20.00**
Channel Depth (ft): **5.00**

Channel Bend:

Channel Bend: **No**
Bend Radius (ft): **0.00**
Outside Bend:

Vegetation:

Vegetated: **Yes**
Vegetation Class: **C**

Soil Filled:

Soil Filled: **No**

Factor of Safety: **1.10**

Functional Longevity: **999**

Analysis Results:

	Side	Lining Type	Manning's "n"	Velocity (ft/s) Actual	Velocity Max. Allowed	Velocity Safety Factor	Shear Stress (lbs/sqft) Actual	Shear Stress Max. Allowed	Shear Stress Safety Factor	Flow Depth (ft)	Discharge (cfs)	OK?
Analysis #1	Left:	LANDLOK TRM	0.0250	10.0	16.5	1.6	4.2	4.7	1.1	4.2678	1374.0	No
	Bottom:	LANDLOK TRM	0.0250	11.3	16.5	1.5	5.3	4.7	0.9			
	Right:	LANDLOK TRM 435	0.0250	10.0	16.5	1.6	4.2	4.7	1.1			
Analysis #2	Left:	LANDLOK TRM	0.0250	10.0	16.8	1.7	4.2	6.5	1.6	4.2678	1374.0	Yes
	Bottom:	LANDLOK TRM	0.0250	11.3	16.8	1.5	5.3	6.5	1.2			
	Right:	LANDLOK TRM 450	0.0250	10.0	16.8	1.7	4.2	6.5	1.6			
Analysis #3	Left:		0.0000	0.0	0.0	0.0	0.0	0.0	0.0	0.0000	0.0	No
	Bottom:		0.0000	0.0	0.0	0.0	0.0	0.0	0.0			
	Right:		0.0000	0.0	0.0	0.0	0.0	0.0	0.0			

Channel Calculation Results:

	Flow Area (sq ft)	Hydraulic Radius (ft)	Composite 'n'	Left Wetted Perimeter(ft)	Right Wetted Perimeter(ft)	Total Wetted Perimeter(ft)	Average Veleocity (ft/s)	Average Discharge (cfs)	Froude
Analysis #1	121.7841	3.1158	0.0397	9.5431	9.5431	39.0862	11.2823	1374.0	.890
Analysis #2	121.7841	3.1158	0.0397	9.5431	9.5431	39.0862	11.2823	1374.0	.890
Analysis #3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	.000

EC-Design 2000 Channel Analysis Report

Channel Analysis Information:

Name:

Channel Analysis Name: **SE Ditch (5%)**

Channel Geometry & Hydraulics:

Design By:

Designed By: **FLOW**

Channel Side Slopes:

Left Slope (xH:1V): **2.00**
Right Slope (xH:1V): **2.00**

Flow\Velocity:

Discharge (cfs): **1374.00**
Flow Duration (hrs): **1.00**
Average Velocity (ft/s): **0.00**

Channel Geometry:

Bed Slope (ft/ft): **0.05000**
Req. Freeboard (ft): **0.00**
Channel Length (ft): **750.00**
Bottom Width (ft): **20.00**
Channel Depth (ft): **5.00**

Channel Bend:

Channel Bend: **No**
Bend Radius (ft): **0.00**
Outside Bend:

Vegetation:

Vegetated: **Yes**
Vegetation Class: **C**

Soil Filled:

Soil Filled: **No**

Factor of Safety: **1.10**

Functional Longevity: **999**

Analysis Results:

	Side	Lining Type	Manning's "n"	Velocity (ft/s) Actual	Max. Allowed	Safety Factor	Shear Stress (lbs/sqft) Actual	Max. Allowed	Safety Factor	Flow Depth (ft)	Discharge (cfs)	OK?
Analysis #1	Left:	LANDLOK TRM	0.0260	14.3	19.1	1.3	7.8	7.5	1.0	3.2178	1374.0	No
	Bottom:	LANDLOK TRM	0.0260	16.2	19.1	1.2	10.0	7.5	0.8			
	Right:	LANDLOK TRM	0.0260	14.3	19.1	1.3	7.8	7.5	1.0			
Analysis #2	Left:	PYRAMAT	0.0280	14.3	23.3	1.6	7.8	9.4	1.2	3.2184	1374.0	No
	Bottom:	PYRAMAT	0.0280	16.2	23.3	1.4	10.0	9.4	0.9			
	Right:	PYRAMAT	0.0280	14.3	23.3	1.6	7.8	9.4	1.2			
Analysis #3	Left:	ROCK RIPRAP	0.0300	17.6	50.0	2.8	6.6	45.0	6.8	2.7285	1374.0	Yes
	Bottom:	ROCK RIPRAP	0.0300	19.9	50.0	2.5	8.5	45.0	5.3			
	Right:	ROCK RIPRAP	0.0300	17.6	50.0	2.8	6.6	45.0	6.8			

Channel Calculation Results:

	Flow Area (sq ft)	Hydraulic Radius (ft)	Composite 'n'	Left Wetted Perimeter(ft)	Right Wetted Perimeter(ft)	Total Wetted Perimeter(ft)	Average Veleocity (ft/s)	Average Discharge (cfs)	Froude
Analysis #1	85.0635	2.4735	0.0378	7.1952	7.1952	34.3903	16.1526	1374.0	1.47
Analysis #2	85.0856	2.4739	0.0378	7.1967	7.1967	34.3933	16.1484	1374.0	1.47
Analysis #3	69.4578	2.1569	0.0280	6.1010	6.1010	32.2020	19.7818	1374.0	1.96

EC-Design 2000 Channel Analysis Report

Channel Analysis Information:

Name:

Channel Analysis Name: **SE Ditch (1%)**

Channel Geometry & Hydraulics:

Design By:

Designed By: **FLOW**

Channel Side Slopes:

Left Slope (xH:1V): **2.00**
Right Slope (xH:1V): **2.00**

Flow\Velocity:

Discharge (cfs): **1374.00**
Flow Duration (hrs): **1.00**
Average Velocity (ft/s): **0.00**

Channel Geometry:

Bed Slope (ft/ft): **0.01000**
Req. Freeboard (ft): **0.00**
Channel Length (ft): **1000.0**
Bottom Width (ft): **20.00**
Channel Depth (ft): **6.00**

Channel Bend:

Channel Bend: **No**
Bend Radius (ft): **0.00**
Outside Bend:

Vegetation:

Vegetated: **Yes**
Vegetation Class: **C**

Soil Filled:

Soil Filled: **No**

Factor of Safety: **1.10**

Functional Longevity: **999**

Analysis Results:

	Side	Lining Type	Manning's "n"	Velocity (ft/s) Actual	Max. Allowed	Safety Factor	Shear Stress (lbs/sqft) Actual	Max. Allowed	Safety Factor	Flow Depth (ft)	Discharge (cfs)	OK?
Analysis #1	Left: Bottom: Right:	LANDLOK TRM LANDLOK TRM LANDLOK TRM 435	0.0250 0.0250 0.0250	7.7 8.6 7.7	16.5 16.5 16.5	2.2 1.9 2.2	2.6 3.3 2.6	4.7 4.7 4.7	1.8 1.4 1.8	5.2542	1374.0	Yes
Analysis #2	Left: Bottom: Right:		0.0000 0.0000 0.0000	0.0 0.0 0.0	0.0 0.0 0.0	0.0 0.0 0.0	0.0 0.0 0.0	0.0 0.0 0.0	0.0 0.0 0.0	0.0000	0.0	No
Analysis #3	Left: Bottom: Right:		0.0000 0.0000 0.0000	0.0 0.0 0.0	0.0 0.0 0.0	0.0 0.0 0.0	0.0 0.0 0.0	0.0 0.0 0.0	0.0 0.0 0.0	0.0000	0.0	No

Channel Calculation Results:

	Flow Area (sq ft)	Hydraulic Radius (ft)	Composite 'n'	Left Wetted Perimeter(ft)	Right Wetted Perimeter(ft)	Total Wetted Perimeter(ft)	Average Veleocity (ft/s)	Average Discharge (cfs)	Froude
Analysis #1	160.2976	3.6852	0.0413	11.7488	11.7488	43.4975	8.5716	1374.0	.615
Analysis #2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	.000
Analysis #3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	.000

EC-Design 2000 Channel Analysis Report

Channel Analysis Information:

Name:

Channel Analysis Name: **NE Ditch**

Channel Geometry & Hydraulics:

Design By:

Designed By: **FLOW**

Channel Side Slopes:

Left Slope (xH:1V): **2.00**
Right Slope (xH:1V): **2.00**

Flow\Velocity:

Discharge (cfs): **399.00**
Flow Duration (hrs): **1.00**
Average Velocity (ft/s): **0.00**

Channel Geometry:

Bed Slope (ft/ft): **0.02000**
Req. Freeboard (ft): **0.00**
Channel Length (ft): **1800.0**
Bottom Width (ft): **10.00**
Channel Depth (ft): **5.00**

Channel Bend:

Channel Bend: **No**
Bend Radius (ft): **0.00**
Outside Bend:

Vegetation:

Vegetated: **Yes**
Vegetation Class: **C**

Soil Filled:

Soil Filled: **No**

Factor of Safety: 1.10

Functional Longevity: 999

Analysis Results:

	Side	Lining Type	Manning's "n"	Velocity (ft/s) Actual	Velocity Max. Allowed	Velocity Safety Factor	Shear Stress (lbs/sqft) Actual	Shear Stress Max. Allowed	Shear Stress Safety Factor	Flow Depth (ft)	Discharge (cfs)	OK?
Analysis #1	Left:	LANDLOK TRM	0.0250	7.1	16.5	2.3	3.1	4.7	1.5	3.1235	399.0	Yes
	Bottom:	LANDLOK TRM	0.0250	7.9	16.5	2.1	3.9	4.7	1.2			
	Right:	LANDLOK TRM 435	0.0250	7.1	16.5	2.3	3.1	4.7	1.5			
Analysis #2	Left:		0.0000	0.0	0.0	0.0	0.0	0.0	0.0	0.0000	0.0	No
	Bottom:		0.0000	0.0	0.0	0.0	0.0	0.0	0.0			
	Right:		0.0000	0.0	0.0	0.0	0.0	0.0	0.0			
Analysis #3	Left:		0.0000	0.0	0.0	0.0	0.0	0.0	0.0	0.0000	0.0	No
	Bottom:		0.0000	0.0	0.0	0.0	0.0	0.0	0.0			
	Right:		0.0000	0.0	0.0	0.0	0.0	0.0	0.0			

Channel Calculation Results:

	Flow Area (sq ft)	Hydraulic Radius (ft)	Composite 'n'	Left Wetted Perimeter(ft)	Right Wetted Perimeter(ft)	Total Wetted Perimeter(ft)	Average Velocity (ft/s)	Average Discharge (cfs)	Froude
Analysis #1	50.7483	2.1173	0.0440	6.9844	6.9844	23.9689	7.8623	399.0	.735
Analysis #2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	.000
Analysis #3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	.000

Channel Analysis Information:

Name:

Channel Analysis Name: **East Ditch**

Channel Geometry & Hydraulics:

Design By:

Designed By: **FLOW**

Channel Side Slopes:

Left Slope (xH:1V): **2.00**
Right Slope (xH:1V): **2.00**

Flow\Velocity:

Discharge (cfs): **509.00**
Flow Duration (hrs): **1.00**
Average Velocity (ft/s): **0.00**

Channel Geometry:

Bed Slope (ft/ft): **0.02000**
Req. Freeboard (ft): **0.00**
Channel Length (ft): **350.00**
Bottom Width (ft): **10.00**
Channel Depth (ft): **5.00**

Channel Bend:

Channel Bend: **Yes**
Bend Radius (ft): **200.00**
Outside Bend: **L**

Vegetation:

Vegetated: **Yes**
Vegetation Class: **C**

Soil Filled:

Soil Filled: **No**

Factor of Safety: **1.10**

Functional Longevity: **999**

Analysis Results:

	Side	Lining Type	Manning's "n"	Velocity (ft/s) Actual	Max. Allowed	Safety Factor	Shear Stress (lbs/sqft) Actual	Max. Allowed	Safety Factor	Flow Depth (ft)	Discharge (cfs)	OK?
Analysis #1	Left:	LANDLOK TRM	0.0250	7.8	16.5	2.1	3.6	4.7	1.3	3.4942	509.0	No
	Bottom:	LANDLOK TRM	0.0250	8.6	16.5	1.9	4.4	4.7	1.1			
	Right:	LANDLOK TRM	0.0250	7.8	16.5	2.1	3.6	4.7	1.3			
Analysis #2	Left:	LANDLOK TRM	0.0250	7.8	16.8	2.2	3.6	6.5	1.8	3.4942	509.0	Yes
	Bottom:	LANDLOK TRM	0.0250	8.6	16.8	1.9	4.4	6.5	1.5			
	Right:	LANDLOK TRM 450	0.0250	7.8	16.8	2.2	3.6	6.5	1.8			
Analysis #3	Left:		0.0000	0.0	0.0	0.0	0.0	0.0	0.0	0.0000	0.0	No
	Bottom:		0.0000	0.0	0.0	0.0	0.0	0.0	0.0			
	Right:		0.0000	0.0	0.0	0.0	0.0	0.0	0.0			

Channel Calculation Results:

	Flow Area (sq ft)	Hydraulic Radius (ft)	Composite 'n'	Left Wetted Perimeter(ft)	Right Wetted Perimeter(ft)	Total Wetted Perimeter(ft)	Average Velocity (ft/s)	Average Discharge (cfs)	Froude
Analysis #1	59.3615	2.3164	0.0429	7.8133	7.8133	25.6267	8.5746	509.0	.760
Analysis #2	59.3615	2.3164	0.0429	7.8133	7.8133	25.6267	8.5746	509.0	.760
Analysis #3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	.000

EC-Design 2000 Channel Analysis Report

Channel Analysis Information:

Name:

Channel Analysis Name: **NW Ditch**

Channel Geometry & Hydraulics:

Design By:

Designed By: **FLOW**

Channel Side Slopes:

Left Slope (xH:1V): **2.00**
Right Slope (xH:1V): **2.00**

Flow\Velocity:

Discharge (cfs): **73.00**
Flow Duration (hrs): **1.00**
Average Velocity (ft/s): **0.00**

Channel Geometry:

Bed Slope (ft/ft): **0.01000**
Req. Freeboard (ft): **0.00**
Channel Length (ft): **1000.0**
Bottom Width (ft): **0.01**
Channel Depth (ft): **4.00**

Channel Bend:

Channel Bend: **No**
Bend Radius (ft): **0.00**
Outside Bend:

Vegetation:

Vegetated: **Yes**
Vegetation Class: **C**

Soil Filled:

Soil Filled: **No**

Factor of Safety: **1.10**

Functional Longevity: **999**

Analysis Results:

	Side	Lining Type	Manning's "n"	Velocity (ft/s) Actual	Max. Allowed	Safety Factor	Shear Stress (lbs/sqft) Actual	Max. Allowed	Safety Factor	Flow Depth (ft)	Discharge (cfs)	OK?
Analysis #1	Left:	LANDLOK TRM	0.0250	3.4	16.5	4.8	2.1	4.7	2.3	3.2826	73.0	Yes
	Bottom:	LANDLOK TRM	0.0250	3.4	16.5	4.8	2.0	4.7	2.3			
	Right:	LANDLOK TRM	0.0250	3.4	16.5	4.8	2.1	4.7	2.3			
Analysis #2	Left:		0.0000	0.0	0.0	0.0	0.0	0.0	0.0	0.0000	0.0	No
	Bottom:		0.0000	0.0	0.0	0.0	0.0	0.0	0.0			
	Right:		0.0000	0.0	0.0	0.0	0.0	0.0	0.0			
Analysis #3	Left:		0.0000	0.0	0.0	0.0	0.0	0.0	0.0	0.0000	0.0	No
	Bottom:		0.0000	0.0	0.0	0.0	0.0	0.0	0.0			
	Right:		0.0000	0.0	0.0	0.0	0.0	0.0	0.0			

Channel Calculation Results:

	Flow Area (sq ft)	Hydraulic Radius (ft)	Composite 'n'	Left Wetted Perimeter(ft)	Right Wetted Perimeter(ft)	Total Wetted Perimeter(ft)	Average Velocity (ft/s)	Average Discharge (cfs)	Froude
Analysis #1	21.5836	1.4693	0.0564	7.3401	7.3401	14.6902	3.3822	73.0	.331
Analysis #2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	.000
Analysis #3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	.000

EC-Design 2000 Channel Analysis Report

Channel Analysis Information:

Name:

Channel Analysis Name: **West Ditch**

Channel Geometry & Hydraulics:

Design By:

Designed By: **FLOW**

Channel Side Slopes:

Left Slope (xH:1V): **2.00**
Right Slope (xH:1V): **2.00**

Flow\Velocity:

Discharge (cfs): **241.00**
Flow Duration (hrs): **1.00**
Average Velocity (ft/s): **0.00**

Channel Geometry:

Bed Slope (ft/ft): **0.06000**
Req. Freeboard (ft): **0.00**
Channel Length (ft): **1020.0**
Bottom Width (ft): **10.00**
Channel Depth (ft): **6.00**

Channel Bend:

Channel Bend: **No**
Bend Radius (ft): **0.00**
Outside Bend:

Vegetation:

Vegetated: **Yes**
Vegetation Class: **C**

Soil Filled:

Soil Filled: **No**

Factor of Safety: **1.10**

Functional Longevity: **999**

Analysis Results:

	Side	Lining Type	Manning's "n"	Velocity (ft/s) Actual	Max. Allowed	Safety Factor	Shear Stress (lbs/sqft) Actual	Max. Allowed	Safety Factor	Flow Depth (ft)	Discharge (cfs)	OK?
Analysis #1	Left:	PYRAMAT	0.0280	8.9	23.3	2.6	5.1	9.4	1.8	1.7595	241.0	Yes
	Bottom:	PYRAMAT	0.0280	10.1	23.3	2.3	6.6	9.4	1.4			
	Right:	PYRAMAT	0.0280	8.9	23.3	2.6	5.1	9.4	1.8			
Analysis #2	Left:	LANDLOK TRM	0.0260	8.9	19.1	2.1	5.1	7.5	1.5	1.7684	241.0	No
	Bottom:	LANDLOK TRM	0.0260	10.1	19.1	1.9	6.6	7.5	1.1			
	Right:	LANDLOK TRM	0.0260	8.9	19.1	2.1	5.1	7.5	1.5			
Analysis #3	Left:		0.0000	0.0	0.0	0.0	0.0	0.0	0.0	0.0000	0.0	No
	Bottom:		0.0000	0.0	0.0	0.0	0.0	0.0	0.0			
	Right:		0.0000	0.0	0.0	0.0	0.0	0.0	0.0			

Channel Calculation Results:

	Flow Area (sq ft)	Hydraulic Radius (ft)	Composite 'n'	Left Wetted Perimeter(ft)	Right Wetted Perimeter(ft)	Total Wetted Perimeter(ft)	Average Veleocity (ft/s)	Average Discharge (cfs)	Froude
Analysis #1	23.7860	1.3312	0.0439	3.9343	3.9343	17.8685	10.1320	241.0	1.24
Analysis #2	23.9376	1.3367	0.0438	3.9541	3.9541	17.9083	10.0679	241.0	1.23
Analysis #3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	.000

EC-Design 2000 Channel Analysis Report

Channel Analysis Information:

Name:

Channel Analysis Name: **SW Ditch (7%)**

Channel Geometry & Hydraulics:

Design By:

Designed By: **FLOW**

Channel Side Slopes:

Left Slope (xH:1V): **2.00**
Right Slope (xH:1V): **2.00**

Flow\Velocity:

Discharge (cfs): **323.00**
Flow Duration (hrs): **1.00**
Average Velocity (ft/s): **0.00**

Channel Geometry:

Bed Slope (ft/ft): **0.07000**
Req. Freeboard (ft): **0.00**
Channel Length (ft): **225.00**
Bottom Width (ft): **10.00**
Channel Depth (ft): **4.00**

Channel Bend:

Channel Bend: **No**
Bend Radius (ft): **0.00**
Outside Bend:

Vegetation:

Vegetated: **Yes**
Vegetation Class: **C**

Soil Filled:

Soil Filled: **No**

Factor of Safety: 1.10

Functional Longevity: 999

Analysis Results:

	Side	Lining Type	Manning's "n"	Velocity (ft/s) Actual	Max. Allowed	Safety Factor	Shear Stress (lbs/sqft) Actual	Max. Allowed	Safety Factor	Flow Depth (ft)	Discharge (cfs)	OK?
Analysis #1	Left:	PYRAMAT	0.0280	10.6	23.3	2.2	6.6	9.4	1.4	1.9335	323.0	No
	Bottom:	PYRAMAT	0.0280	12.0	23.3	1.9	8.4	9.4	1.1			
	Right:	PYRAMAT	0.0280	10.6	23.3	2.2	6.6	9.4	1.4			
Analysis #2	Left:	ROCK RIPRAP	0.0300	13.4	50.0	3.7	5.5	45.0	8.2	1.6178	323.0	Yes
	Bottom:	ROCK RIPRAP	0.0300	15.2	50.0	3.3	7.1	45.0	6.4			
	Right:	ROCK RIPRAP	0.0300	13.4	50.0	3.7	5.5	45.0	8.2			
Analysis #3	Left:		0.0280	0.0	0.0	0.0	0.0	0.0	0.0	0.0000	0.0	No
	Bottom:		0.0000	0.0	0.0	0.0	0.0	0.0	0.0			
	Right:		0.0000	0.0	0.0	0.0	0.0	0.0	0.0			

Channel Calculation Results:

	Flow Area (sq ft)	Hydraulic Radius (ft)	Composite 'n'	Left Wetted Perimeter(ft)	Right Wetted Perimeter(ft)	Total Wetted Perimeter(ft)	Average Velocity (ft/s)	Average Discharge (cfs)	Froude
Analysis #1	26.8125	1.4379	0.0419	4.3235	4.3235	18.6470	12.0466	323.0	1.40
Analysis #2	21.4118	1.2424	0.0300	3.6174	3.6174	17.2348	15.0851	323.0	1.94
Analysis #3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	.000

EC-Design 2000 Channel Analysis Report

Channel Analysis Information:

Name:

Channel Analysis Name: **SW Ditch (2%)**

Channel Geometry & Hydraulics:

Design By:

Designed By: **FLOW**

Channel Side Slopes:

Left Slope (xH:1V): **2.00**
Right Slope (xH:1V): **2.00**

Flow\Velocity:

Discharge (cfs): **323.00**
Flow Duration (hrs): **1.00**
Average Velocity (ft/s): **0.00**

Channel Geometry:

Bed Slope (ft/ft): **0.02000**
Req. Freeboard (ft): **0.00**
Channel Length (ft): **300.00**
Bottom Width (ft): **10.00**
Channel Depth (ft): **4.00**

Channel Bend:

Channel Bend: **No**
Bend Radius (ft): **0.00**
Outside Bend:

Vegetation:

Vegetated: **Yes**
Vegetation Class: **C**

Soil Filled:

Soil Filled: **No**

Factor of Safety: **1.10**

Functional Longevity: **999**

Analysis Results:

	Side	Lining Type	Manning's "n"	Velocity (ft/s) Actual	Max. Allowed	Safety Factor	Shear Stress (lbs/sqft) Actual	Max. Allowed	Safety Factor	Flow Depth (ft)	Discharge (cfs)	OK?
Analysis #1	Left:	PYRAMAT	0.0280	6.5	23.3	3.6	2.8	9.4	3.3	2.8325	323.0	Yes
	Bottom:	PYRAMAT	0.0280	7.3	23.3	3.2	3.5	9.4	2.7			
	Right:	PYRAMAT	0.0280	6.5	23.3	3.6	2.8	9.4	3.3			
Analysis #2	Left:		0.0000	0.0	0.0	0.0	0.0	0.0	0.0	0.0000	0.0	No
	Bottom:		0.0000	0.0	0.0	0.0	0.0	0.0	0.0			
	Right:		0.0000	0.0	0.0	0.0	0.0	0.0	0.0			
Analysis #3	Left:		0.0000	0.0	0.0	0.0	0.0	0.0	0.0	0.0000	0.0	No
	Bottom:		0.0000	0.0	0.0	0.0	0.0	0.0	0.0			
	Right:		0.0000	0.0	0.0	0.0	0.0	0.0	0.0			

Channel Calculation Results:

	Flow Area (sq ft)	Hydraulic Radius (ft)	Composite 'n'	Left Wetted Perimeter(ft)	Right Wetted Perimeter(ft)	Total Wetted Perimeter(ft)	Average Veleocity (ft/s)	Average Discharge (cfs)	Froude
Analysis #1	44.3719	1.9575	0.0451	6.3337	6.3337	22.6675	7.2794	323.0	.709
Analysis #2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	.000
Analysis #3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	.000

EC-Design 2000 Channel Analysis Report

Channel Analysis Information:

Name:

Channel Analysis Name: **SW Ditch (5%)**

Channel Geometry & Hydraulics:

Design By:

Designed By: **FLOW**

Channel Side Slopes:

Left Slope (xH:1V): **2.00**
Right Slope (xH:1V): **2.00**

Flow\Velocity:

Discharge (cfs): **323.00**
Flow Duration (hrs): **1.00**
Average Velocity (ft/s): **0.00**

Channel Geometry:

Bed Slope (ft/ft): **0.05000**
Req. Freeboard (ft): **0.00**
Channel Length (ft): **240.00**
Bottom Width (ft): **10.00**
Channel Depth (ft): **4.00**

Channel Bend:

Channel Bend: **No**
Bend Radius (ft): **0.00**
Outside Bend:

Vegetation:

Vegetated: **Yes**
Vegetation Class: **C**

Soil Filled:

Soil Filled: **No**

Factor of Safety: **1.10**

Functional Longevity: **999**

Analysis Results:

	Side	Lining Type	Manning's "n"	Velocity (ft/s) Actual	Max. Allowed	Safety Factor	Shear Stress (lbs/sqft) Actual	Max. Allowed	Safety Factor	Flow Depth (ft)	Discharge (cfs)	OK?
Analysis #1	Left:	PYRAMAT	0.0280	9.3	23.3	2.5	5.2	9.4	1.8	2.1429	323.0	Yes
	Bottom:	PYRAMAT	0.0280	10.5	23.3	2.2	6.7	9.4	1.4			
	Right:	PYRAMAT	0.0280	9.3	23.3	2.5	5.2	9.4	1.8			
Analysis #2	Left:		0.0000	0.0	0.0	0.0	0.0	0.0	0.0	0.0000	0.0	No
	Bottom:		0.0000	0.0	0.0	0.0	0.0	0.0	0.0			
	Right:		0.0000	0.0	0.0	0.0	0.0	0.0	0.0			
Analysis #3	Left:		0.0000	0.0	0.0	0.0	0.0	0.0	0.0	0.0000	0.0	No
	Bottom:		0.0000	0.0	0.0	0.0	0.0	0.0	0.0			
	Right:		0.0000	0.0	0.0	0.0	0.0	0.0	0.0			

Channel Calculation Results:

	Flow Area (sq ft)	Hydraulic Radius (ft)	Composite 'n'	Left Wetted Perimeter(ft)	Right Wetted Perimeter(ft)	Total Wetted Perimeter(ft)	Average Velocity (ft/s)	Average Discharge (cfs)	Froude
Analysis #1	30.6135	1.5632	0.0427	4.7917	4.7917	19.5835	10.5509	323.0	1.17
Analysis #2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	.000
Analysis #3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	.000

EC-Design 2000 Channel Analysis Report

Channel Analysis Information:

Name:
Channel Analysis Name: **Main Channel**

Channel Geometry & Hydraulics:

Design By:

Designed By: **FLOW**

Channel Side Slopes:

Left Slope (xH:1V): **2.00**
Right Slope (xH:1V): **2.00**

Flow\Velocity:

Discharge (cfs): **1660.00**
Flow Duration (hrs): **1.00**
Average Velocity (ft/s): **0.00**

Channel Geometry:

Bed Slope (ft/ft): **0.01300**
Req. Freeboard (ft): **0.00**
Channel Length (ft): **3500.0**
Bottom Width (ft): **20.00**
Channel Depth (ft): **6.00**

Channel Bend:

Channel Bend: **No**
Bend Radius (ft): **0.00**
Outside Bend:

Vegetation:

Vegetated: **Yes**
Vegetation Class: **C**

Soil Filled:

Soil Filled: **No**

Factor of Safety: **1.10**

Functional Longevity: **999**

Analysis Results:

	Side	Lining Type	Manning's "n"	Velocity (ft/s) Actual	Max. Allowed	Safety Factor	Shear Stress (lbs/sqft) Actual	Max. Allowed	Safety Factor	Flow Depth (ft)	Discharge (cfs)	OK?
Analysis #1	Left:	LANDLOK TRM	0.0250	9.1	16.5	1.8	3.4	4.7	1.4	5.3260	1660.0	No
	Bottom:	LANDLOK TRM	0.0250	10.2	16.5	1.6	4.3	4.7	1.1			
	Right:	LANDLOK TRM	0.0250	9.1	16.5	1.8	3.4	4.7	1.4			
Analysis #2	Left:	LANDLOK TRM	0.0250	9.1	16.8	1.8	3.4	6.5	1.9	5.3260	1660.0	Yes
	Bottom:	LANDLOK TRM	0.0250	10.2	16.8	1.6	4.3	6.5	1.5			
	Right:	LANDLOK TRM	0.0250	9.1	16.8	1.8	3.4	6.5	1.9			
Analysis #3	Left:		0.0000	0.0	0.0	0.0	0.0	0.0	0.0	0.0000	0.0	No
	Bottom:		0.0000	0.0	0.0	0.0	0.0	0.0	0.0			
	Right:		0.0000	0.0	0.0	0.0	0.0	0.0	0.0			

Channel Calculation Results:

	Flow Area (sq ft)	Hydraulic Radius (ft)	Composite 'n'	Left Wetted Perimeter(ft)	Right Wetted Perimeter(ft)	Total Wetted Perimeter(ft)	Average Velocity (ft/s)	Average Discharge (cfs)	Froude
Analysis #1	163.2521	3.7256	0.0400	11.9093	11.9093	43.8185	10.1683	1660.0	.723
Analysis #2	163.2521	3.7256	0.0400	11.9093	11.9093	43.8185	10.1683	1660.0	.723
Analysis #3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	.000

EC-Design 2000 Channel Analysis Report

Channel Analysis Information:

Name:

Channel Analysis Name: **Area 1G Ditch**

Channel Geometry & Hydraulics:

Design By:

Designed By: **FLOW**

Channel Side Slopes:

Left Slope (xH:1V): **2.00**
Right Slope (xH:1V): **2.00**

Flow\Velocity:

Discharge (cfs): **15.00**
Flow Duration (hrs): **1.00**
Average Velocity (ft/s): **0.00**

Channel Geometry:

Bed Slope (ft/ft): **0.08000**
Req. Freeboard (ft): **0.00**
Channel Length (ft): **140.00**
Bottom Width (ft): **0.10**
Channel Depth (ft): **4.00**

Channel Bend:

Channel Bend: **No**
Bend Radius (ft): **0.00**
Outside Bend:

Vegetation:

Vegetated: **Yes**
Vegetation Class: **C**

Soil Filled:

Soil Filled: **No**

Factor of Safety: **1.10**

Functional Longevity: **999**

Analysis Results:

	Side	Lining Type	Manning's "n"	Velocity (ft/s) Actual	Max. Allowed	Safety Factor	Shear Stress (lbs/sqft) Actual	Max. Allowed	Safety Factor	Flow Depth (ft)	Discharge (cfs)	OK?
Analysis #1	Left:	LANDLOK TRM	0.0250	4.7	16.5	3.5	6.3	4.7	0.8	1.2450	15.0	No
	Bottom:	LANDLOK TRM	0.0250	4.6	16.5	3.5	6.2	4.7	0.8			
	Right:	LANDLOK TRM	0.0250	4.7	16.5	3.5	6.3	4.7	0.8			
Analysis #2	Left:	LANDLOK TRM	0.0250	4.7	16.8	3.6	6.3	6.5	1.0	1.2450	15.0	No
	Bottom:	LANDLOK TRM	0.0250	4.6	16.8	3.6	6.2	6.5	1.1			
	Right:	LANDLOK TRM	0.0250	4.7	16.8	3.6	6.3	6.5	1.0			
Analysis #3	Left:	PYRAMAT	0.0280	4.7	23.3	5.0	6.3	9.4	1.5	1.2502	15.0	Yes
	Bottom:	PYRAMAT	0.0280	4.7	23.3	5.0	6.2	9.4	1.5			
	Right:	PYRAMAT	0.0280	4.7	23.3	5.0	6.3	9.4	1.5			

Channel Calculation Results:

	Flow Area (sq ft)	Hydraulic Radius (ft)	Composite 'n'	Left Wetted Perimeter(ft)	Right Wetted Perimeter(ft)	Total Wetted Perimeter(ft)	Average Velocity (ft/s)	Average Discharge (cfs)	Froude
Analysis #1	3.2247	0.5689	0.0624	2.7840	2.7840	5.6680	4.6516	15.0	.737
Analysis #2	3.2247	0.5689	0.0624	2.7840	2.7840	5.6680	4.6516	15.0	.737
Analysis #3	3.2511	0.5713	0.0622	2.7956	2.7956	5.6912	4.6138	15.0	.741

EC-Design 2000 Channel Analysis Report

Channel Analysis Information:

Name:

Channel Analysis Name: **Phase 2 Ditch**

Channel Geometry & Hydraulics:

Design By:

Designed By: **FLOW**

Channel Side Slopes:

Left Slope (xH:1V): **4.00**
Right Slope (xH:1V): **2.00**

Flow\Velocity:

Discharge (cfs): **4.00**
Flow Duration (hrs): **1.00**
Average Velocity (ft/s): **0.00**

Channel Geometry:

Bed Slope (ft/ft): **0.06000**
Req. Freeboard (ft): **0.00**
Channel Length (ft): **560.00**
Bottom Width (ft): **0.01**
Channel Depth (ft): **2.00**

Channel Bend:

Channel Bend: **No**
Bend Radius (ft): **0.00**
Outside Bend:

Vegetation:

Vegetated: **Yes**
Vegetation Class: **C**

Soil Filled:

Soil Filled: **No**

Factor of Safety: **1.10**

Functional Longevity: **999**

Analysis Results:

	Side	Lining Type	Manning's "n"	Velocity (ft/s) Actual	Max. Allowed	Safety Factor	Shear Stress (lbs/sqft) Actual	Max. Allowed	Safety Factor	Flow Depth (ft)	Discharge (cfs)	OK?
Analysis #1	Left:	LANDLOK TRM	0.0250	2.3	16.5	7.1	4.0	4.7	1.2	0.8207	4.0	Yes
	Bottom:	LANDLOK TRM	0.0250	2.0	16.5	8.1	3.1	4.7	1.5			
	Right:	LANDLOK TRM	0.0250	2.1	16.5	8.0	3.1	4.7	1.5			
Analysis #2	Left:		0.0000	0.0	0.0	0.0	0.0	0.0	0.0	0.0000	0.0	No
	Bottom:		0.0000	0.0	0.0	0.0	0.0	0.0	0.0			
	Right:		0.0000	0.0	0.0	0.0	0.0	0.0	0.0			
Analysis #3	Left:		0.0000	0.0	0.0	0.0	0.0	0.0	0.0	0.0000	0.0	No
	Bottom:		0.0000	0.0	0.0	0.0	0.0	0.0	0.0			
	Right:		0.0000	0.0	0.0	0.0	0.0	0.0	0.0			

Channel Calculation Results:

	Flow Area (sq ft)	Hydraulic Radius (ft)	Composite 'n'	Left Wetted Perimeter(ft)	Right Wetted Perimeter(ft)	Total Wetted Perimeter(ft)	Average Velocity (ft/s)	Average Discharge (cfs)	Froude
Analysis #1	2.0287	0.3880	0.0955	3.3837	1.8351	5.2288	1.9717	4.0	.415
Analysis #2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	.000
Analysis #3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	.000

Suggested Vegetation for: La Crosse,WI

All Season Grasses					
Species	Scentific Name	Retardance Class	Seed Rate (lbs/ac)	Height at Maturity (in)	Recommended Planting Dates
Alsike Clover	Trifolium hybridum	A - E	15		4/1 - 5/31 or8/16 - 10/15
Reed Canarygrass	Phalaris arundinacea	A- E	20		4/1 - 5/31 or 8/16 - 10/15
Colonial Bentgrass	Agrostis tenius	A - E	50		4/1 - 5/31 or 8/16 - 10/15
Creeping Bentgrass	Agrostis palustris	A - E	50		4/1 - 5/31 or 8/16 - 10/15
Poa Trivialis	Poa trivialis	A - E	50		4/1 - 5/31 or 8/16 - 10/15
Creeping Foxtrail	Alopecurus arundinaceus	A - E	50		4/1 - 5/31 or 8/16 - 10/15
Meadow Foxtail	Alopecurus pratensis	A - E	50		4/1 - 5/31 or 8/16 - 10/15
Perennial Ryegrass	Lolium perenne	A - E	240		4/1 - 5/31 or 8/16 - 10/15
RedTop	Agrostis alba	A - E	80		4/1 - 5/31 or 8/16 - 10/15
Meadow Fescue	Festuca elatior	A - E	160		4/1 - 5/31 or 8/16 - 10/15
Cold Season Grasses					
Species	Scentific Name	Retardance Class	Seed Rate (lbs/ac)	Height at Maturity (in)	Recommended Planting Dates
Crested Wheatgrass	Agropyron desertorum	A		2 - 3	
Green Needlegrass	Stipa viridula	A		3 - 4	
Russian WildRye	Psathyrostachys gunceus	A		3 - 4	
Smooth Bromegrass	Bromus inermis	A		3 - 4	
Tall Fescue	Festuca arundinacea	A		3 - 4	
Tall Wheatgrass	Elytriga pontica	A		4 - 5	
Western Wheatgrass	Agropyron smithii	A		2 - 3	
Warm Season Grasses					
Species	Scentific Name	Retardance Class	Seed Rate (lbs/ac)	Height at Maturity (in)	Recommended Planting Dates
Bermuda Grass	Cynodon dactylon	C		3/4 - 2	
Big Bluestem	Andropogon gerardii	B		4 - 6	
Blue grama	Boutelova gracillis	B		1 - 2	
Buffalo grass	Buchloe dactyloides	D		1/3 - 1	
Green Sprangletop	Leptochloa dubia	A		3 - 4	
Indian grass	Sorghastrum nutans	A		5 - 6	
Kleingrass	Panicum coloratum	A		3 - 4	
Little bluestem	Schizachyrium scoparium	A		3 - 4	
Plains bristlegrass	Setaria macrostachya	B		1 - 2	
Sand bluestem	Andropogon hallii	A		5 - 6	
Sideoats grama	Bouteloua curtipendula	A		2 - 3	
Switch grass	Panicum Virgatum	A		4 - 5	
Vine mesquitegrass	Panicum Obtusum	B		1 - 2	
Weeping lovegrass	Eragrostis Curvula	A		3 - 4	

Calculations – Operational Landfill Conditions

RMT
744 Heartland Trail
Madison, WI 53717-1934
Tel. (608) 831-4444 • Fax (608) 831-3334

PROJECT / PROPOSAL NAME / LOCATION: OPC - POO		PROJECT / PROPOSAL NO. 3078.40
SUBJECT: OPERATIONAL DITCH SIZING		
PREPARED BY: BJK	DATE: 10/00	FINAL ☒
CHECKED BY:	DATE:	REVISION ☐

OPERATIONAL DITCHES (SEE FIGURES K-4 to K-9, OPERATIONAL RUNOFF CALCULATIONS)

DITCH	LOCATION	100-YR FLOW	SLOPE	SHAPE
V-NOTCH DITCH A	CELL 1 ACTIVE	5 CFS	6%	V-NOTCH
DITCH B	CELL 1 ACTIVE	~~583~~ 561 CFS[1]	2%	10' FLAT
DITCH C	CELL 2A ACTIVE	6 CFS	6.3%	V-NOTCH
DITCH D	CELL 2B ACTIVE	3 CFS	12%	V-NOTCH
DITCH E	CELL 3 ACTIVE	~~583~~ 561 CFS[1] ✓	1%	10' FLAT
DITCH F	CELL 4A ACTIVE	~~433~~ 373 CFS[2]	1%	10' FLAT
DITCH G	CELL 2A ACTIVE	360 CFS[4]		

NOTES
1. FLOWS FROM PREDEVELOPMENT AREAS NORTH + WEST (See p. 95) @ 12.6 hrs
2. FLOWS FROM PREDEVELOPMENT AREAS NORTH + 2B @ 12.6 HRS (See p. 66/95)
3. PERMANANT DITCHES SIZED UNDER POST-DEVELOPMENT CALCULATIONS.
4. FLOW FROM PREDEVELOPMENT ~~[illegible]~~ AREA NORTH (See p. 95)

SW DITCH	CELL 2A ACTIVE	561 CFS[1]	5%	10' FLAT

FORM 383A

RMT, Inc.
Grass Channel Sizing Calculations

Site:	Dairyland Power Cooperative	Date:	10/00
Project #:	3081.40	User:	BJK
Channel:	Ditch A		

==

I. Input Parameters.

A. Side slope, Z1 (hor/vert) =	3.000	ft/ft
B. Side slope, Z2 (hor/vert) =	16.000	ft/ft
C. Bottom width, B =	0.000	ft
D. Design channel slope, S =	0.060	ft/ft
E. Channel Peak Flow, Q =	5.000	cfs
F. Enter - 1 - for Type "C" Veg. Retardence - 2 - for Type "D" Veg. Retardence	2	

II. Peak Flow Calculations.

A. Trial flow depth, D = (Bisection method until Va=Vb)	**0.533**	**ft**
B. Channel flow area, Ac = (.5*Z1*D^2) + (B*D) + (.5*Z2*D^2)	2.703	sq ft
C. Wetted Perimeter, Pw = (D*(Z1^2+1)^.5) + B + (D*(Z2^2+1)^.5)	10.239	ft
D. Hydraulic radius, Rh = (Ac/Pw)	0.264	ft
E. Velocity and hydraulic radius, VR = (Va * Rh)	0.488	sfps
F. Channel flow Manning's coeff, nc = 0	0.081	
G. Trial velocity, Va = (Q/Ac)	1.850	fps
H. Resultant velocity, Vb = (1.49/nc) * (Rh^.667) * (S^.5)	**1.850**	**fps** ✓ OK

Invoke Solution Macro by typing - 'ctrl' D

Channel Analysis Information:

Name:

Channel Analysis Name: **Ditch B**

Channel Geometry & Hydraulics:

Design By:

Designed By: **FLOW**

Channel Side Slopes:

Left Slope (xH:1V): **3.00**
Right Slope (xH:1V): **3.00**

Flow\Velocity:

Discharge (cfs): **583.00**
Flow Duration (hrs): **1.00**
Average Velocity (ft/s): **0.00**

Channel Geometry:

Bed Slope (ft/ft): **0.02000**
Req. Freeboard (ft): **0.00**
Channel Length (ft): **530.00**
Bottom Width (ft): **10.00**
Channel Depth (ft): **4.00**

Channel Bend:

Channel Bend: **No**
Bend Radius (ft): **0.00**
Outside Bend:

Vegetation:

Vegetated: **No**
Vegetation Class:

Soil Filled:

Soil Filled: **Yes**

Factor of Safety: **1.00**

Functional Longevity: **48**

Analysis Results:

	Side	Lining Type	Manning's "n"	Velocity (ft/s) Actual	Max. Allowed	Safety Factor	Shear Stress (lbs/sqft) Actual	Max. Allowed	Safety Factor	Flow Depth (ft)	Discharge (cfs)	OK?
Analysis #1	Left:	LANDLOK TRM	0.0250	13.4	16.5	1.2	2.5	6.2	2.5	2.3594	583.0	Yes
	Bottom:	LANDLOK TRM	0.0250	14.5	16.5	1.1	2.9	6.2	2.1			
	Right:	LANDLOK TRM 450	0.0250	13.4	16.5	1.2	2.5	6.2	2.5			
Analysis #2	Left:		0.0000	0.0	0.0	0.0	0.0	0.0	0.0	0.0000	0.0	No
	Bottom:		0.0000	0.0	0.0	0.0	0.0	0.0	0.0			
	Right:		0.0000	0.0	0.0	0.0	0.0	0.0	0.0			
Analysis #3	Left:		0.0000	0.0	0.0	0.0	0.0	0.0	0.0	0.0000	0.0	No
	Bottom:		0.0000	0.0	0.0	0.0	0.0	0.0	0.0			
	Right:		0.0000	0.0	0.0	0.0	0.0	0.0	0.0			

Channel Calculation Results:

	Flow Area (sq ft)	Hydraulic Radius (ft)	Composite 'n'	Left Wetted Perimeter(ft)	Right Wetted Perimeter(ft)	Total Wetted Perimeter(ft)	Average Veleocity (ft/s)	Average Discharge (cfs)	Froude
Analysis #1	40.2945	1.6168	0.0200	7.4611	7.4611	24.9222	14.4685	583.0	1.58
Analysis #2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	.000
Analysis #3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	.000

RMT, Inc.
Grass Channel Sizing Calculations

Site:	Dairyland Power Cooperative	Date:	10/00
Project #:	3081.40	User:	BJK
Channel:	Ditch C		

==

I. Input Parameters.

A. Side slope, Z1 (hor/vert) =		3.000	ft/ft
B. Side slope, Z2 (hor/vert) =		16.000	ft/ft
C. Bottom width, B =		0.000	ft
D. Design channel slope, S =		0.063	ft/ft
E. Channel Peak Flow, Q =		6.000	cfs
F. Enter	- 1 - for Type "C" Veg. Retardence - 2 - for Type "D" Veg. Retardence	2	

II. Peak Flow Calculations.

A. Trial flow depth, D =	(Bisection method until Va=Vb)	**0.550**	**ft**
B. Channel flow area, Ac =	(.5*Z1*D^2) + (B*D) + (.5*Z2*D^2)	2.870	sq ft
C. Wetted Perimeter, Pw =	(D*(Z1^2+1)^.5) + B + (D*(Z2^2+1)^.5)	10.549	ft
D. Hydraulic radius, Rh =	(Ac/Pw)	0.272	ft
E. Velocity and hydraulic radius, VR =	(Va * Rh)	0.569	sfps
F. Channel flow Manning's coeff, nc =	0	0.075	
G. Trial velocity, Va =	(Q/Ac)	2.091	fps
H. Resultant velocity, Vb =	(1.49/nc) * (Rh^.667) * (S^.5)	**2.091**	**fps** ✓ OK

Invoke Solution Macro by typing - 'ctrl' D

RMT, Inc.
Grass Channel Sizing Calculations

Site:	Dairyland Power Cooperative	Date:	10/00
Project #:	3081.40	User:	BJK
Channel:	Ditch D		

==

I. Input Parameters.

A. Side slope, Z1 (hor/vert) =	3.000	ft/ft
B. Side slope, Z2 (hor/vert) =	3.000	ft/ft
C. Bottom width, B =	0.000	ft
D. Design channel slope, S =	0.120	ft/ft
E. Channel Peak Flow, Q =	3.000	cfs
F. Enter - 1 - for Type "C" Veg. Retardence - 2 - for Type "D" Veg. Retardence	2	

II. Peak Flow Calculations.

A. Trial flow depth, D = (Bisection method until Va=Vb)	**0.547**	**ft**
B. Channel flow area, Ac = (.5*Z1*D^2) + (B*D) + (.5*Z2*D^2)	0.897	sq ft
C. Wetted Perimeter, Pw = (D*(Z1^2+1)^.5) + B + (D*(Z2^2+1)^.5)	3.459	ft
D. Hydraulic radius, Rh = (Ac/Pw)	0.259	ft
E. Velocity and hydraulic radius, VR = (Va * Rh)	0.867	sfps
F. Channel flow Manning's coeff, nc = 0	0.063	
G. Trial velocity, Va = (Q/Ac)	3.344	fps
H. Resultant velocity, Vb = (1.49/nc) * (Rh^.667) * (S^.5)	**3.344**	**fps** ✓ ok

Invoke Solution Macro by typing - 'ctrl' D

h:\data\common\template\sc-51\grasscha.xls

Channel Analysis Information:

Name:

Channel Analysis Name: **Ditch E**

Channel Geometry & Hydraulics:

Design By:

Designed By: **FLOW**

Channel Side Slopes:

Left Slope (xH:1V): **3.00**
Right Slope (xH:1V): **10.00**

Flow\Velocity:

Discharge (cfs): **583.00**
Flow Duration (hrs): **1.00**
Average Velocity (ft/s): **0.00**

Channel Geometry:

Bed Slope (ft/ft): **0.01000**
Req. Freeboard (ft): **0.00**
Channel Length (ft): **1000.0**
Bottom Width (ft): **10.00**
Channel Depth (ft): **3.00**

Channel Bend:

Channel Bend: **No**
Bend Radius (ft): **0.00**
Outside Bend:

Vegetation:

Vegetated: **No**
Vegetation Class:

Soil Filled:

Soil Filled: **Yes**

Factor of Safety: **1.00**

Functional Longevity: **60**

Analysis Results:

	Side	Lining Type	Manning's "n"	Velocity (ft/s) Actual	Velocity Max. Allowed	Velocity Safety Factor	Shear Stress (lbs/sqft) Actual	Shear Stress Max. Allowed	Shear Stress Safety Factor	Flow Depth (ft)	Discharge (cfs)	OK?
Analysis #1	Left:	LANDLOK TRM	0.0250	8.9	16.5	1.9	1.3	6.2	4.9	2.3865	583.0	Yes
	Bottom:	LANDLOK TRM	0.0250	9.6	16.5	1.7	1.5	6.2	4.2			
	Right:	LANDLOK TRM	0.0250	9.3	16.5	1.8	1.4	6.2	4.5			
Analysis #2	Left:		0.0000	0.0	0.0	0.0	0.0	0.0	0.0	0.0000	0.0	No
	Bottom:		0.0000	0.0	0.0	0.0	0.0	0.0	0.0			
	Right:		0.0000	0.0	0.0	0.0	0.0	0.0	0.0			
Analysis #3	Left:		0.0000	0.0	0.0	0.0	0.0	0.0	0.0	0.0000	0.0	No
	Bottom:		0.0000	0.0	0.0	0.0	0.0	0.0	0.0			
	Right:		0.0000	0.0	0.0	0.0	0.0	0.0	0.0			

Channel Calculation Results:

	Flow Area (sq ft)	Hydraulic Radius (ft)	Composite 'n'	Left Wetted Perimeter(ft)	Right Wetted Perimeter(ft)	Total Wetted Perimeter(ft)	Average Veleocity (ft/s)	Average Discharge (cfs)	Froude
Analysis #1	60.8850	1.4660	0.0200	7.5468	23.9840	41.5308	9.5754	583.0	1.06
Analysis #2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	.000
Analysis #3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	.000

EC-Design 2000 Channel Analysis Report

Channel Analysis Information:

Name:

Channel Analysis Name: **Ditch F**

Channel Geometry & Hydraulics:

Design By:

Designed By: **FLOW**

Channel Side Slopes:

Left Slope (xH:1V): **3.00**
Right Slope (xH:1V): **5.00**

Flow\Velocity:

Discharge (cfs): **433.00**
Flow Duration (hrs): **1.00**
Average Velocity (ft/s): **0.00**

Channel Geometry:

Bed Slope (ft/ft): **0.01000**
Req. Freeboard (ft): **0.00**
Channel Length (ft): **750.00**
Bottom Width (ft): **10.00**
Channel Depth (ft): **3.00**

Channel Bend:

Channel Bend: **No**
Bend Radius (ft): **0.00**
Outside Bend:

Vegetation:

Vegetated: **No**
Vegetation Class:

Soil Filled:

Soil Filled: **Yes**

Factor of Safety: **1.00**

Functional Longevity: **0**

Analysis Results:

	Side	Lining Type	Manning's "n"	Velocity (ft/s) Actual	Velocity Max. Allowed	Velocity Safety Factor	Shear Stress (lbs/sqft) Actual	Shear Stress Max. Allowed	Shear Stress Safety Factor	Flow Depth (ft)	Discharge (cfs)	OK?
Analysis #1	Left:	LANDLOK TRM	0.0250	9.1	16.5	1.8	1.2	6.2	5.1	2.2978	433.0	Yes
	Bottom:	LANDLOK TRM	0.0250	9.9	16.5	1.7	1.4	6.2	4.4			
	Right:	LANDLOK TRM	0.0250	9.5	16.5	1.7	1.3	6.2	4.7			
Analysis #2	Left:		0.0000	0.0	0.0	0.0	0.0	0.0	0.0	0.0000	0.0	No
	Bottom:		0.0000	0.0	0.0	0.0	0.0	0.0	0.0			
	Right:		0.0000	0.0	0.0	0.0	0.0	0.0	0.0			
Analysis #3	Left:		0.0000	0.0	0.0	0.0	0.0	0.0	0.0	0.0000	0.0	No
	Bottom:		0.0000	0.0	0.0	0.0	0.0	0.0	0.0			
	Right:		0.0000	0.0	0.0	0.0	0.0	0.0	0.0			

Channel Calculation Results:

	Flow Area (sq ft)	Hydraulic Radius (ft)	Composite 'n'	Left Wetted Perimeter(ft)	Right Wetted Perimeter(ft)	Total Wetted Perimeter(ft)	Average Velocity (ft/s)	Average Discharge (cfs)	Froude
Analysis #1	44.0967	1.5215	0.0200	7.2662	11.7164	28.9826	9.8193	433.0	1.10
Analysis #2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	.000
Analysis #3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	.000

EC-DESIGN(R) 2000 Channel Analysis Report

Project Information

Project Name: DPC

Description: Cell 2A operational Calcs

Last Update: 8/25/2003 10:58:10 A

Units: English

Nearest City:

Notes: Calculated for 1% slope section
Backwater from culvert 1 will
Protect 5% slope section

Channel Design

Channel Name: SW Ditch - Operational 100 yr | **Units:** English | **Design life:** 1,200 months

Design Criteria	
Flow Rate (Q)	

Vegetation and Soil	
Vegetated	Yes
Vegetation Class	B
Soil Filled	No

Channel Geometry	
Bed Slope (ft/ft)	0.010
Req. Freeboard (ft)	0.000
Channel Length (ft)	475.000
Bottom Width (ft)	10.000
Channel Depth (ft)	6.000

Flow/Velocity	
Discharge (cf/s)	561.000
Flow Duration (hrs)	1.000
Avg. Velocity (ft/s)	5.490

Channel Side Slopes	
Left (H:1 V)	2.000
Right (H:1 V)	2.000

Channel Bend	No
Bend Radius (ft)	0.000
Outside Bend	

Required Factor of Safety 1.00

Results

Lining Materials		Velocity (ft/s) Computed	Max Allowed	Safety Factor	Shear Stress (lbs/sqft) Computed	Max Allowed	Safety Factor
Left	PYRAMAT	5.100	23.340	4.580	2.720	9.400	3.460
Bottom	PYRAMAT	5.510	23.340	4.240	3.170	9.400	2.970
Right	PYRAMAT	5.100	23.340	4.580	2.720	9.400	3.460

Avg. Flow Depth (ft) 5.070

Calculation Results:

Flow Depth (ft)	5.070
Flow Area (ft)	102.230
Hydraulic Radius (ft)	3.130
Composite 'n'	0.0580

Left Wetted Perimeter (ft)	11.350
Bottom Wetted Perimeter (ft)	9.990
Right Wetted Perimeter (ft)	11.350
Total Wetted Perimeter (ft)	32.690
Avg. Velocity (ft/s)	5.490
Avg. Discharge (cf/s)	561.000

EC-DESIGN(R) 2000 Channel Analysis Report

Project Information

Project Name:	**DPC**	**Last Update:**	8/25/2003 10:53:12 A
Description:	Cell 2A operational Calcs	**Units:**	English
		Nearest City:	

Notes: FOR 5% SLOPE SECTION 25-YR STORM

Channel Design

Channel Name: SW Ditch - Operational 25 yr **Units:** English **Design life:** 48 months

Design Criteria	
Flow Rate (Q)	

Vegetation and Soil	
Vegetated	Yes
Vegetation Class	B
Soil Filled	No

Channel Geometry	
Bed Slope (ft/ft)	0.050
Req. Freeboard (ft)	0.000
Channel Length (ft)	450.000
Bottom Width (ft)	10.000
Channel Depth (ft)	4.000

Flow/Velocity	
Discharge (cf/s)	355.000
Flow Duration (hrs)	1.000
Avg. Velocity (ft/s)	8.940

Channel Side Slopes	
Left (H:1 V)	2.000
Right (H:1 V)	2.000

Channel Bend	No
Bend Radius (ft)	0.000
Outside Bend	

Required Factor of Safety 1.00

Results

Lining Materials		Velocity (ft/s)			Shear Stress (lbs/sqft)			Avg. Flow Depth (ft)
		Computed	Max Allowed	Safety Factor	Computed	Max Allowed	Safety Factor	2.610
Left	PYRAMAT	8.030	23.340	2.910	6.450	9.400	1.460	
Bottom	PYRAMAT	9.020	23.340	2.590	8.140	9.400	1.150	
Right	PYRAMAT	8.030	23.340	2.910	6.450	9.400	1.460	

Calculation Results:

Flow Depth (ft)	2.610	**Left Wetted Perimeter (ft)**	5.830
Flow Area (ft)	39.690	**Bottom Wetted Perimeter (ft)**	10.000
		Right Wetted Perimeter (ft)	5.830
		Total Wetted Perimeter (ft)	21.660
Hydraulic Radius (ft)	1.830	**Avg. Velocity (ft/s)**	8.940
Composite 'n'	0.0554	**Avg. Discharge (cf/s)**	355.000

EC-DESIGN(R) 2000 Channel Analysis Report

Project Information

Project Name:	**DPC**	**Last Update:**	8/25/2003 11:00:48 A
Description:	Cell 2A operational Calcs	**Units:**	English
		Nearest City:	

Notes:

Channel Design

Channel Name: **Phase III South Slope Ditch** **Units:** English **Design life:** 24 months

Design Criteria

Flow Rate (Q)

Vegetation and Soil

Vegetated	No
Vegetation Class	
Soil Filled	Yes

Channel Geometry

Bed Slope (ft/ft)	0.060
Req. Freeboard (ft)	0.000
Channel Length (ft)	500.000
Bottom Width (ft)	1.000
Channel Depth (ft)	1.500

Flow/Velocity

Discharge (cf/s)	4.000
Flow Duration (hrs)	1.000
Avg. Velocity (ft/s)	6.280

Channel Side Slopes

Left (H:1 V)	2.000
Right (H:1 V)	3.000

Channel Bend **No**

Bend Radius (ft)	0.000
Outside Bend	

Required Factor of Safety 1.00

Results

Lining Materials		**Velocity (ft/s)** Computed	Max Allowed	Safety Factor	**Shear Stress (lbs/sqft)** Computed	Max Allowed	Safety Factor	**Avg. Flow Depth (ft)**
								0.340
Left	LANDLOK TRM 450	6.080	16.490	2.710	1.050	6.250	5.950	
Bottom	LANDLOK TRM 450	6.730	16.490	2.450	1.280	6.250	4.880	
Right	LANDLOK TRM 450	6.350	16.490	2.600	1.140	6.250	5.480	

Calculation Results:

Flow Depth (ft)	0.340	**Left Wetted Perimeter (ft)**	0.770
Flow Area (ft)	0.640	**Bottom Wetted Perimeter (ft)**	1.000
		Right Wetted Perimeter (ft)	1.080
		Total Wetted Perimeter (ft)	2.850
Hydraulic Radius (ft)	0.220	**Avg. Velocity (ft/s)**	6.280
Composite 'n'	0.0200	**Avg. Discharge (cf/s)**	4.000

EC-DESIGN(R) 2000 Channel Analysis Report

Project Information

Project Name:	**DPC**	**Last Update:**	8/25/2003 11:00:48 A
Description:	Cell 2A operational Calcs	**Units:**	English
		Nearest City:	
Notes:			

Channel Design

Channel Name: **Ditch G** **Units:** English **Design life:** 48 months

Design Criteria	
Flow Rate (Q)	

Vegetation and Soil	
Vegetated	No
Vegetation Class	
Soil Filled	No

Channel Geometry	
Bed Slope (ft/ft)	0.015
Req. Freeboard (ft)	0.000
Channel Length (ft)	1.000
Bottom Width (ft)	10.000
Channel Depth (ft)	4.000

Flow/Velocity	
Discharge (cf/s)	360.000
Flow Duration (hrs)	1.000
Avg. Velocity (ft/s)	10.930

Channel Side Slopes	
Left (H:1 V)	3.000
Right (H:1 V)	3.000

Channel Bend	**No**
Bend Radius (ft)	0.000
Outside Bend	

Required Factor of Safety 1.00

Results

Lining Materials		**Velocity (ft/s)** Computed	Max Allowed	Safety Factor	**Shear Stress (lbs/sqft)** Computed	Max Allowed	Safety Factor
Left	LANDLOK TRM 450	10.170	16.490	1.620	1.610	6.250	3.880
Bottom	LANDLOK TRM 450	11.090	16.490	1.490	1.910	6.250	3.270
Right	LANDLOK TRM 450	10.170	16.490	1.620	1.610	6.250	3.880

Avg. Flow Depth (ft) 2.040

Calculation Results:

Flow Depth (ft)	2.040	**Left Wetted Perimeter (ft)**	6.460
Flow Area (ft)	32.920	**Bottom Wetted Perimeter (ft)**	9.990
		Right Wetted Perimeter (ft)	6.460
		Total Wetted Perimeter (ft)	22.910
Hydraulic Radius (ft)	1.440	**Avg. Velocity (ft/s)**	10.930
Composite 'n'	0.0210	**Avg. Discharge (cf/s)**	360.000

Reference Information

roughness) varies with VR. The term VR is the product of velocity and the hydraulic radius. This relationship will be referred to as the "n-VR relationship", which is the recommended basis for vegetated channel design.

The five general retardance curves, designated as A, B, C, D, and E in Exhibit 7-1, have been developed for various cover conditions. The vegetal conditions under which the various retardance values apply are shown in Exhibit 7-2. These cover classifications are based on tests in experimental channels when the covers were green and generally uniform.

Most of the vegetation used in waterways does not exceed 18 inches in height and may be much shorter at times during the year. Therefore, it is recommended that when designing the channel for safe velocity, a retardance not greater than "D" be used. After designing the channel for safe velocity, it must be checked for capacity to accommodate the peak flow under conditions where vegetation gives the highest retardance. The retardance used in this instance is the curve corresponding to the expected vegetal cover and, in most cases, it will be retardance "C", though curve "B" may be used where considered appropriate.

All pertinent design data and computations should be recorded.

DESIGN DATA

The following information is required for designing a waterway:

1. Watershed area in acres, together with the soil characteristics, cover and topography. This information is used to estimate runoff by the procedures set forth in Chapter 2 of this manual.

2. Grade of the proposed waterway in percent slope (this is the fall in feet per 100 feet of length).

3. Vegetal cover adapted to site conditions.

4. Erodibility of the soil in the waterway.

5. Expected height at which vegetative cover will be maintained.

6. The permissible velocity for the conditions encountered.

7. Allowance for space that will be occupied by the vegetative lining.

8. Allowance for freeboard, if required by State Standards and Specifications.

NON-EROSIVE VELOCITY OF FLOW

In designing grassed waterways, care must be taken to insure that the design velocity is well within the limits of permissible velocities given in Exhibit 7-3. These values apply to average, uniform stands of each type of cover.

Source: U.S. Department of Agriculture, Soil Conservation Service. Engineering Field Manual. November 1986.

Cover	Slope range 2/ (percent)	Permissible velocity 1/ Erosion resistant soils (ft.per sec.)	Easily eroded soils (ft.per sec.)
Bermudagrass	0-5 5-10 over 10	8 7 6	6 5 4
Bahia Buffalograss Kentucky bluegrass Smooth brome Blue grama Tall fescue	0-5 5-10 over 10	7 6 5	5 4 3
Grass mixtures Reed canarygrass	2/ 0-5 5-10	5 4	4 3
Lespedeza sericea Weeping lovegrass Yellow bluestem Redtop Alfalfa Red fescue	3/ 0-5	3.5	2.5
Common lespedeza 4/ Sudangrass 4/	5/ 0-5	3.5	2.5

1/ Use velocities exceeding 5 feet per second only where good covers and proper maintenance can be obtained.

2/ Do not use on slopes steeper than 10 percent except for vegetated side slopes in combination with a stone, concrete, or highly resistant vegetative center section.

3/ Do not use on slopes steeper than 5 percent except for vegetated side slopes in combination with a stone, concrete, or highly resistant vegetative center section.

4/ Annuals--use on mild slopes or as temporary protection until permanent covers are established.

5/ Use on slopes steeper than 5 percent is not recommended.

Exhibit 7-3. Permissible velocities for channels lined with vegetation

Source: U.S. Department of Agriculture, Soil Conservation Service. Engineering Field Manual. November 1986.

Culvert/Downslope Flume Design Calculations

Purpose/Methodology/Assumptions/Results/References

744 Heartland Trail (53717-8923) P. O. Box 8923 (53708-8923) Madison, WI (608) 831-4444 FAX: (608) 831-3334 VOICE: (608) 831-1989

PROJECT/PROPOSAL NAME	PREPARED By:	PREPARED Date:	CHECKED By:	CHECKED Date:	PROJECT/PROPOSAL NO.
Dairyland Power Cooperative	BJK	9/00	RAA	10/00	3081.40

CULVERT DESIGN CALCULATIONS

Purpose

To determine the appropriate culvert and downslope flume sizes for the anticipated peak flows resulting from the 100-year, 24-hour storm at the proposed Dairyland Power Cooperative Landfill.

Methodologies

Culvert design involves the process of selecting an appropriate culvert size capable of allowing the estimated peak storm water runoff to pass through it without creating surface water breaching (i.e., berm overflow) or excessive backwater levels. Culvert sizing was performed using design charts developed by the U.S. Department of Transportation Federal Highway Administration.

Downslope flumes will convey flow from the final cover diversion berms to the sedimentation basin. Downslope flumes were also sized using design charts developed by the U.S. Department of Transportation Federal Highway Administration. The energy dissipater for the downslope flume was sized using design guidance from the US Department of the Interior, Bureau of Reclamation.

Assumptions

The following assumptions were used in the culvert and downslope flume sizing analysis:

1. Culvert and downslope flume layout and allowable headwater levels are shown on the accompanying plan set.
2. Tailwater depths were assumed based on anticipated flows within the ditching. For culverts discharging into sedimentation basins, the tailwater elevation in the basin from the routing calculations.
3. Culverts are assumed to be corrugated metal culvert pipes or concrete box culverts.
4. Culverts were designed to maintain a minimum 1 to 2 feet of freeboard, depending on the location.

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Dairyland Power Cooperative	BJK	9/00	RAA	10/00	3081.40

Results

The table below summarizes the results of the culvert pipe sizing analyses:

CULVERT	SLOPE (%)	LENGTH (ft)	100-YR. FLOW (cfs)	SIZE
Culvert #1	7.0	96	323	4'x 7' Box
Culvert #2	7.7	126	323	4'x 7' Box
Culvert #3	11.2	125	15	30" CMP
Culvert #4	9.3	75	15	30" CMP
Culvert #5	5	85	323	4' x 7' Box

Note:
Culvert lengths to be adjusted based on available culvert section lengths.

Downslope pipe and energy dissipater sizing are shown on the engineering details included in the Plan Set.

References

U.S. Department of Transportation. Hydraulics charts for the selection of highway culverts. Hydraulic engineering circular no. 5. December 1965.

U.S. Department of the Interior, Bureau of Reclamation. Hydraulic Design of Stilling Basins and Energy Dissipaters. Engineering Nomograph No. 25. May 1984.

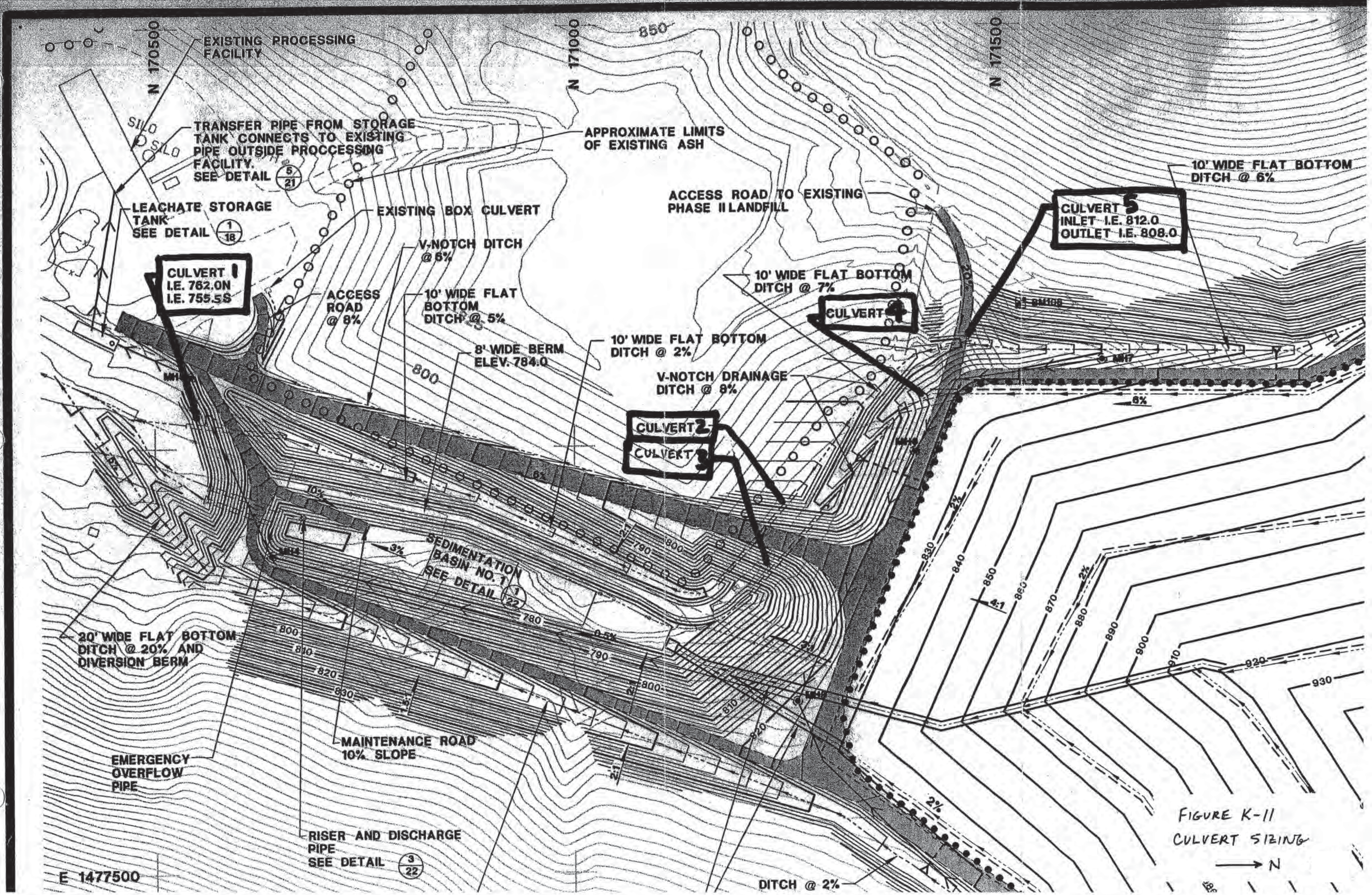

FIGURE K-11
CULVERT SIZING
→ N

Calculations – Post-closure Landfill Conditions

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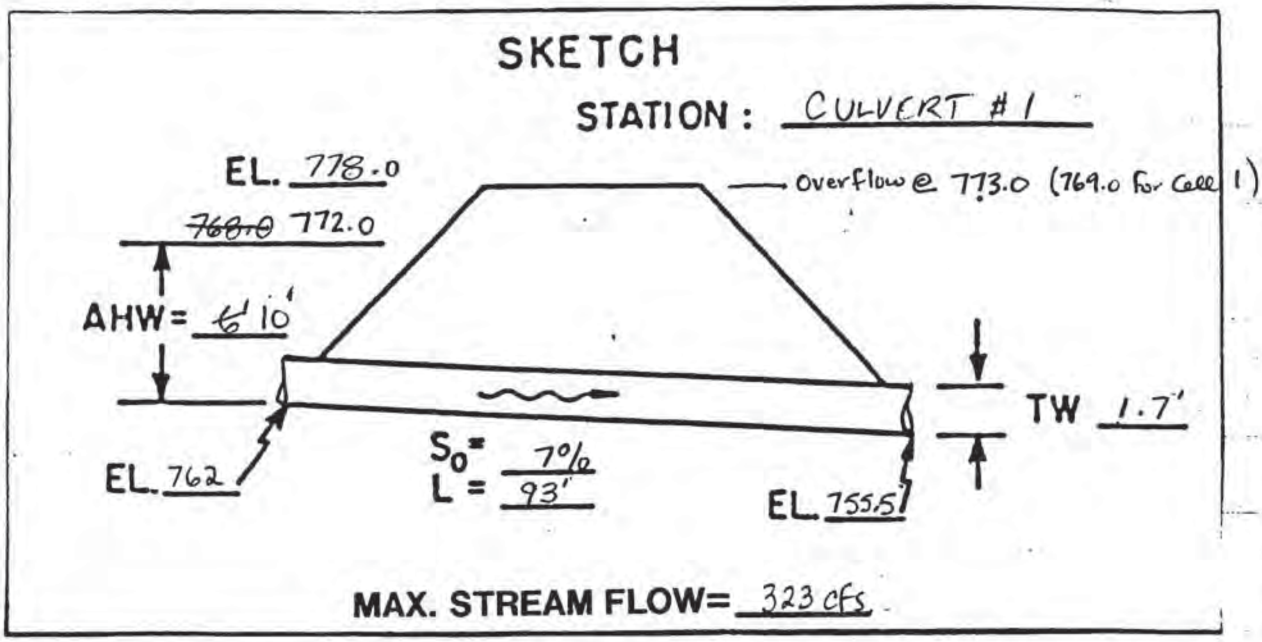
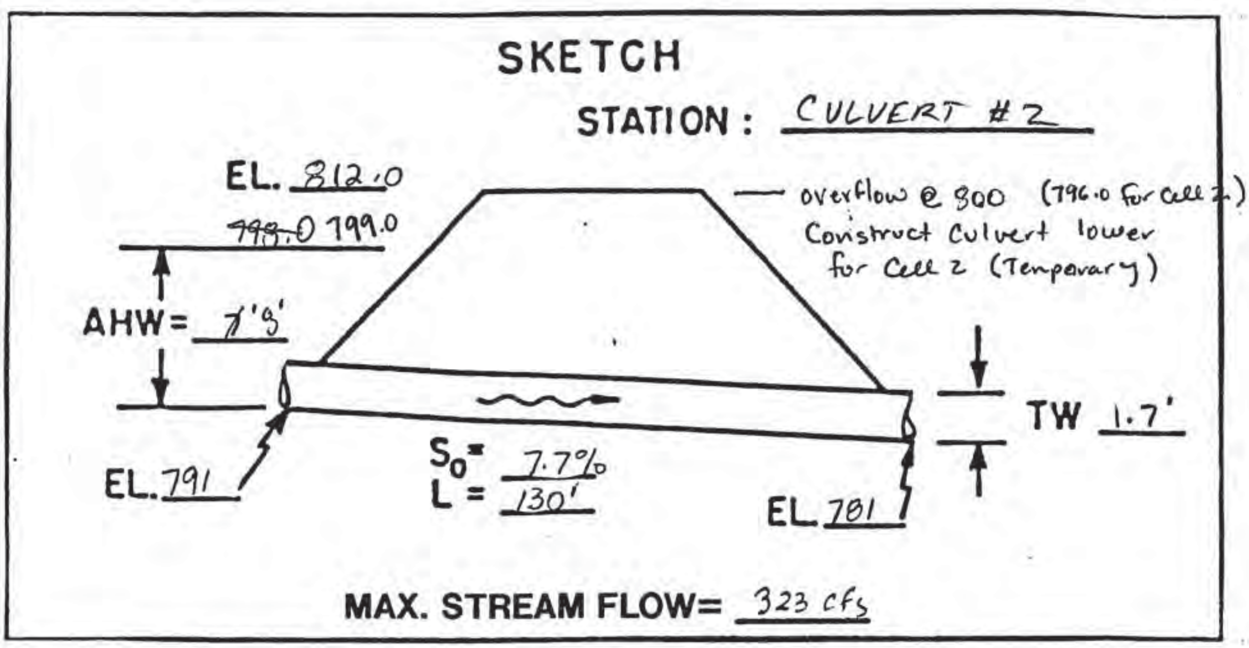
DPC - PLAN OF OPERATION	By: BJK	Date: 9/00	By:	Date:	3081.40

Rev. 7/03
BJK





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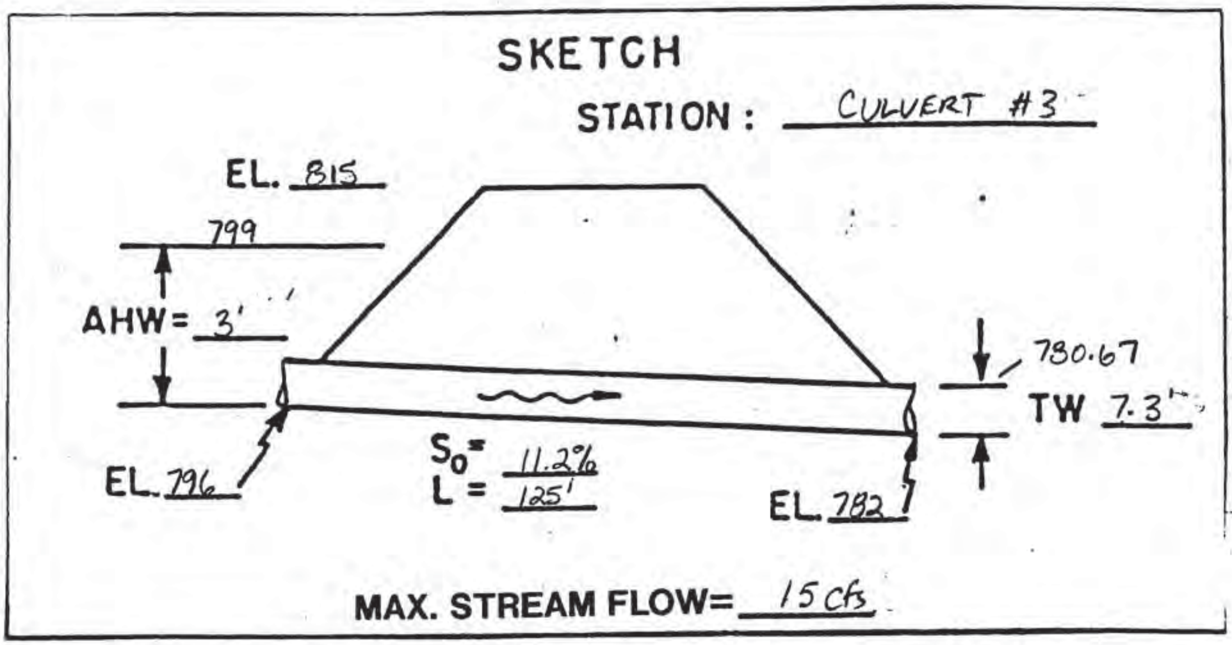
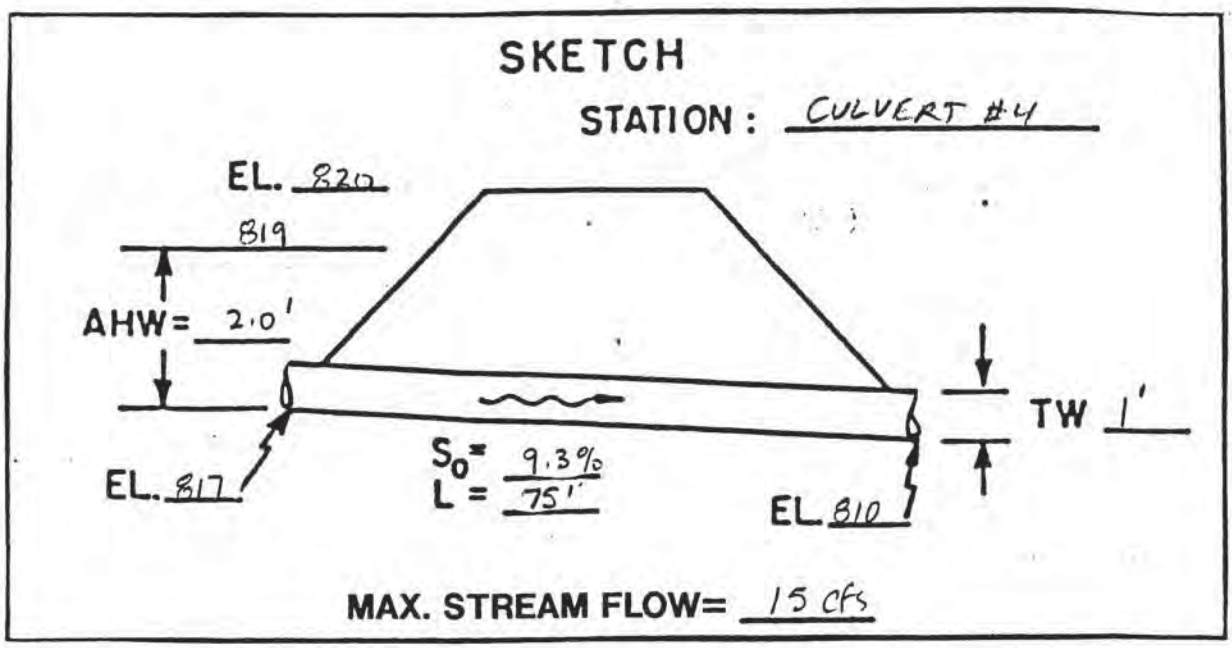
DPC · PLAN OF OPERATION	By: BJN	Date: 9/00	By:	Date:	3081.40





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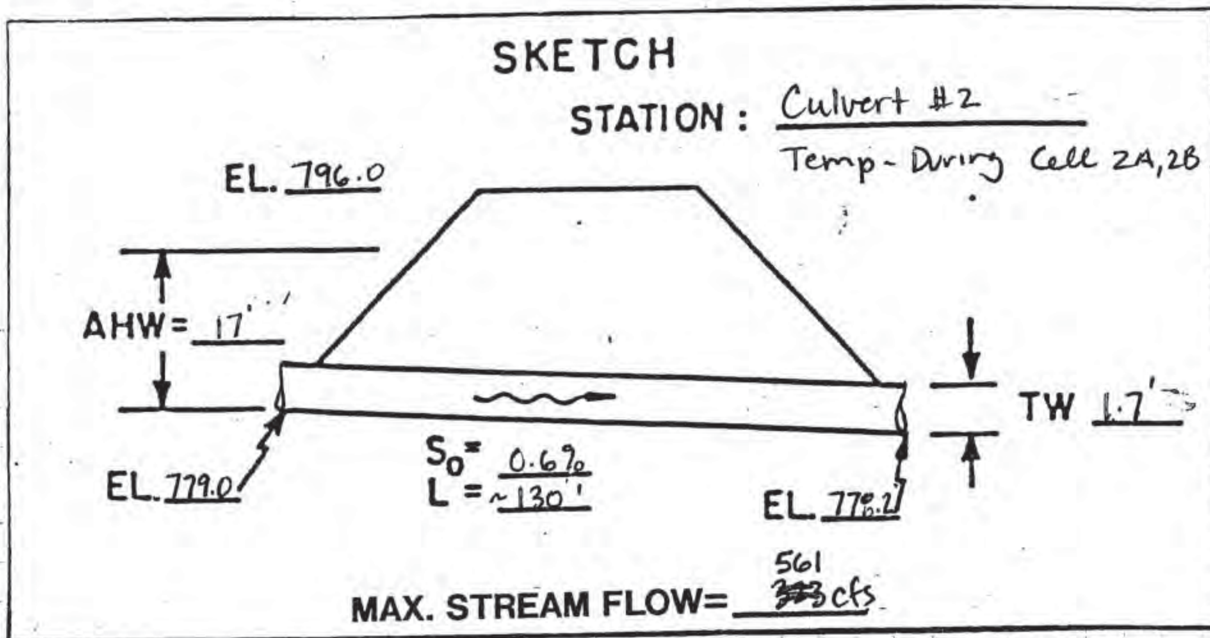
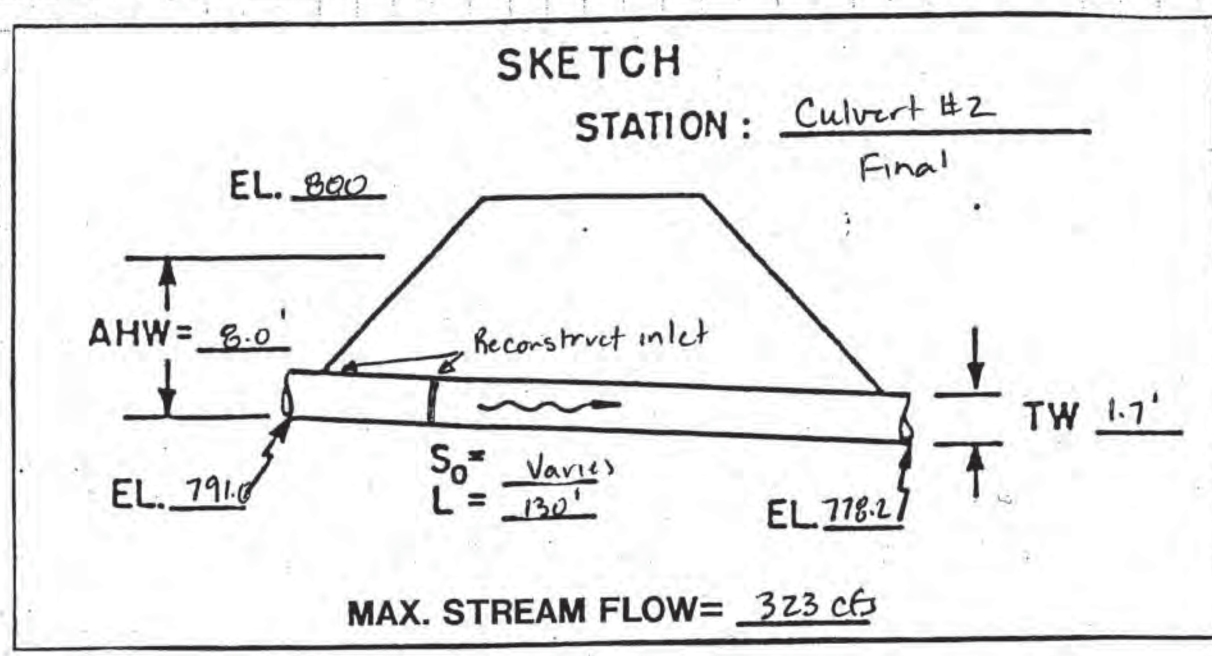
Dairyland Power – Phase IV	BJT	7/03			3061.56





Culvert Calculator Report
Culvert 2 - Operational

Solve For: Headwater Elevation

Culvert Summary

Allowable HW Elevation	796.00 ft	Headwater Depth/ Height	3.86
Computed Headwater Elevation	794.45 ft	Discharge	561.00 cfs
Inlet Control HW Elev	792.30 ft	Tailwater Elevation	779.90 ft
Outlet Control HW Elev	794.45 ft	Control Type	Outlet Control

Grades

Upstream Invert	779.00 ft	Downstream Invert	778.20 ft
Length	130.00 ft	Constructed Slope	0.006154 ft/ft

Hydraulic Profile

Profile	Pressure	Depth, Downstream	4.00 ft
Slope Type	N/A	Normal Depth	N/A ft
Flow Regime	N/A	Critical Depth	4.00 ft
Velocity Downstream	20.04 ft/s	Critical Slope	0.022277 ft/ft

Section

Section Shape	Box	Mannings Coefficient	0.013
Section Material	Concrete	Span	7.00 ft
Section Size	7 x 4 ft	Rise	4.00 ft
Number Sections	1		

Outlet Control Properties

Outlet Control HW Elev	794.45 ft	Upstream Velocity Head	6.24 ft
Ke	0.50	Entrance Loss	3.12 ft

Inlet Control Properties

Inlet Control HW Elev	792.30 ft	Flow Control	Submerged
Inlet Type	18 to 33.7 ° wingwall flare, d=0.0830	Area Full	28.0 ft²
K	0.48600	HDS 5 Chart	9
M	0.66700	HDS 5 Scale	2
C	0.02490	Equation Form	2
Y	0.83000		

Culvert Calculator Report
Culvert 2 - Final

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	799.00 ft	Headwater Depth/ Height	1.78
Computed Headwater Elevation	798.10 ft	Discharge	323.00 cfs
Inlet Control HW Elev	797.44 ft	Tailwater Elevation	779.90 ft
Outlet Control HW Elev	798.10 ft	Control Type	Entrance Control

Grades			
Upstream Invert	791.00 ft	Downstream Invert	778.20 ft
Length	130.00 ft	Constructed Slope	0.098462 ft/ft

Hydraulic Profile			
Profile	S2	Depth, Downstream	1.60 ft
Slope Type	Steep	Normal Depth	1.32 ft
Flow Regime	Supercritical	Critical Depth	4.00 ft
Velocity Downstream	28.87 ft/s	Critical Slope	0.007385 ft/ft

Section			
Section Shape	Box	Mannings Coefficient	0.013
Section Material	Concrete	Span	7.00 ft
Section Size	7 x 4 ft	Rise	4.00 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev	798.10 ft	Upstream Velocity Head	2.07 ft
Ke	0.50	Entrance Loss	1.03 ft

Inlet Control Properties			
Inlet Control HW Elev	797.44 ft	Flow Control	Submerged
Inlet Type	18 to 33.7 ° wingwall flare, d=0.0830	Area Full	28.0 ft²
K	0.48600	HDS 5 Chart	9
M	0.66700	HDS 5 Scale	2
C	0.02490	Equation Form	2
Y	0.83000		

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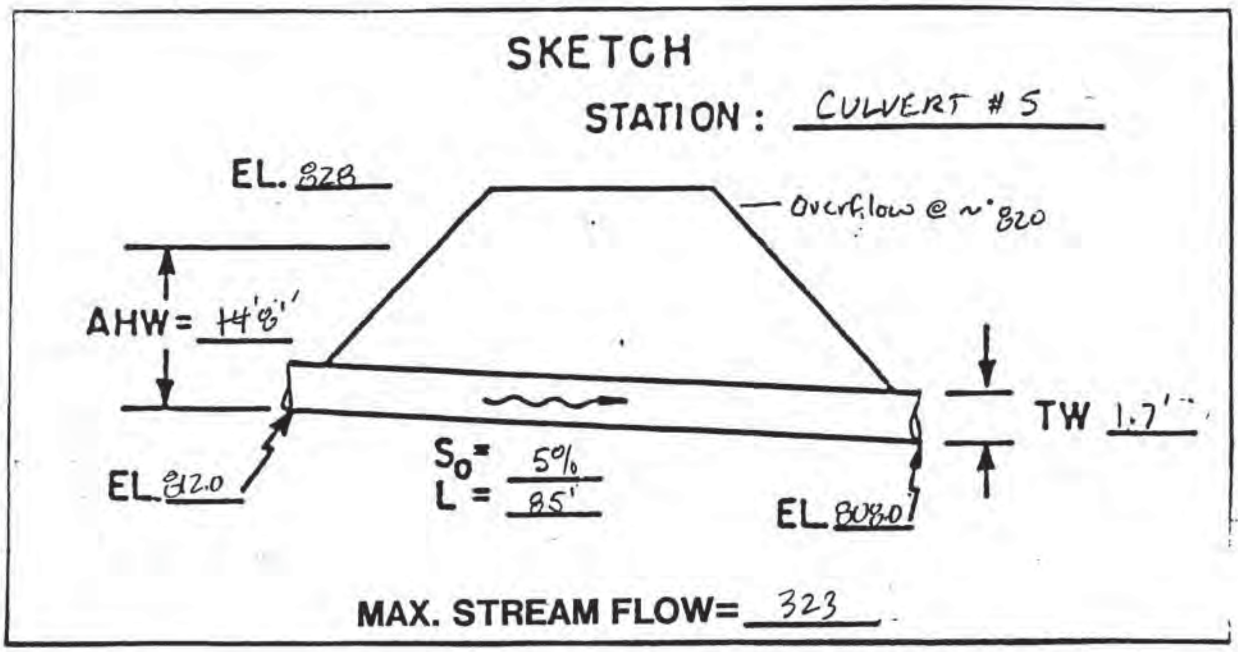
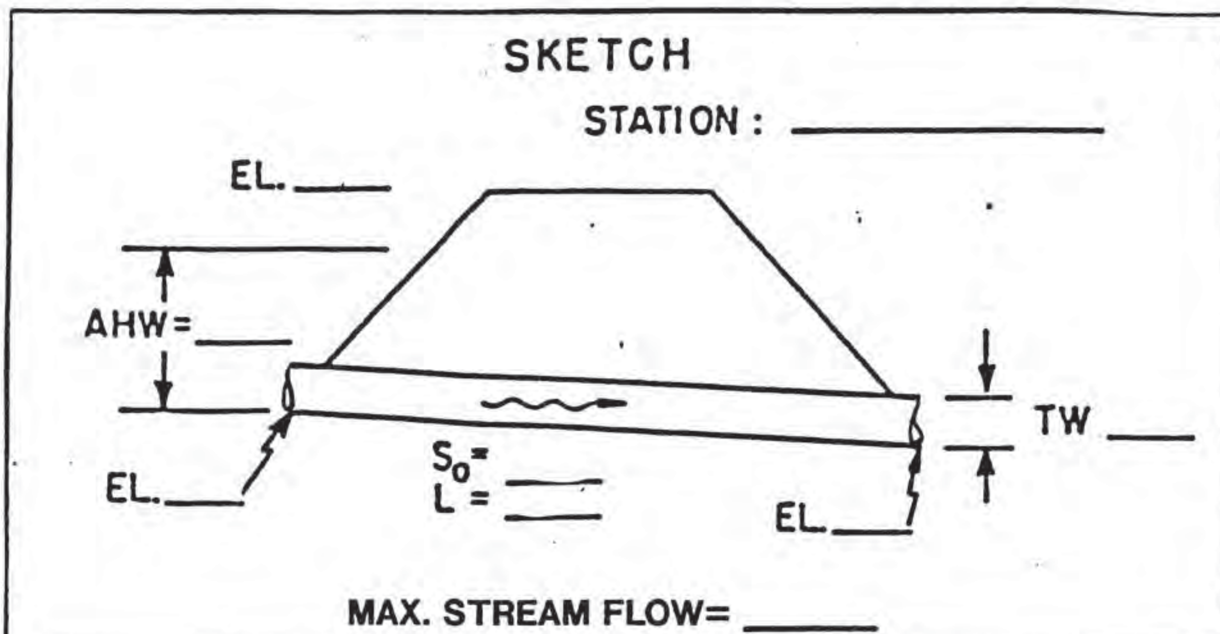
OPC POO	BJP	9/01			3081.40





PROJECT: DPC POO

DESIGNER: BJK

DATE: 9/2000

HYDROLOGIC AND CHANNEL INFORMATION

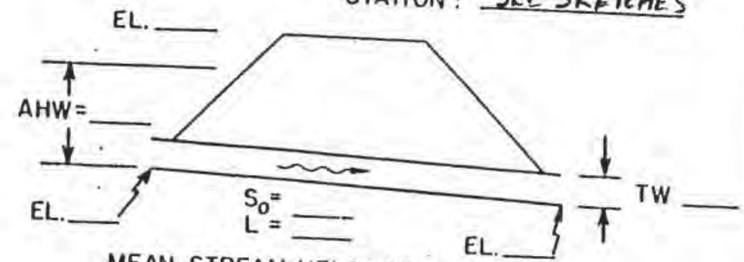
Q_1 = SEE SKETCHES TW_1 = ____

Q_2 = ____ TW_2 = ____

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH

STATION: SEE SKETCHES



MEAN STREAM VELOCITY = ____

MAX. STREAM VELOCITY = ____

CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION: INLET CONT. $\frac{HW}{D}$	INLET CONT. HW	OUTLET CONTROL $HW=H+h_o-LS_o$: K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW	CONTROLLING HW	OUTLET VELOCITY	COST	COMMENTS
CULVERT #1 CMP	162 EA	2-60"	1.2	6'												Not Rec.
CULVERT #1 BOX CULVERT	323 46/ft	7'x4'	~~1.45~~ 1.95	~~5.8~~ 7.8	0.4	3.8'	4.0'	4.0'	1.7'	4.0	6.5'	1.3	~~5.8~~ 7.8			Recommended
CULVERT #2 BOX CULVERT	323 46/ft	7'x4'	~~1.45~~ 1.95	~~5.8'~~ 7.8	0.4	3.8	4.0'	4.0'	1.7	4.0	10'	—	~~5.8'~~ 7.8			Recommended
CULVERT #3 CMP	15	24"	1.15	2.3'	0.5	2.8'	1.4	1.7	7.3'	7.3'	6'	4.1				Not Rec.
CULVERT #3 CMP	15	30"	0.77	1.9	0.5	0.8	1.3	1.9	7.3'	7.3'	6'	2.1				Recommended

SUMMARY & RECOMMENDATIONS:

ACTUAL LENGTHS OF CULVERTS #1 + 2 = 96' and 126' RESPECTIVELY
BASED ON 6' CULVERT SECTION LENGTHS

Figure 7

PROJECT: DPC - POO

DESIGNER: BJK

DATE: 9/2000

HYDROLOGIC AND CHANNEL INFORMATION

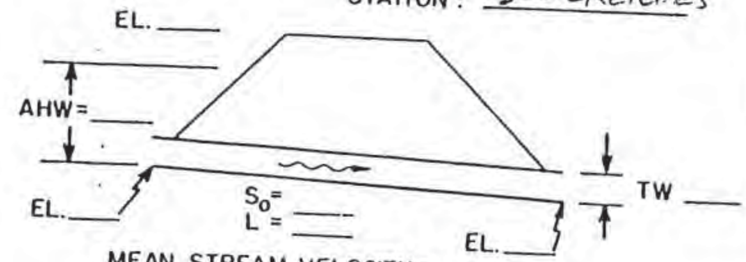
Q_1 = SEE SKETCHES TW_1 = ______

Q_2 = ______ TW_2 = ______

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH

STATION : SEE SKETCHES



MEAN STREAM VELOCITY = ______

MAX. STREAM VELOCITY = ______

CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION: INLET CONT.		OUTLET CONTROL $HW = H + h_o - LS_o$								CONTROLLING HW	OUTLET VELOCITY	COST	COMMENTS
			$\frac{HW}{D}$	HW	K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW				
CULVERT #4 CMP	15	30"	0.77	1.9'	0.5	0.7	1.3	1.9	1.0	1.9	7'	—	1.9'			Recommended
CULVERT #5 BOX CULVERT	323 46/ft	7'x 4'	~~1.45~~ 1.95	~~5.8~~ 7.8	0.4	3.8	4.0	4.0	1.7	4.0	4'	3.8	~~5.8~~ 7.8			Recommended

SUMMARY & RECOMMENDATIONS:

Figure 7

TABLE 1 - ENTRANCE LOSS COEFFICIENTS

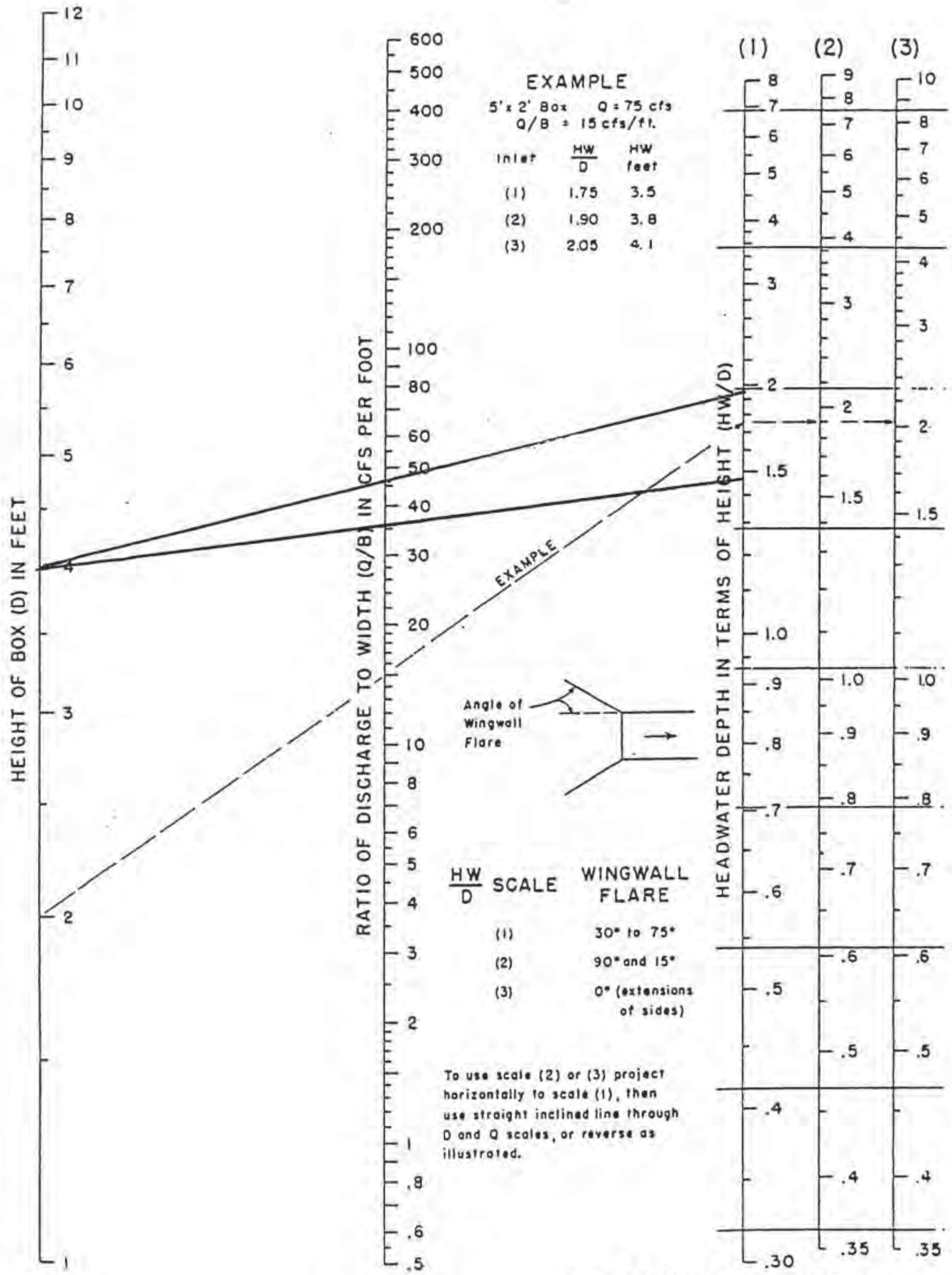
Outlet Control, Full or Partly Full

Entrance head loss $H_e = k_e \frac{V^2}{2g}$

Type of Structure and Design of Entrance	Coefficient k_e
Pipe, Concrete	
Projecting from fill, socket end (groove-end)	0.2
Projecting from fill, sq. cut end	0.5
Headwall or headwall and wingwalls	
Socket end of pipe (groove-end)	0.2
Square-edge	0.5
Rounded (radius = 1/12D)	0.2
Mitered to conform to fill slope	0.7
*End-Section conforming to fill slope	0.5
Beveled edges, 33.7° or 45° bevels	0.2
Side-or slope-tapered inlet	0.2
Pipe, or Pipe-Arch, Corrugated Metal	
Projecting from fill (no headwall)	0.9
Headwall or headwall and wingwalls square-edge . .	0.5
Mitered to conform to fill slope, paved or unpaved slope	0.7
*End-Section conforming to fill slope	0.5 ← CULVERTS 3,4
Beveled edges, 33.7° or 45° bevels	0.2
Side-or slope-tapered inlet	0.2
Box, Reinforced Concrete	
Headwall parallel to embankment (no wingwalls)	
Square-edged on 3 edges	0.5
Rounded on 3 edges to radius of 1/12 barrel dimension, or beveled edges on 3 sides	0.2
Wingwalls at 30° to 75° to barrel	
Square-edged at crown	0.4 ← CULVERTS 1,2
Crown edge rounded to radius of 1/12 barrel dimension, or beveled top edge	0.2
Wingwall at 10° to 25° to barrel	
Square-edged at crown	0.5
Wingwalls parallel (extension of sides)	
Square-edged at crown	0.7
Side-or slope-tapered inlet	0.2

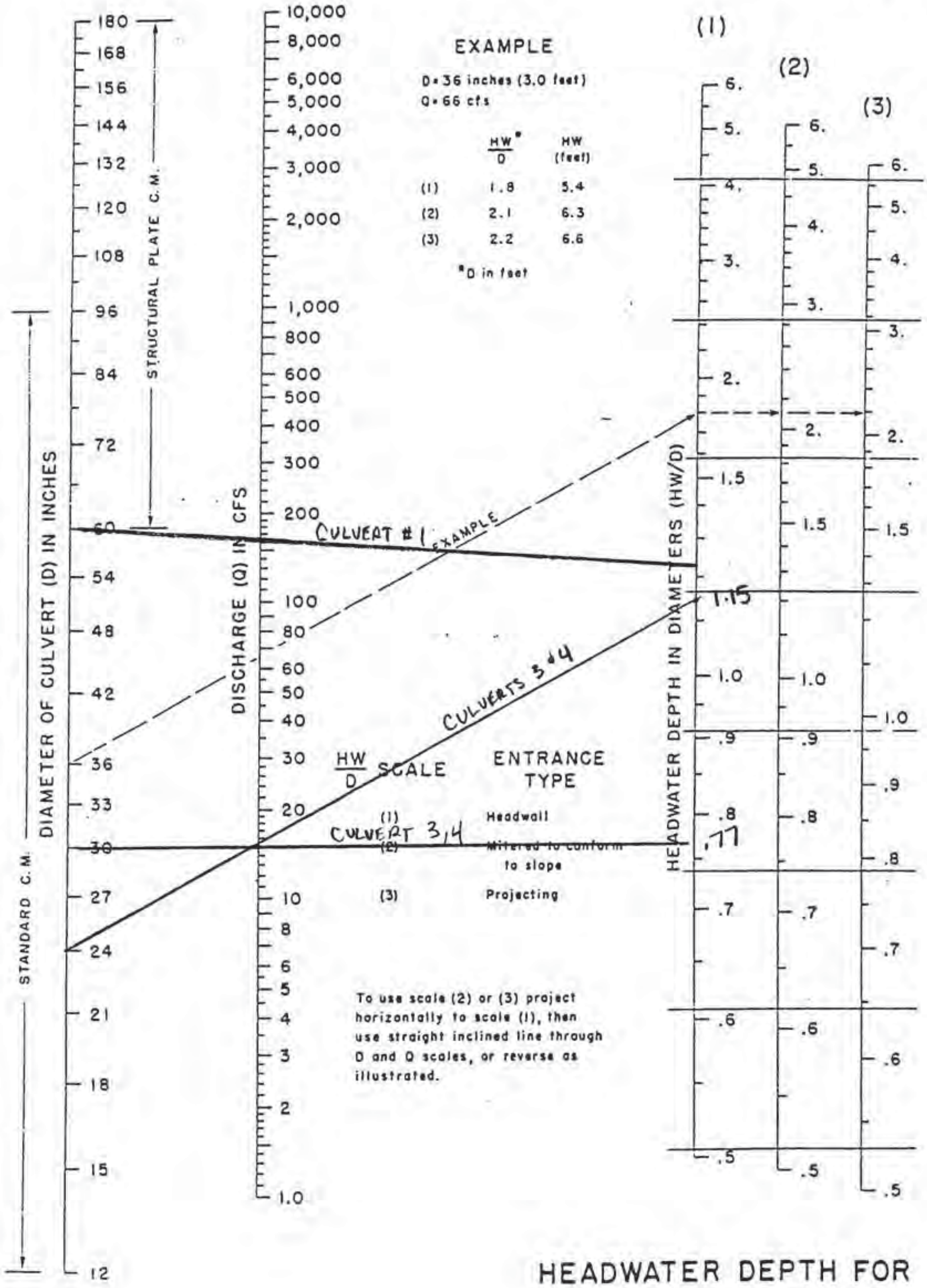
*Note: "End Section conforming to fill slope," made of either metal or concrete, are the sections commonly available from manufacturers. From limited hydraulic tests they are equivalent in operation to a headwall in both inlet and outlet control. Some end sections, incorporating a closed taper in their design have a superior hydraulic performance. These latter sections can be designed using the information given for the beveled inlet, p. 5-13.

CHART I

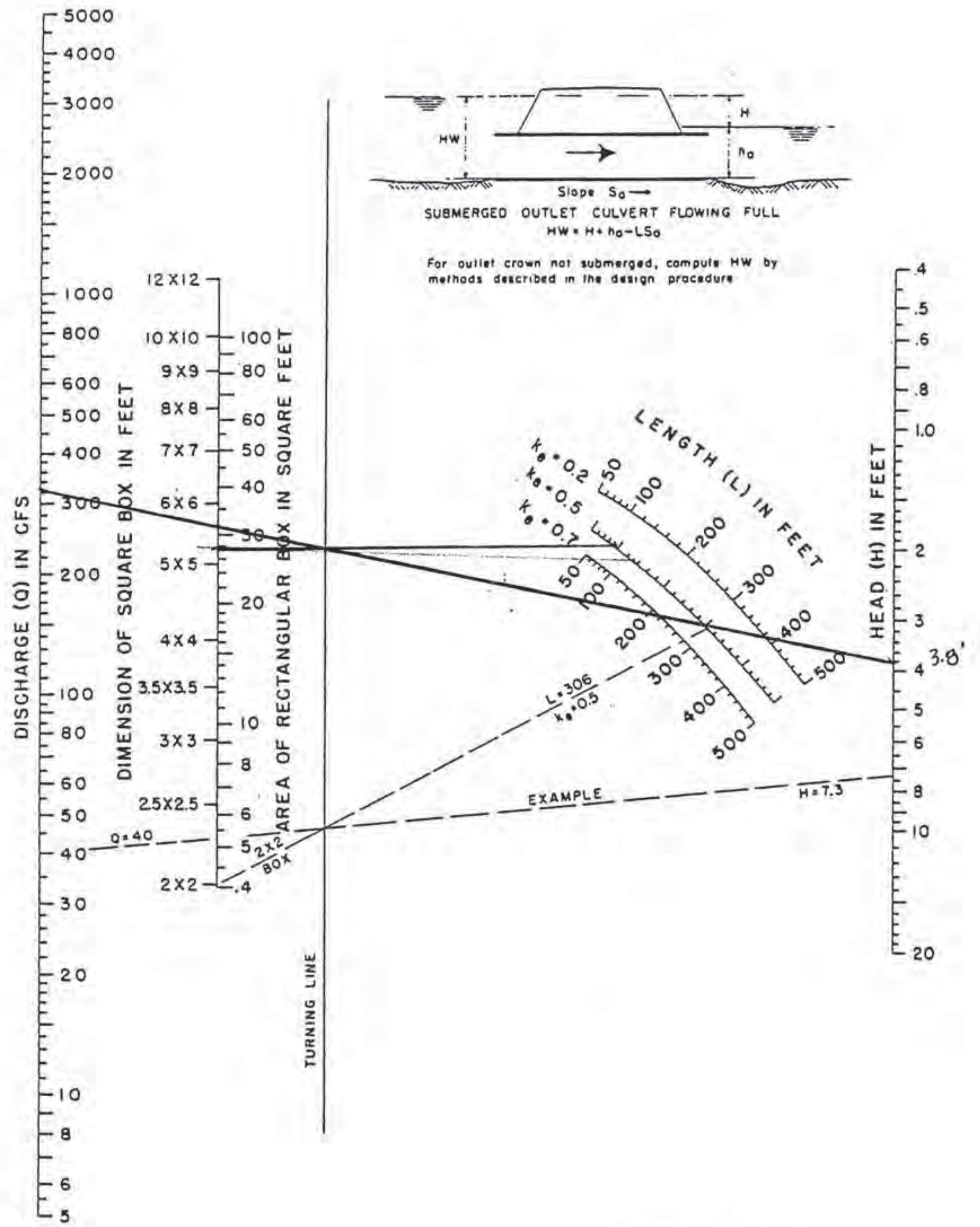


HEADWATER DEPTH
FOR BOX CULVERTS
WITH INLET CONTROL

CHART 5



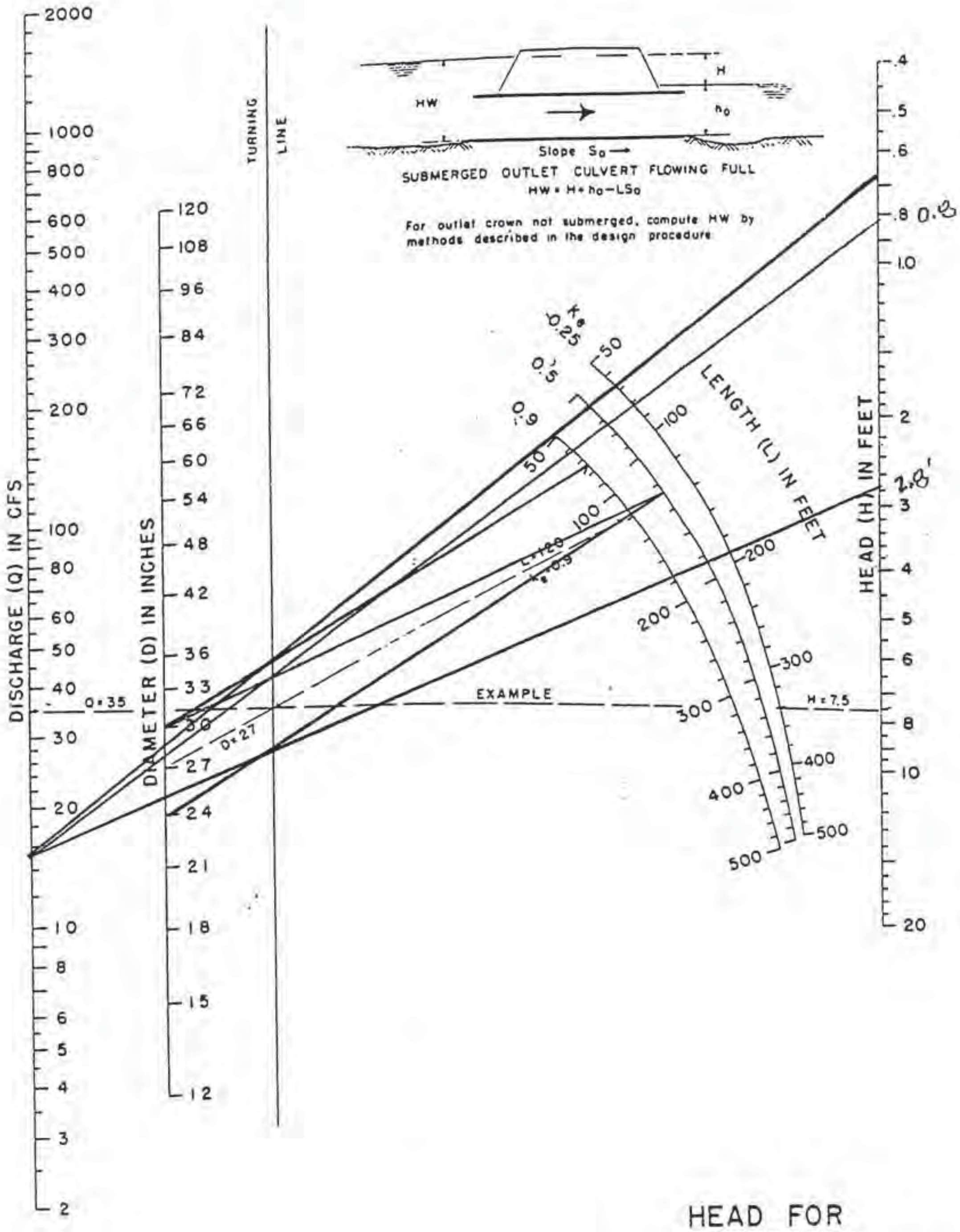
HEADWATER DEPTH FOR
C. M. PIPE CULVERTS
WITH INLET CONTROL



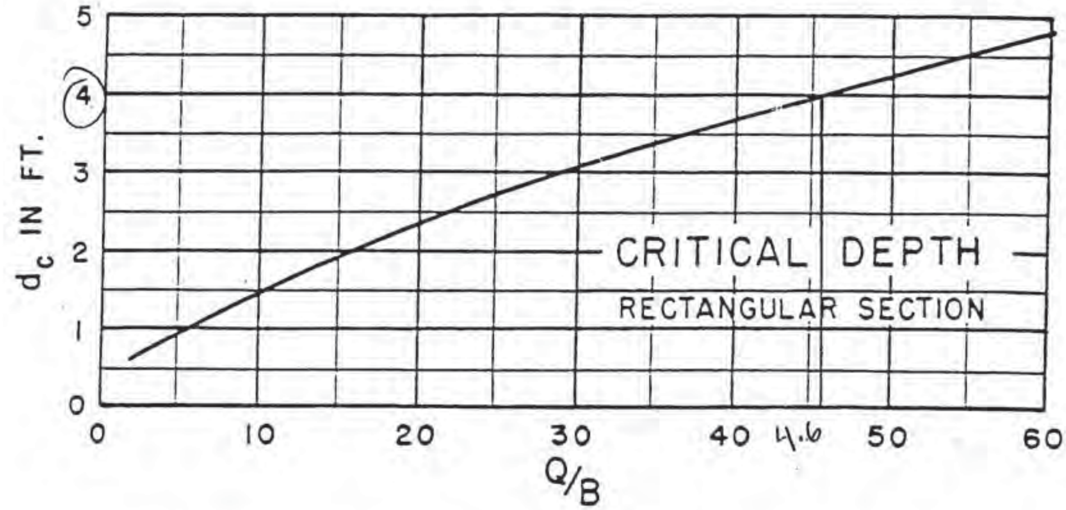
HEAD FOR CONCRETE BOX CULVERTS FLOWING FULL

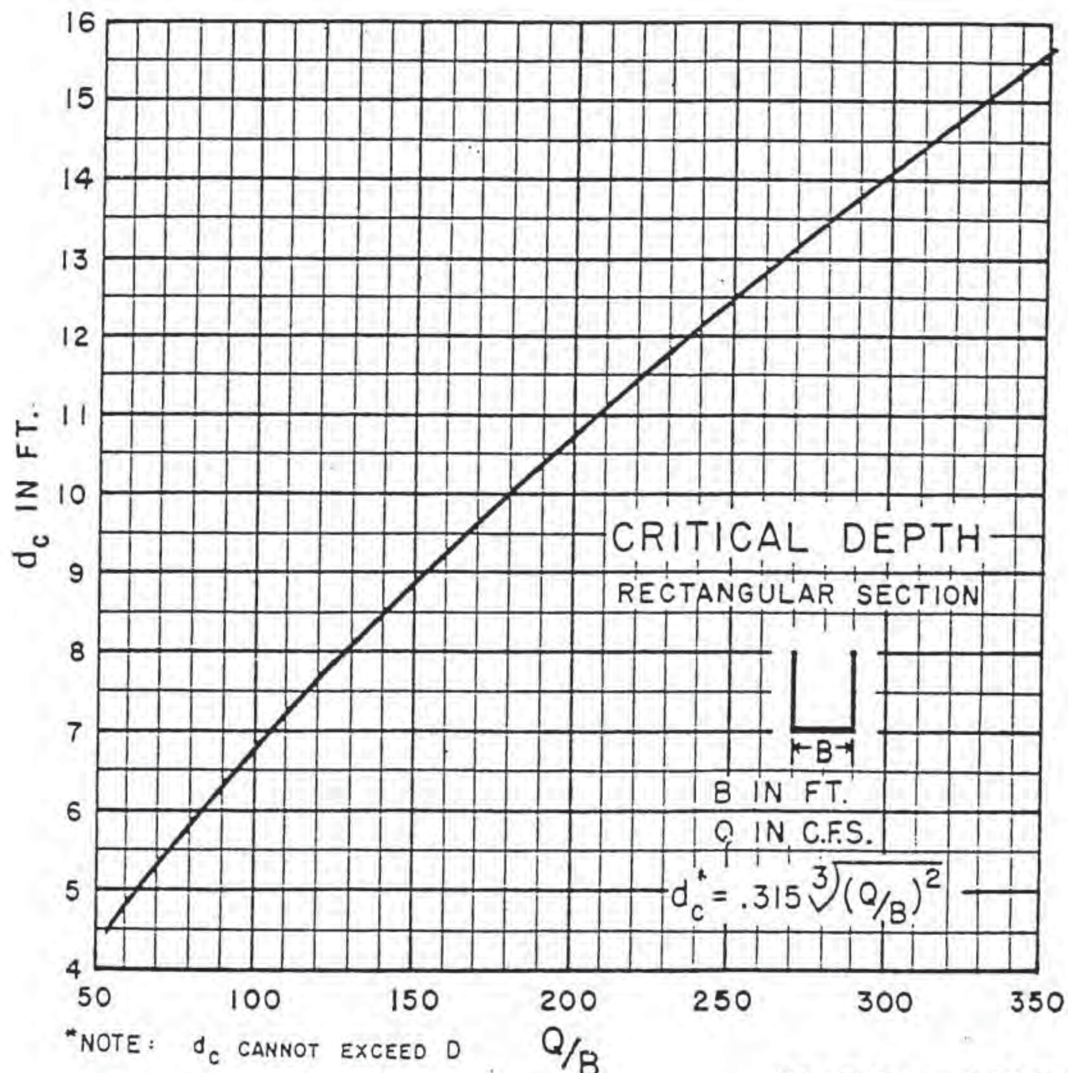
$n = 0.012$

CHART 11



HEAD FOR STANDARD C. M. PIPE CULVERTS FLOWING FULL $n = 0.024$

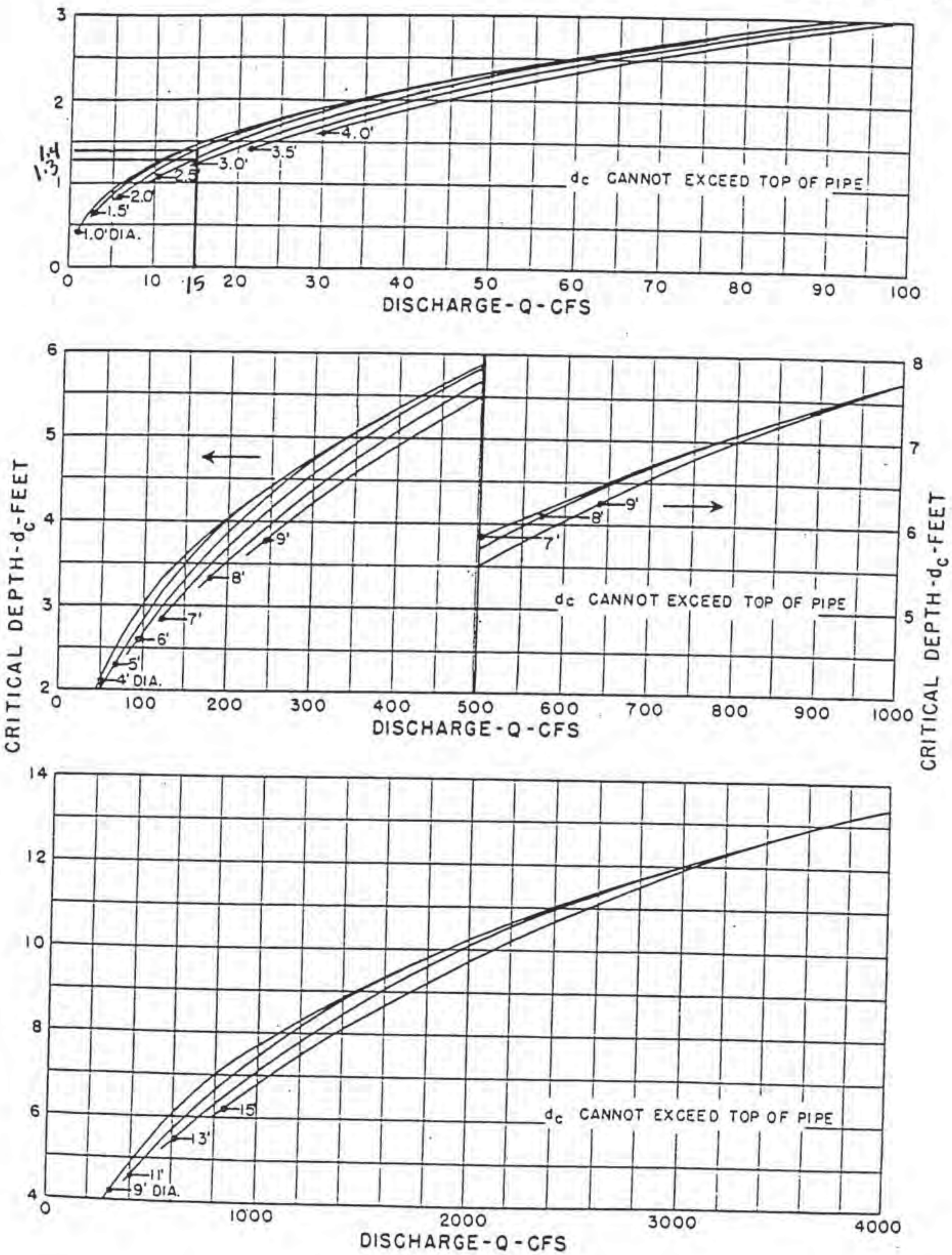




*NOTE: d_c CANNOT EXCEED D

CRITICAL DEPTH
RECTANGULAR SECTION

CHART 16



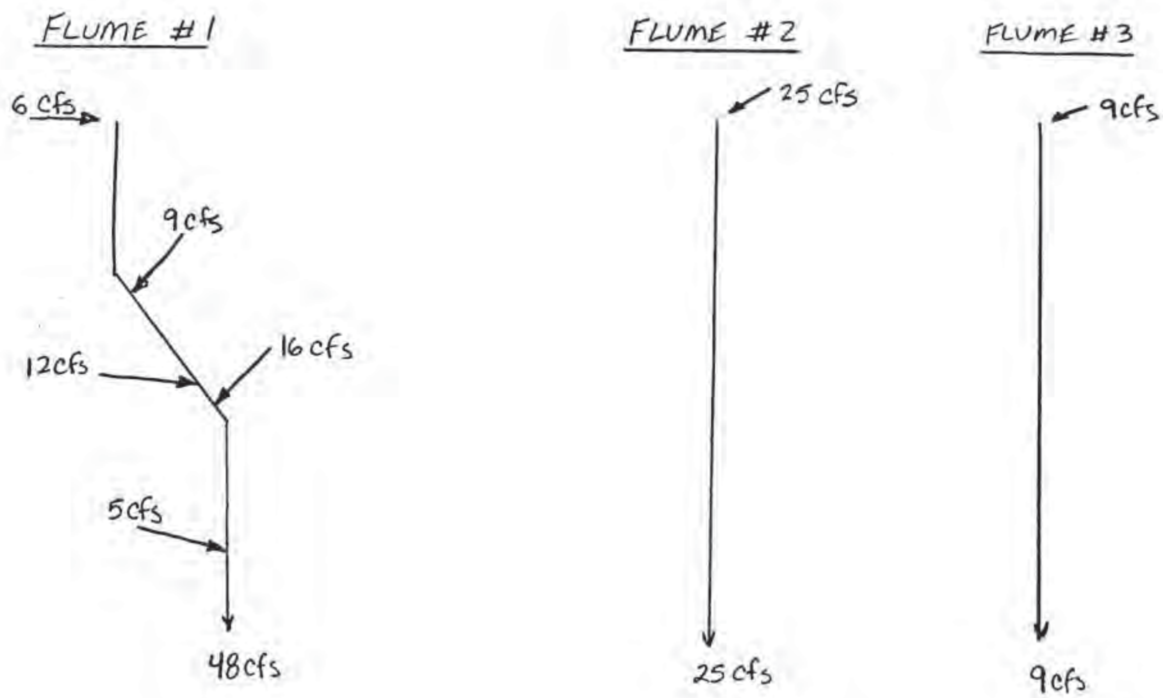
CRITICAL DEPTH
CIRCULAR PIPE

RMT
744 Heartland Trail
Madison, WI 53717-1934
Tel. (608) 831-4444 • Fax (608) 831-3334

PROJECT / PROPOSAL NAME / LOCATION: DAIRYLAND POWER – POO		PROJECT / PROPOSAL NO. 3081.40
SUBJECT: FLUME SIZING		
PREPARED BY: B.J.K	DATE: 9/00	FINAL ☐
CHECKED BY:	DATE:	REVISION ☐

DOWNSLOPE FLUME SIZING

1. SIZE INLET PIPES

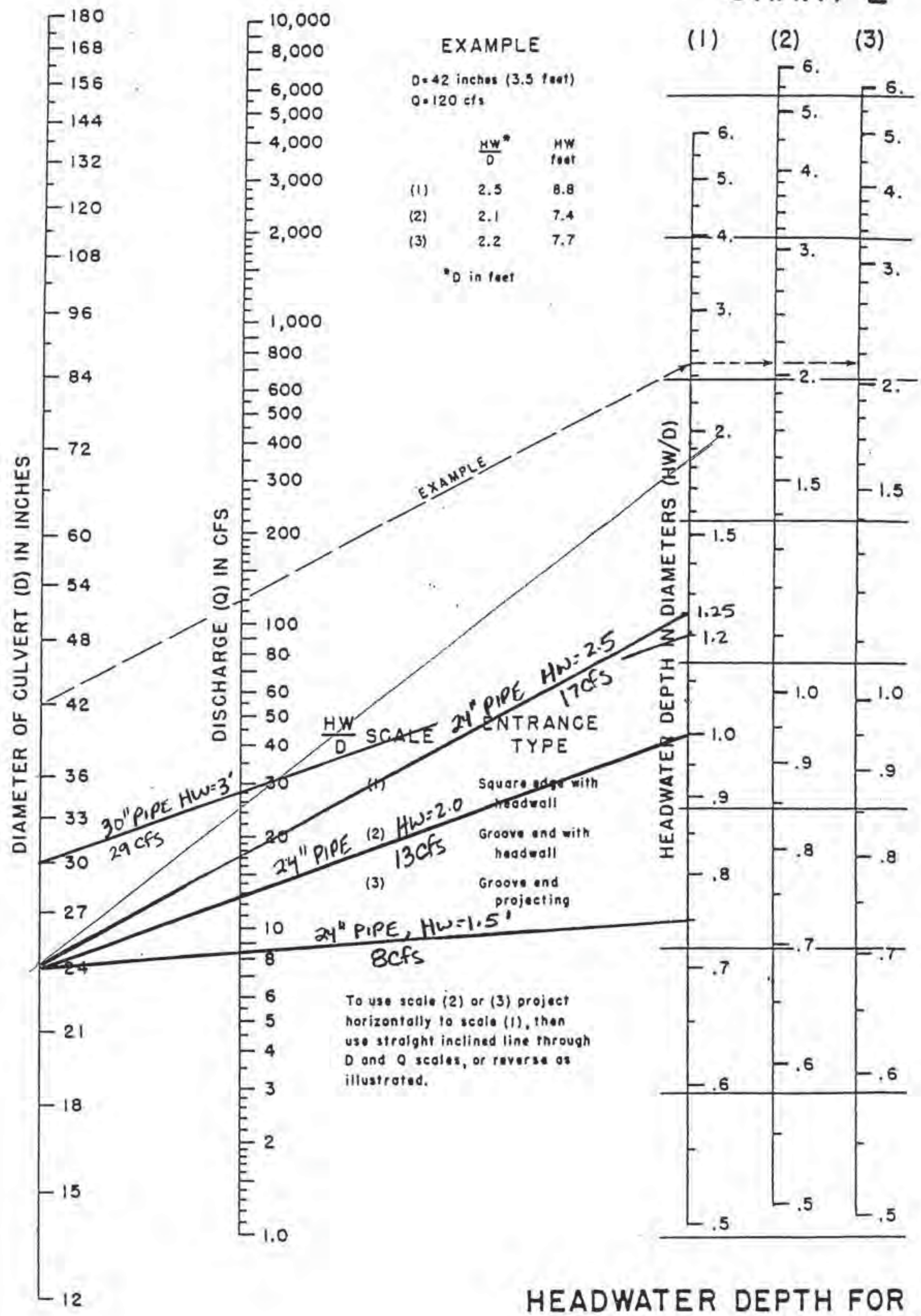


NOTE: PEAK FLOWS OBTAINED FROM RUNOFF CALCULATIONS
PEAK FLOWS ADDED TO OBTAIN TOTALS (CONSERVATIVE)

ESTABLISH INLET PIPE SIZES AND BERM HEIGHTS USING INLET CONTROL NOMOGRAPHS:

FLOW RANGE	INLET PIPE SIZE	HW	REQ'D BERM HEIGHT
0-8 cfs	24"	1.5'	2.5'
9-13 cfs	24"	2.0'	2.5'
14-17 cfs	24"	2.5'	3.0'
18-29 cfs	30"	3.0'	3.5'

CHART 2



HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

RMT
744 Heartland Trail
Madison, WI 53717-1934
Tel. (608) 831-4444 • Fax (608) 831-3334

SHEET ____ OF ____

PROJECT / PROPOSAL NAME / LOCATION: DAIRYLAND POWER - POO		PROJECT / PROPOSAL NO.
SUBJECT: FLUME SIZING		308140
PREPARED BY: BJK	DATE: 9/00	FINAL ☐
CHECKED BY:	DATE:	REVISION ☐

CHECK STRAIGHT PIPE FLUME SIZING

WORST-CASE FLOW - FLUME #1

SLOPE = 20% (AT RIDGE)
PIPE DIA = 1.5'
MAX FLOW = 48 cfs

FULL PIPE FLOW:

$$Q = \frac{1.49}{n} R^{2/3} S^{1/2} A$$

n = 0.010 for HDPE PIPE
$R = D/4 = 1.5/4 = 0.375$
$S = 0.20$ ft/ft
$A = \pi D^2/4 = \pi (1.5)^2/4 = 1.77 \text{ ft}^2$

$$Q_{FULL} = \frac{1.49}{0.01} (0.375)^{2/3} (0.20)^{1/2} (1.77)$$

$= 61$ cfs > 48 cfs ok ✓

A WATER RESOURCES TECHNICAL PUBLICATION

Engineering Monograph No. 25

Hydraulic Design of Stilling Basins and Energy Dissipators

By A. J. PETERKA

Denver, Colorado

United States Department of the Interior

BUREAU OF RECLAMATION

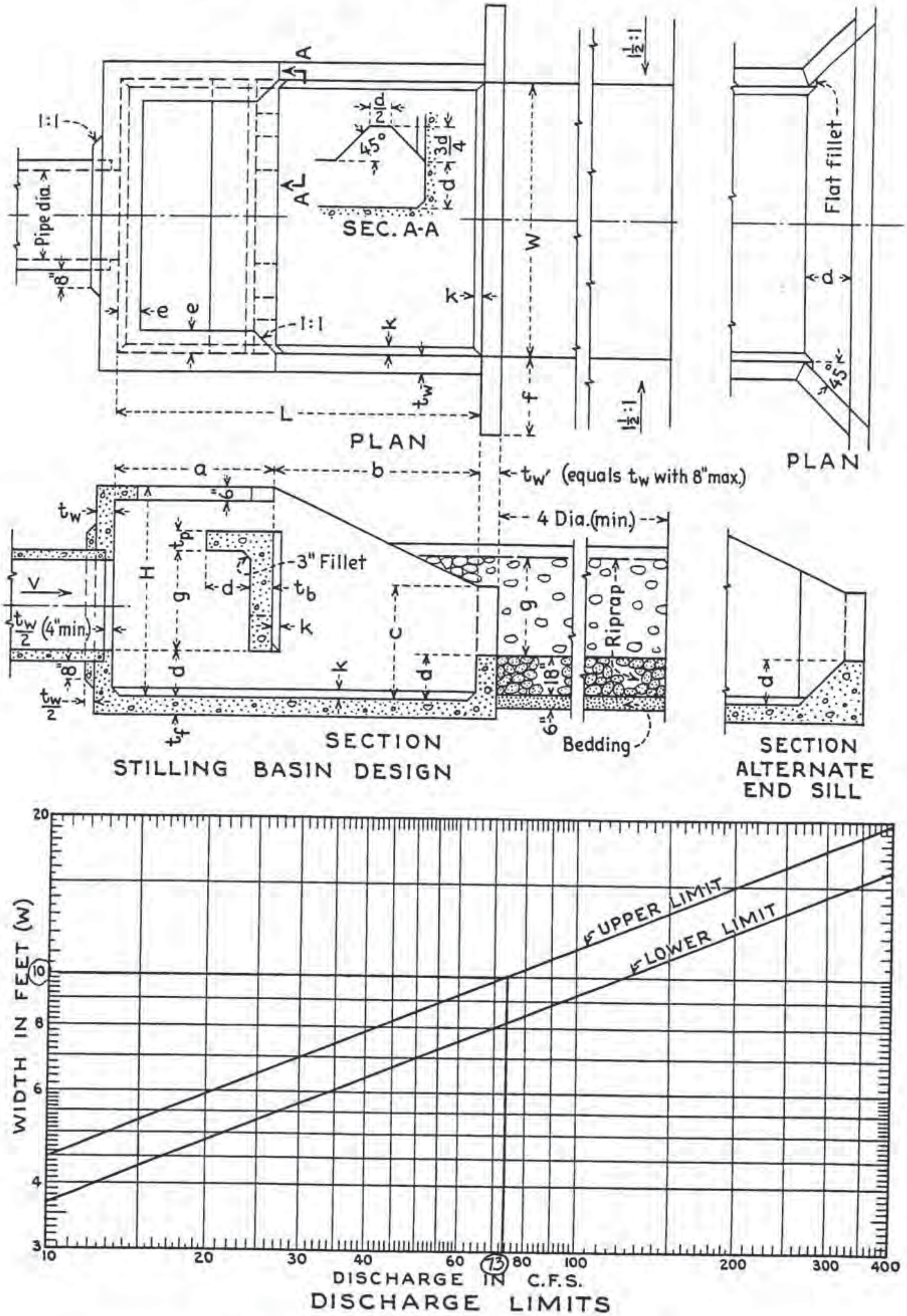


FIGURE 42.—*Impact-type energy dissipator (Basin VI).*

TABLE 11.—*Stilling basin dimensions (Basin VI). Impact-type energy dissipator.*

Suggested pipe size [1]		Max discharge Q	Feet and inches										Inches					
Dia in.	Area (sq ft)		W	H	L	a	b	c	d	e	f	g	t_w	t_f	t_b	t_p	K	Suggested riprap size
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19) [3]
18	1.77	[2] 21	5-6	4-3	7-4	3-3	4-1	2-4	0-11	0-6	1-6	2-1	6	6½	6	6	3	4.0
24	3.14	38	6-9	5-3	9-0	3-11	5-1	2-10	1-2	0-6	2-0	2-6	6	6½	6	6	3	7.0
30	4.91	59	8-0	6-3	10-8	4-7	6-1	3-4	1-4	0-8	2-6	3-0	6	6½	7	7	3	8.5
36	7.07	85	9-3	7-3	12-4	5-3	7-1	3-10	1-7	0-8	3-0	3-6	7	7½	8	8	3	9.0
42	9.62	115	10-6	8-0	14-0	6-0	8-0	4-5	1-9	0-10	3-0	3-11	8	8½	9	8	4	9.5
48	12.57	151	11-9	9-0	15-8	6-9	8-11	4-11	2-0	0-10	3-0	4-5	9	9½	10	8	4	10.5
54	15.90	191	13-0	9-9	17-4	7-4	10-0	5-5	2-2	1-0	3-0	4-11	10	10½	10	8	4	12.0
60	19.63	236	14-3	10-9	19-0	8-0	11-0	5-11	2-5	1-0	3-0	5-4	11	11½	11	8	6	13.0
72	28.27	339	16-6	12-3	22-0	9-3	12-9	6-11	2-9	1-3	3-0	6-2	12	12½	12	8	6	14.0

[1] Suggested pipe will run full when velocity is 12 feet per second or half full when velocity is 24 feet per second. Size may be modified for other velocities by Q=AV, but relation between Q and basin dimensions shown must be maintained.

[2] For discharges less than 21 second-feet, obtain basin width from curve of Fig. 42. Other dimensions proportional to W; $H=\frac{3W}{4}$, $L=\frac{4W}{3}$, $d=\frac{W}{6}$, etc.

[3] Determination of riprap size explained in Sec. 10.

Calculations – Temporary Culverts, Operational Conditions

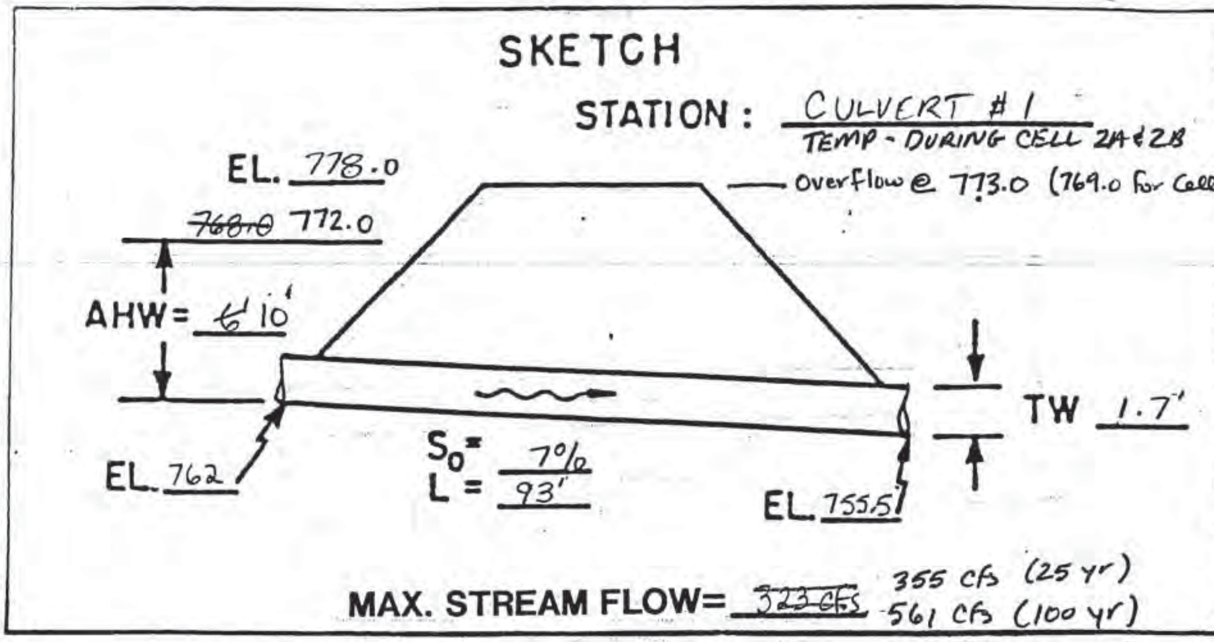
COMPUTATION SHEET

RMT INC.
744 Heartland Trail P.O. Box 8923 Madison, WI 53708-8923 (608) 831-4444 FAX: (608) 831-3334

SHEET ____ OF ____

PROJECT / PROPOSAL NAME	PREPARED		CHECKED		PROJECT/PROPOSAL NO.
DPC - PLAN OF OPERATION	By: BJK	Date: 9/00	By:	Date:	3081.40

REV BJK 7/03



Flows for Areas North + West - See Pages 92 & 96 From POO Apx K

Culvert Calculator Report
Culvert 1 - Operational (25-Year)

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	773.00 ft	Headwater Depth/ Height	1.94
Computed Headwater Elevation	769.75 ft	Discharge	355.00 cfs
Inlet Control HW Elev	769.18 ft	Tailwater Elevation	757.20 ft
Outlet Control HW Elev	769.75 ft	Control Type	Entrance Control

Grades			
Upstream Invert	762.00 ft	Downstream Invert	755.50 ft
Length	93.00 ft	Constructed Slope	0.069892 ft/ft

Hydraulic Profile			
Profile	S2	Depth, Downstream	2.10 ft
Slope Type	Steep	Normal Depth	1.58 ft
Flow Regime	Supercritical	Critical Depth	4.00 ft
Velocity Downstream	24.17 ft/s	Critical Slope	0.008921 ft/ft

Section			
Section Shape	Box	Mannings Coefficient	0.013
Section Material	Concrete	Span	7.00 ft
Section Size	7 x 4 ft	Rise	4.00 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev	769.75 ft	Upstream Velocity Head	2.50 ft
Ke	0.50	Entrance Loss	1.25 ft

Inlet Control Properties			
Inlet Control HW Elev	769.18 ft	Flow Control	Submerged
Inlet Type	18 to 33.7 ° wingwall flare, d=0.0830	Area Full	28.0 ft²
K	0.48600	HDS 5 Chart	9
M	0.66700	HDS 5 Scale	2
C	0.02490	Equation Form	2
Y	0.83000		

Culvert Calculator Report
Culvert 1 - Operational (100-Year)

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	773.00 ft	Headwater Depth/ Height	3.34
Computed Headwater Elevation	775.36 ft	Discharge	561.00 cfs
Inlet Control HW Elev	775.18 ft	Tailwater Elevation	757.20 ft
Outlet Control HW Elev	775.36 ft	Control Type	Entrance Control

Grades			
Upstream Invert	762.00 ft	Downstream Invert	755.50 ft
Length	93.00 ft	Constructed Slope	0.069892 ft/ft

Hydraulic Profile			
Profile	S2	Depth, Downstream	2.93 ft
Slope Type	Steep	Normal Depth	2.18 ft
Flow Regime	Supercritical	Critical Depth	4.00 ft
Velocity Downstream	27.37 ft/s	Critical Slope	0.022277 ft/ft

Section			
Section Shape	Box	Mannings Coefficient	0.013
Section Material	Concrete	Span	7.00 ft
Section Size	7 x 4 ft	Rise	4.00 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev	775.36 ft	Upstream Velocity Head	6.24 ft
Ke	0.50	Entrance Loss	3.12 ft

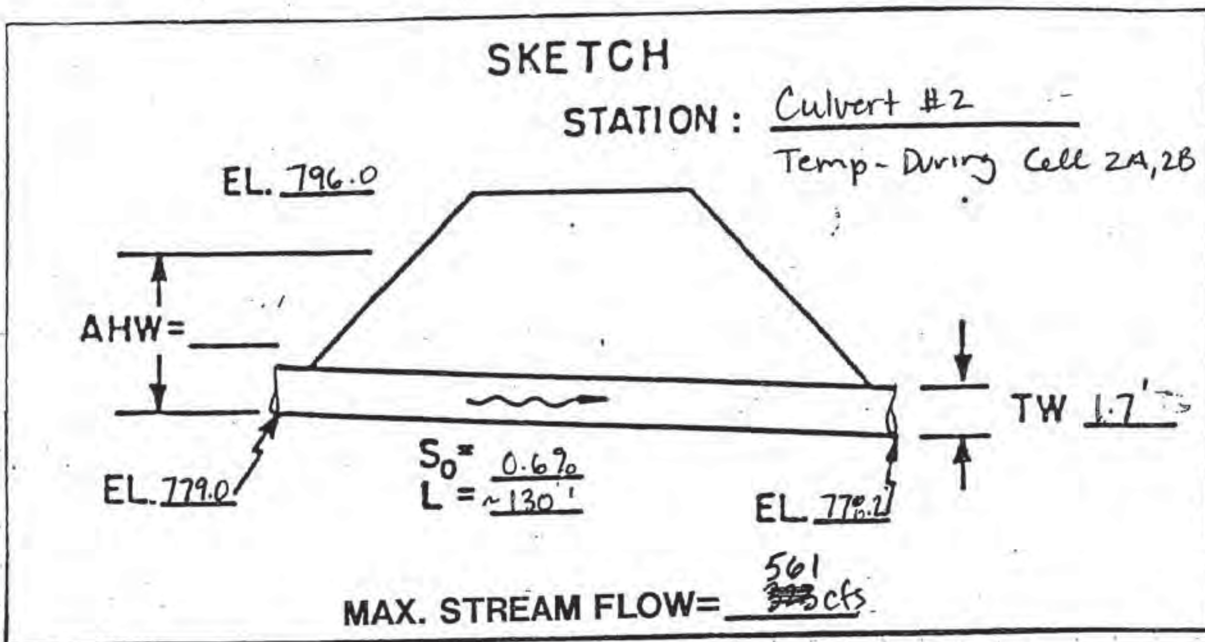
Inlet Control Properties			
Inlet Control HW Elev	775.18 ft	Flow Control	Submerged
Inlet Type	18 to 33.7 ° wingwall flare, d=0.0830	Area Full	28.0 ft²
K	0.48600	HDS 5 Chart	9
M	0.66700	HDS 5 Scale	2
C	0.02490	Equation Form	2
Y	0.83000		

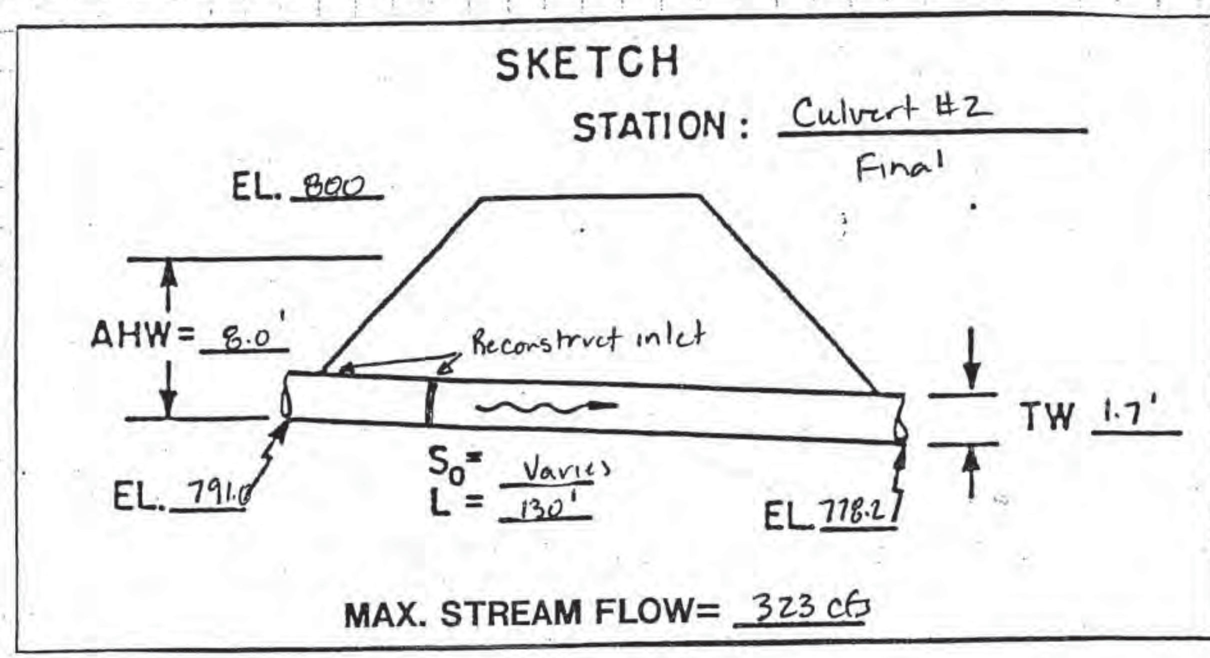
COMPUTATION SHEET

RMT INC.
744 Heartland Trail P.O. Box 8923 Madison, WI 53708-8923 (608) 831-4444 FAX: (608) 831-3334

SHEET ______ OF ______

PROJECT / PROPOSAL NAME	PREPARED		CHECKED		PROJECT/PROPOSAL NO.
Dairyland Power – Phase IV	By: BJH	Date: 7/03	By:	Date:	3081.56





Culvert Calculator Report
Culvert 2 - Operational

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	796.00 ft	Headwater Depth/ Height	3.86
Computed Headwater Elevation	794.45 ft	Discharge	561.00 cfs
Inlet Control HW Elev	792.30 ft	Tailwater Elevation	779.90 ft
Outlet Control HW Elev	794.45 ft	Control Type	Outlet Control

Grades			
Upstream Invert	779.00 ft	Downstream Invert	778.20 ft
Length	130.00 ft	Constructed Slope	0.006154 ft/ft

Hydraulic Profile			
Profile	Pressure	Depth, Downstream	4.00 ft
Slope Type	N/A	Normal Depth	N/A ft
Flow Regime	N/A	Critical Depth	4.00 ft
Velocity Downstream	20.04 ft/s	Critical Slope	0.022277 ft/ft

Section			
Section Shape	Box	Mannings Coefficient	0.013
Section Material	Concrete	Span	7.00 ft
Section Size	7 x 4 ft	Rise	4.00 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev	794.45 ft	Upstream Velocity Head	6.24 ft
Ke	0.50	Entrance Loss	3.12 ft

Inlet Control Properties			
Inlet Control HW Elev	792.30 ft	Flow Control	Submerged
Inlet Type	18 to 33.7 ° wingwall flare, d=0.0830	Area Full	28.0 ft²
K	0.48600	HDS 5 Chart	9
M	0.66700	HDS 5 Scale	2
C	0.02490	Equation Form	2
Y	0.83000		

Culvert Calculator Report
Culvert 2 - Final

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	799.00 ft	Headwater Depth/ Height	1.78
Computed Headwater Elevation	798.10 ft	Discharge	323.00 cfs
Inlet Control HW Elev	797.44 ft	Tailwater Elevation	779.90 ft
Outlet Control HW Elev	798.10 ft	Control Type	Entrance Control

Grades			
Upstream Invert	791.00 ft	Downstream Invert	778.20 ft
Length	130.00 ft	Constructed Slope	0.098462 ft/ft

Hydraulic Profile			
Profile	S2	Depth, Downstream	1.60 ft
Slope Type	Steep	Normal Depth	1.32 ft
Flow Regime	Supercritical	Critical Depth	4.00 ft
Velocity Downstream	28.87 ft/s	Critical Slope	0.007385 ft/ft

Section			
Section Shape	Box	Mannings Coefficient	0.013
Section Material	Concrete	Span	7.00 ft
Section Size	7 x 4 ft	Rise	4.00 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev	798.10 ft	Upstream Velocity Head	2.07 ft
Ke	0.50	Entrance Loss	1.03 ft

Inlet Control Properties			
Inlet Control HW Elev	797.44 ft	Flow Control	Submerged
Inlet Type	18 to 33.7 ° wingwall flare, d=0.0830	Area Full	28.0 ft²
K	0.48600	HDS 5 Chart	9
M	0.66700	HDS 5 Scale	2
C	0.02490	Equation Form	2
Y	0.83000		

COMPUTATION SHEET

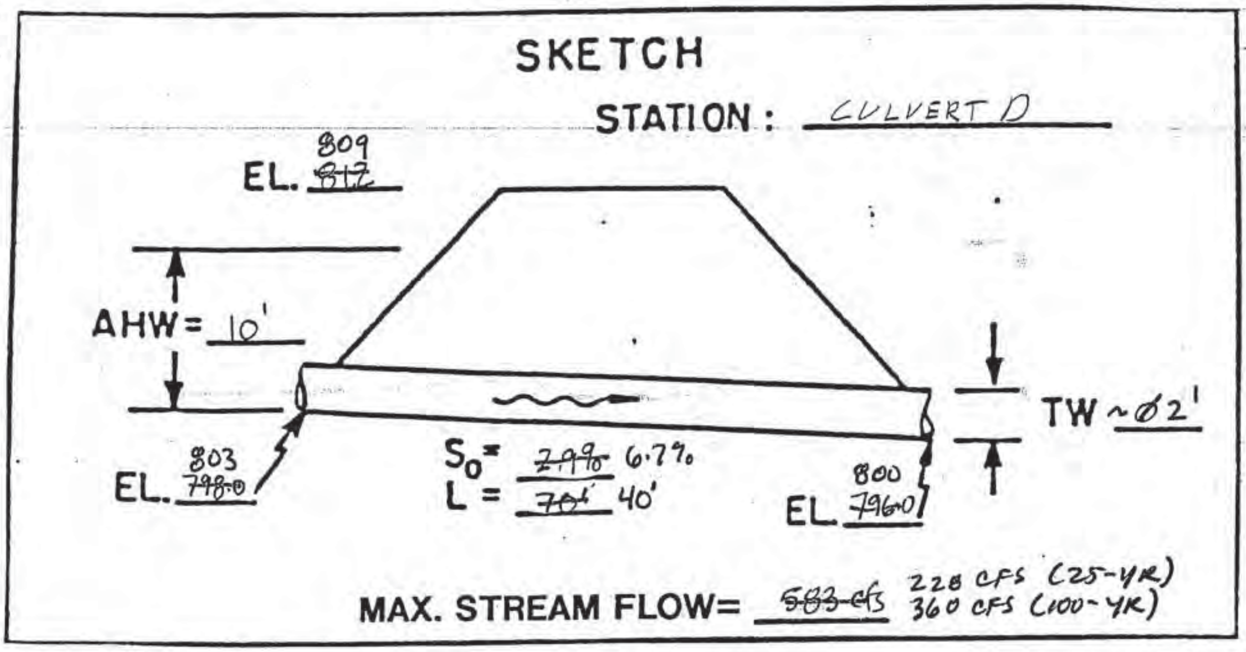
RMT INC.

744 Heartland Trail P.O. Box 8923 Madison, WI 53708-8923 (608) 831-4444 FAX: (608) 831-3334

SHEET ____ OF ____

PROJECT / PROPOSAL NAME	PREPARED By:	Date:	CHECKED By:	Date:	PROJECT/PROPOSAL NO.
DPC-PLAN OF OPERATION	KAA	9/29/00			3081.40

Rev BJK 8/03



Culvert Calculator Report
Culvert D - 25 Year

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	809.00 ft	Headwater Depth/ Height	1.40
Computed Headwater Elevation	808.61 ft	Discharge	228.00 cfs
Inlet Control HW Elev	807.84 ft	Tailwater Elevation	802.00 ft
Outlet Control HW Elev	808.61 ft	Control Type	Entrance Control

Grades			
Upstream Invert	803.00 ft	Downstream Invert	800.00 ft
Length	45.00 ft	Constructed Slope	0.066667 ft/ft

Hydraulic Profile			
Profile	S2	Depth, Downstream	1.74 ft
Slope Type	Steep	Normal Depth	1.19 ft
Flow Regime	Supercritical	Critical Depth	3.21 ft
Velocity Downstream	18.70 ft/s	Critical Slope	0.003975 ft/ft

Section			
Section Shape	Box	Mannings Coefficient	0.013
Section Material	Concrete	Span	7.00 ft
Section Size	7 x 4 ft	Rise	4.00 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev	808.61 ft	Upstream Velocity Head	1.60 ft
Ke	0.50	Entrance Loss	0.80 ft

Inlet Control Properties			
Inlet Control HW Elev	807.84 ft	Flow Control	Submerged
Inlet Type	18 to 33.7 ° wingwall flare, d=0.0830	Area Full	28.0 ft²
K	0.48600	HDS 5 Chart	9
M	0.66700	HDS 5 Scale	2
C	0.02490	Equation Form	2
Y	0.83000		

Culvert Calculator Report
Culvert D - 100 Year

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	809.00 ft	Headwater Depth/ Height	1.96
Computed Headwater Elevation	810.85 ft	Discharge	360.00 cfs
Inlet Control HW Elev	810.30 ft	Tailwater Elevation	802.00 ft
Outlet Control HW Elev	810.85 ft	Control Type	Entrance Control

Grades			
Upstream Invert	803.00 ft	Downstream Invert	800.00 ft
Length	45.00 ft	Constructed Slope	0.066667 ft/ft

Hydraulic Profile			
Profile	S2	Depth, Downstream	2.52 ft
Slope Type	Steep	Normal Depth	1.63 ft
Flow Regime	Supercritical	Critical Depth	4.00 ft
Velocity Downstream	20.38 ft/s	Critical Slope	0.009174 ft/ft

Section			
Section Shape	Box	Mannings Coefficient	0.013
Section Material	Concrete	Span	7.00 ft
Section Size	7 x 4 ft	Rise	4.00 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev	810.85 ft	Upstream Velocity Head	2.57 ft
Ke	0.50	Entrance Loss	1.28 ft

Inlet Control Properties			
Inlet Control HW Elev	810.30 ft	Flow Control	Submerged
Inlet Type	18 to 33.7 ° wingwall flare, d=0.0830	Area Full	28.0 ft²
K	0.48600	HDS 5 Chart	9
M	0.66700	HDS 5 Scale	2
C	0.02490	Equation Form	2
Y	0.83000		

Culvert Calculator Report
Flume MH

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	8.00 ft → 827.5, adjacent pipe inlet	Headwater Depth/ Height	1.98
Computed Headwater Elevation	825.18 ft	Discharge	73.00 cfs
Inlet Control HW Elev	825.18 ft	Tailwater Elevation	780.67 ft
Outlet Control HW Elev	824.72 ft	Control Type	Inlet Control

Grades			
Upstream Invert	819.25 ft	Downstream Invert	779.00 ft
Length	185.00 ft	Constructed Slope	0.217568 ft/ft

Hydraulic Profile			
Profile	S2	Depth, Downstream	0.91 ft
Slope Type	Steep	Normal Depth	0.86 ft
Flow Regime	Supercritical	Critical Depth	2.70 ft
Velocity Downstream	40.57 ft/s	Critical Slope	0.006248 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.010
Section Material	PVC	Span	3.00 ft
Section Size	36 inch	Rise	3.00 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev	824.72 ft	Upstream Velocity Head	1.85 ft
Ke	0.50	Entrance Loss	0.92 ft

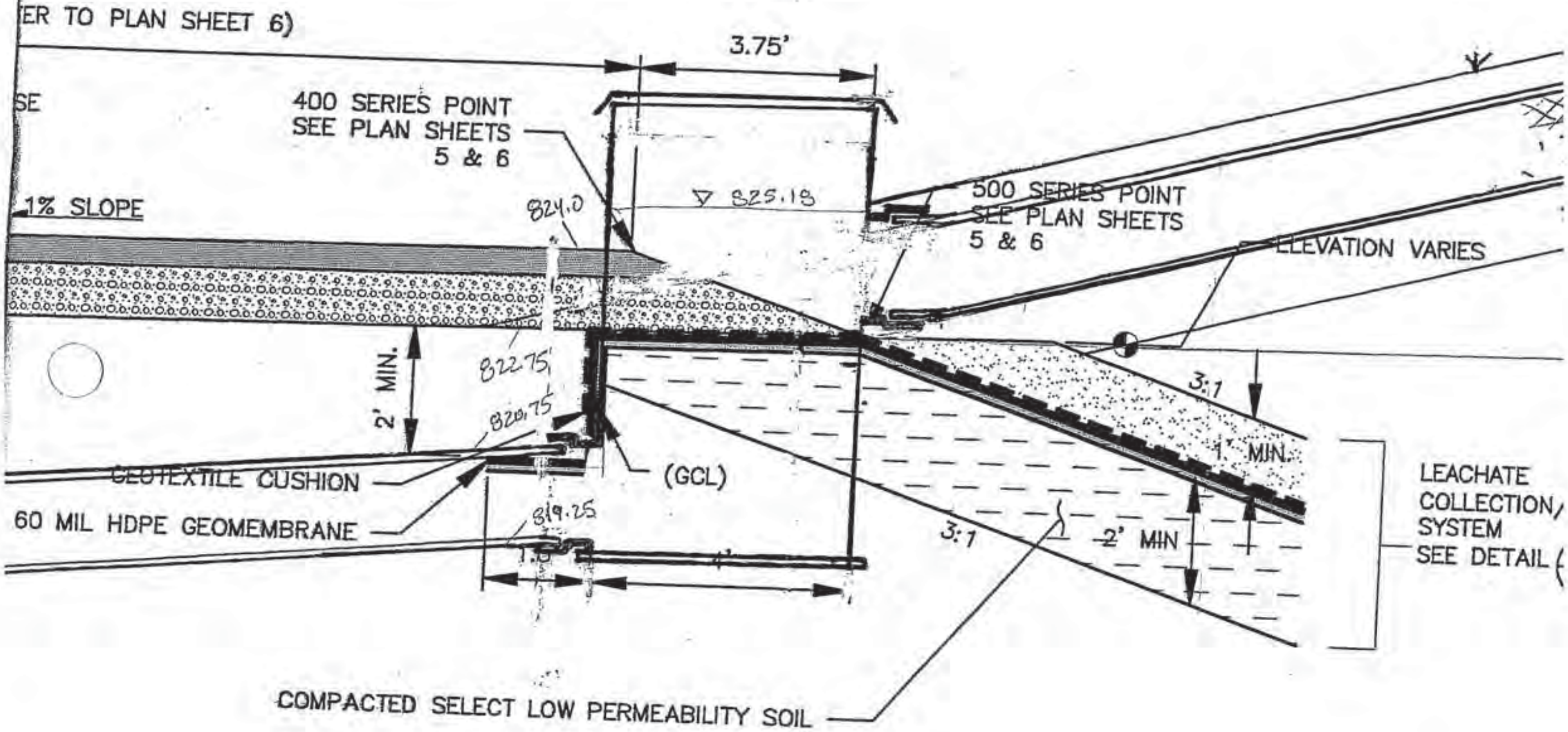
Inlet Control Properties			
Inlet Control HW Elev	825.18 ft	Flow Control	Submerged
Inlet Type	Square edge w/headwall	Area Full	7.1 ft²
K	0.00980	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		

d flange
lid add $500

SUPPLY
LARRY WOOD
262-255-3030
5/27/03

$65/VF × 7 VF BARREL
PLATE 1"

2,200 - 2,500 (incl. $500 for lid)

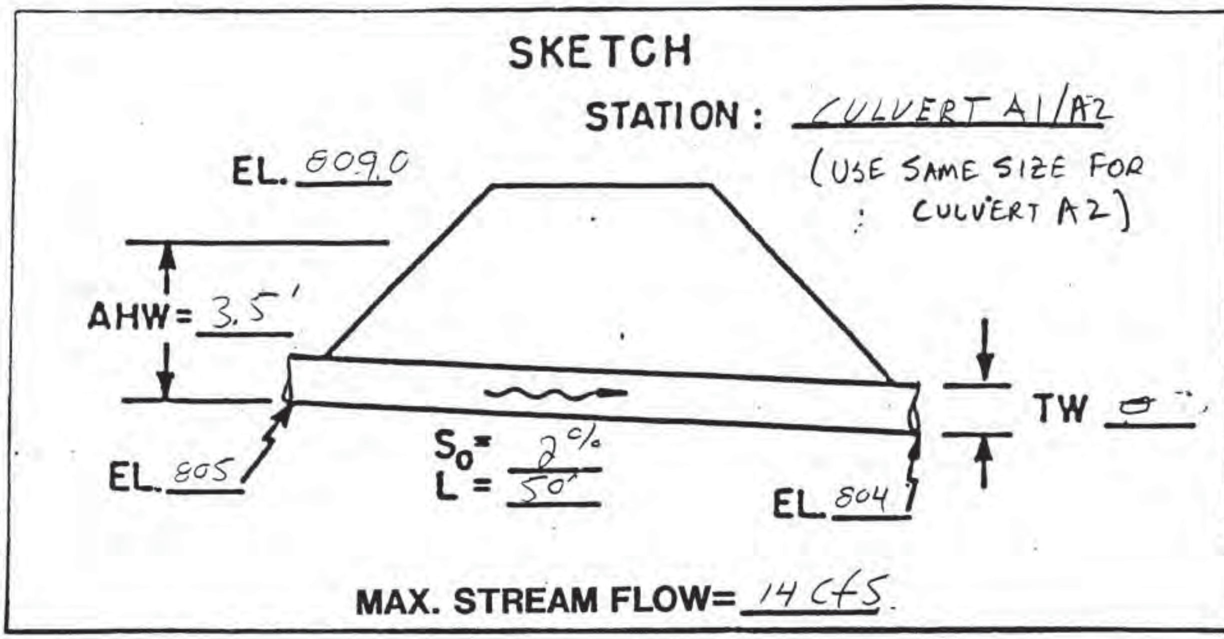


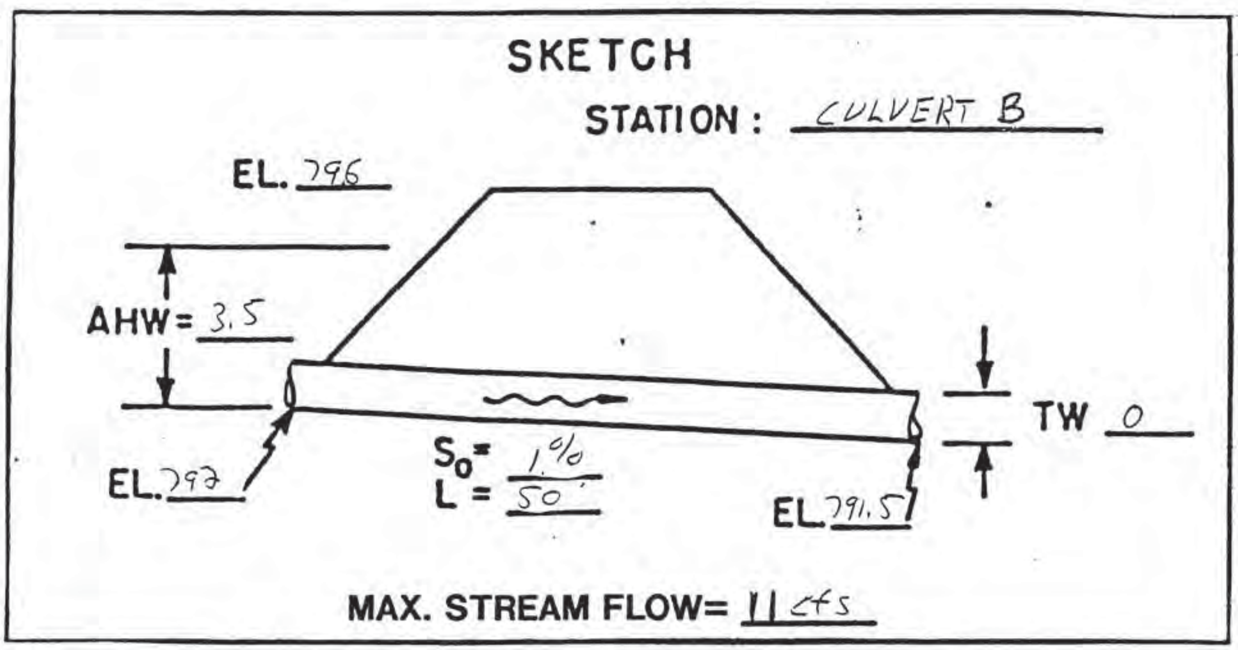
COMPUTATION SHEET

RMT INC.
744 Heartland Trail P.O. Box 8923 Madison, WI 53708-8923 (608) 831-4444 FAX: (608) 831-3334

SHEET ____ OF ____

PROJECT / PROPOSAL NAME	PREPARED		CHECKED		PROJECT/PROPOSAL NO.
DPC-PLAN OF OPERATION	By: SAA	Date: 9/3/96	By: BJK	Date:	3CE1.40





COMPUTATION SHEET

RMT INC.

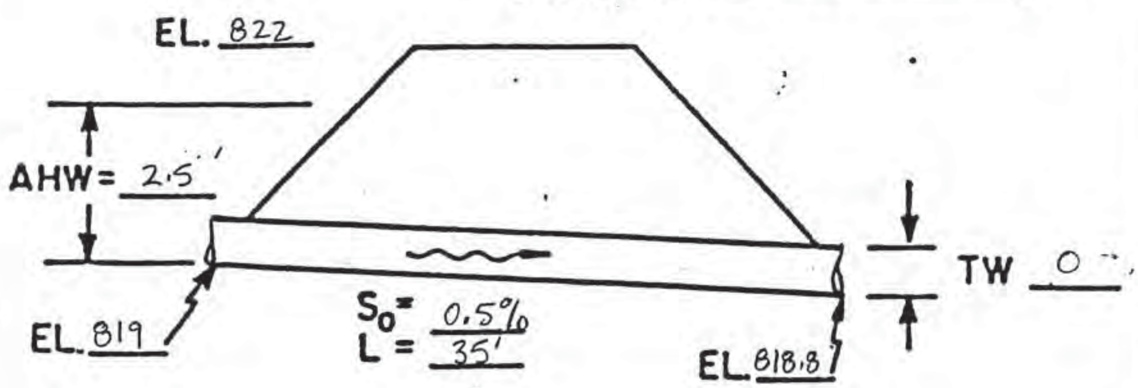
744 Heartland Trail P.O. Box 8923 Madison, WI 53708-8923 (608) 831-4444 FAX: (608) 831-3334

SHEET ______ OF ______

PROJECT / PROPOSAL NAME	PREPARED		CHECKED		PROJECT/PROPOSAL NO.
DPC- PLAN OF OPERATION	By: KAA	Date: 9/29/00	By:	Date:	3081.4C

SKETCH

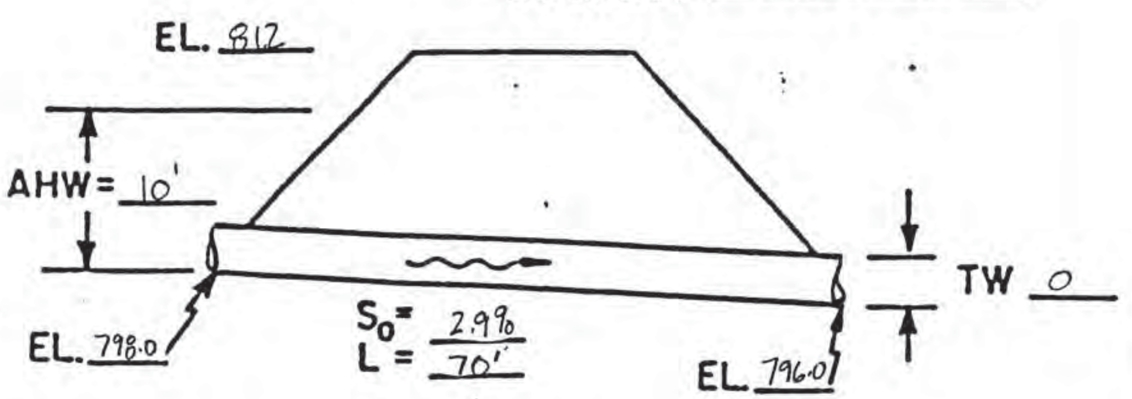
STATION: CULVERT C



MAX. STREAM FLOW = 6 cfs

SKETCH

STATION: CULVERT D



MAX. STREAM FLOW = 583 cfs

COMPUTATION SHEET

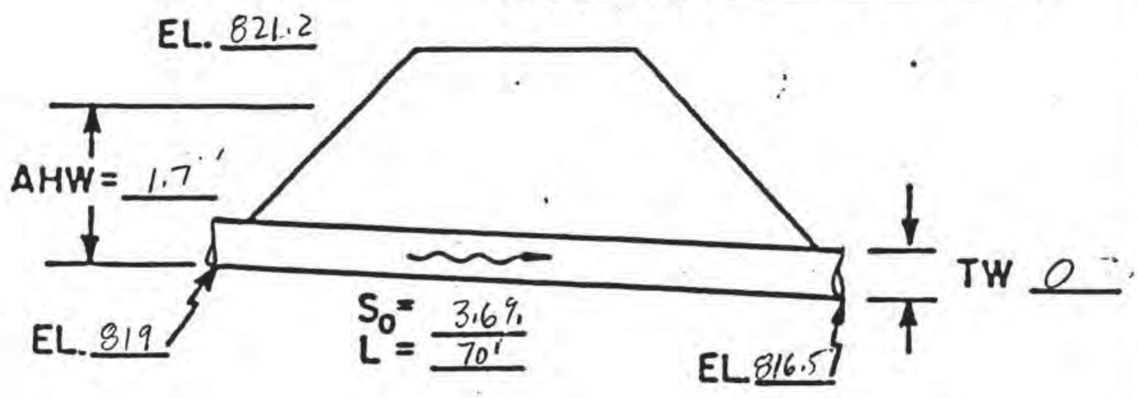
RMT INC.
744 Heartland Trail P.O. Box 8923 Madison, WI 53708-8923 (608) 831-4444 FAX: (608) 831-3334

SHEET ______ OF ______

PROJECT / PROPOSAL NAME	PREPARED		CHECKED		PROJECT/PROPOSAL NO.
DPC - PLAN OF OPERATION	By: BAA	Date: 9/29/96	By:	Date:	3C81.4C

SKETCH

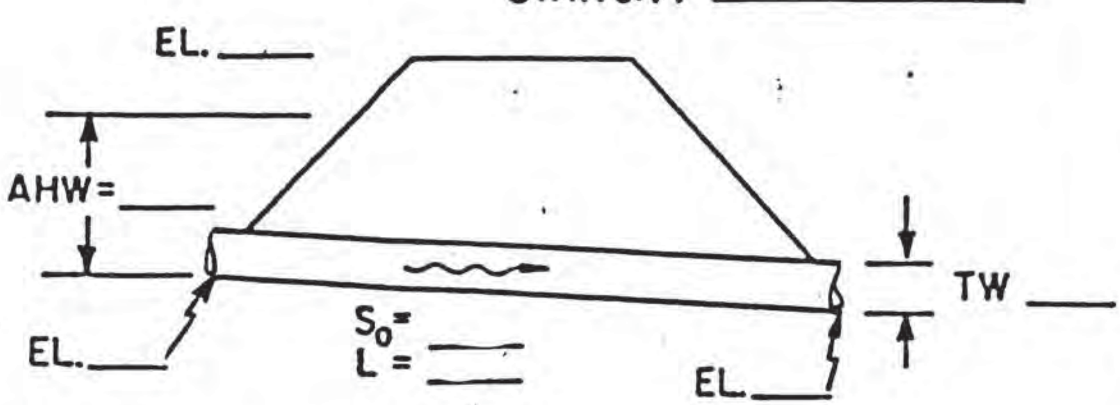
STATION : CULVERT E



MAX. STREAM FLOW = 7 cfs

SKETCH

STATION : ______



MAX. STREAM FLOW = ______

PROJECT: DPC PCO

DESIGNER: BAA

DATE: 9/29/60

HYDROLOGIC AND CHANNEL INFORMATION

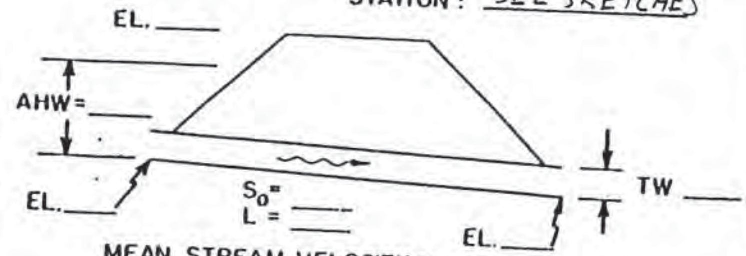
Q_1 = SEE SKETCHES TW_1 = ______

Q_2 = ______ TW_2 = ______

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH

STATION: SEE SKETCHES



MEAN STREAM VELOCITY = ______

MAX. STREAM VELOCITY = ______

CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION: INLET CONT. HW/D	INLET CONT. HW	OUTLET CONTROL $HW=H+h_o-LS_o$: K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW	CONTROLLING HW	OUTLET VELOCITY	COST	COMMENTS
CULVERT A CMP-PROJECTING	14	24"	1.15	2.3	0.9	1.3	1.4	1.7		1.7	1	2	2.3			OK
CULVERT A CONCRETE	14	18"	2	3	0.2	2.1	1.4	1.45		1.45	1	2.55				OK
CULVERT B CMP	11	24"	1.0	2.0	0.9	0.8	1.2	1.6	0	1.6	1.0	1.4				RECOMMENDED
CULVERT C	6	24"	.65	1.3	0.9	0.4	0.8	1.4	0	1.4	0.2	1.6				OK

SUMMARY & RECOMMENDATIONS:

Figure 7

PROJECT: DPC P00

DESIGNER: BAA

DATE: 9/29/00

HYDROLOGIC AND CHANNEL INFORMATION

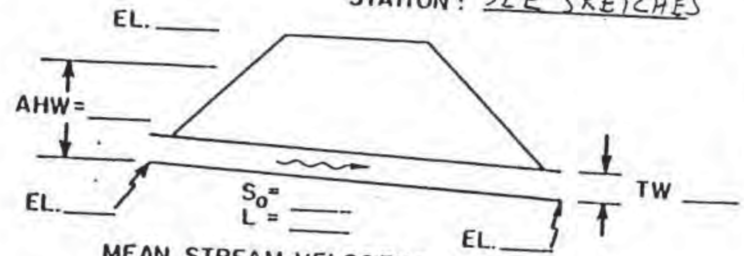
Q_1 = SEE SKETCHES TW_1 = ______

Q_2 = ______ TW_2 = ______

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH

STATION: SEE SKETCHES



MEAN STREAM VELOCITY = ______

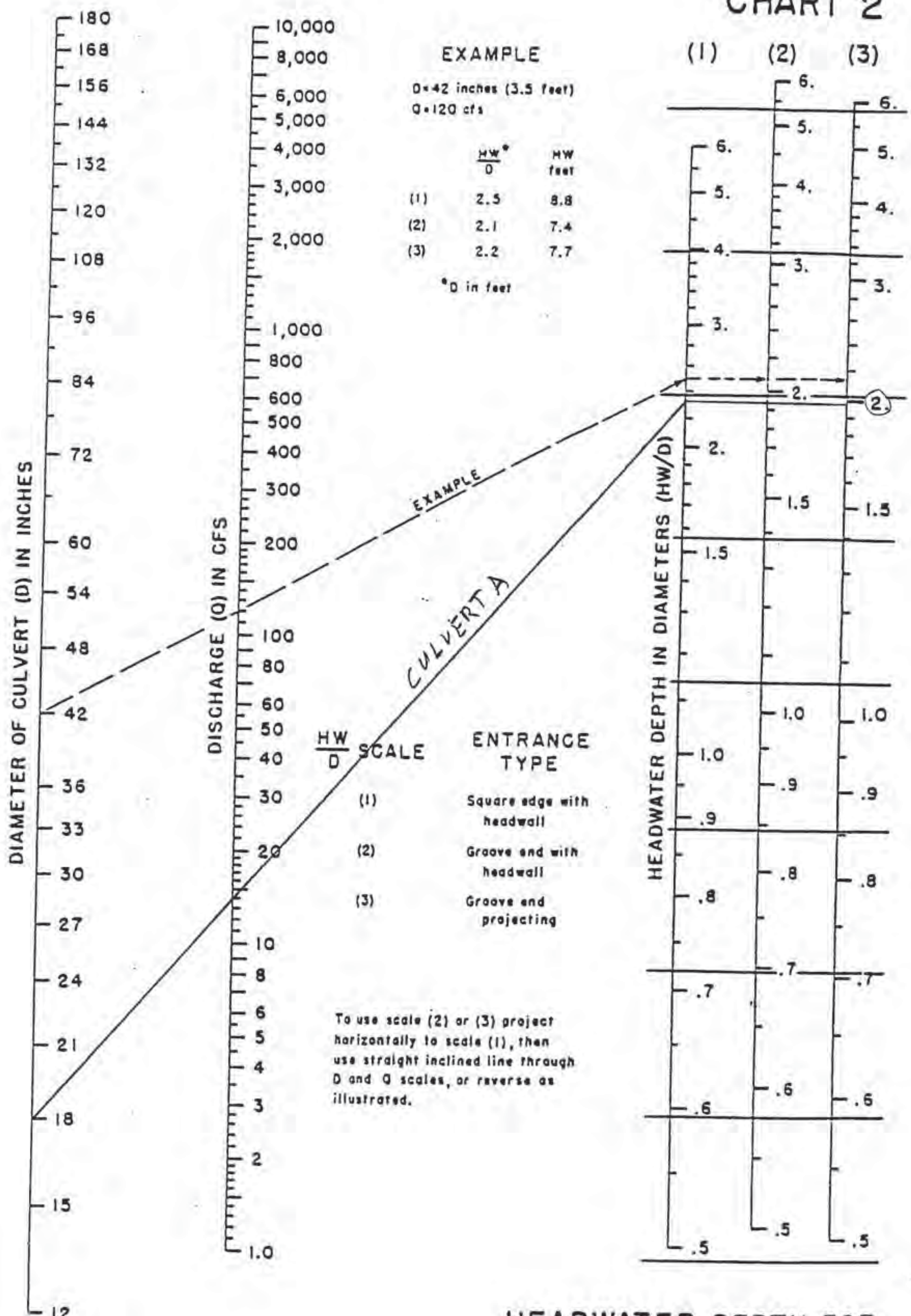
MAX. STREAM VELOCITY = ______

CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION: INLET CONT. $\frac{HW}{D}$	INLET CONT. HW	OUTLET CONTROL $HW = H + h_o - LS_o$: K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW	CONTROLLING HW	OUTLET VELOCITY	COST	COMMENTS
CULVERT E CMP-PROJECTING	7	24"	0.7	1.4	0.9	0.4	0.8	1.4	0	1.4	2.5	—	1.4			OK
CULVERT D 7'X4' BOX	583	SAME FLOW AS PERMANENT CULVERTS 1, 2, and 5.														

SUMMARY & RECOMMENDATIONS:

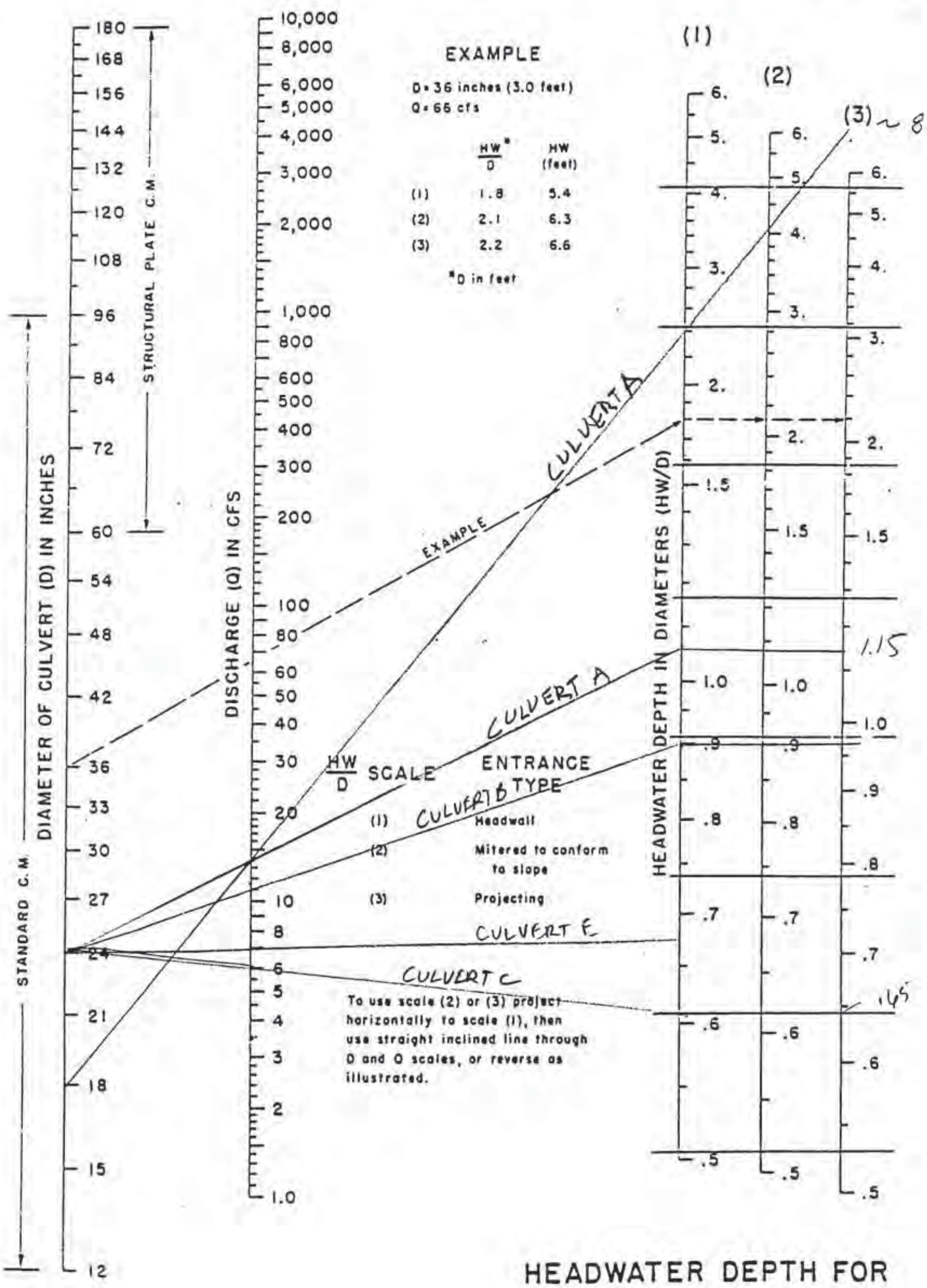
Figure 7

CHART 2



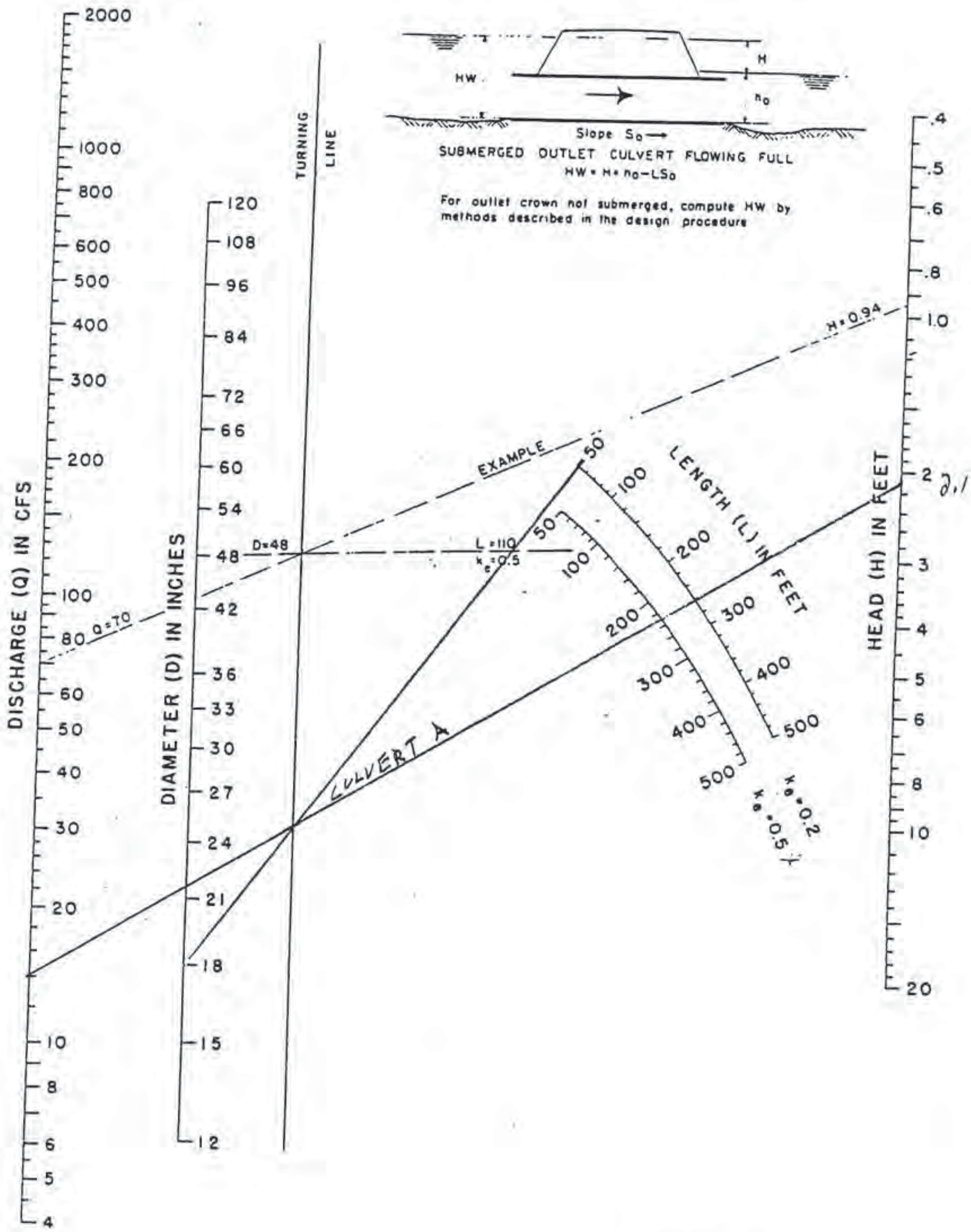
HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

CHART 5



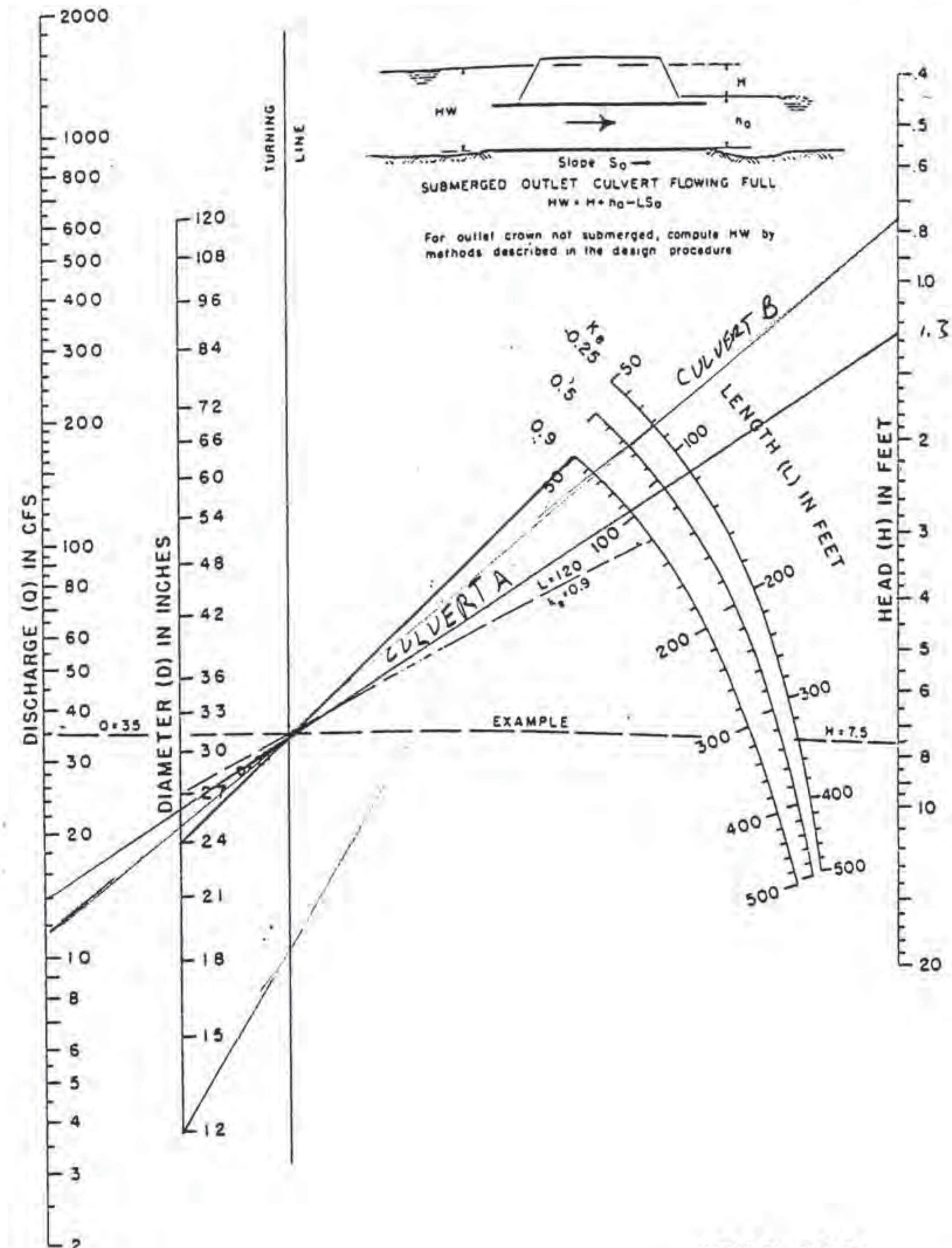
HEADWATER DEPTH FOR
C. M. PIPE CULVERTS
WITH INLET CONTROL

CHART 9



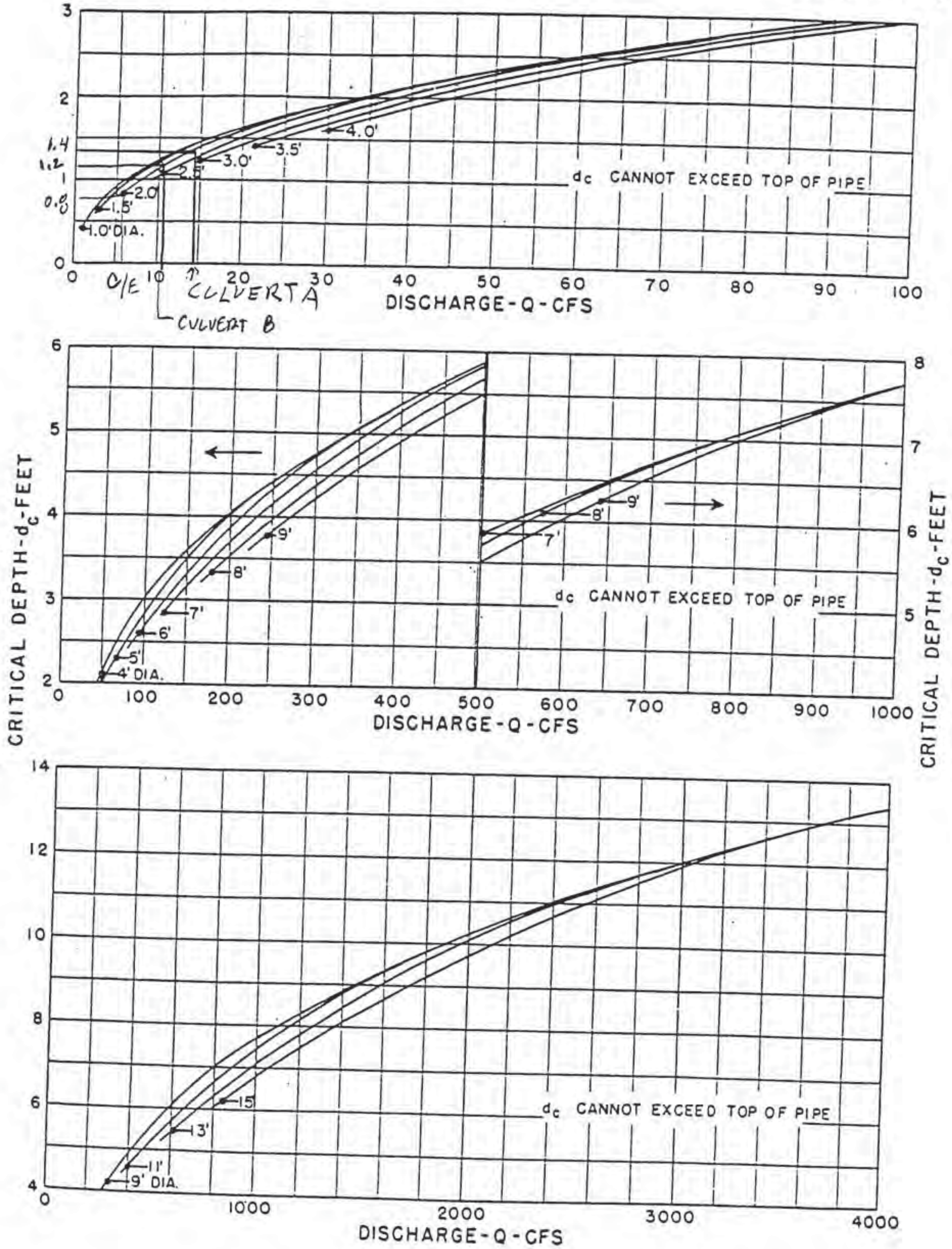
HEAD FOR
CONCRETE PIPE CULVERTS
FLOWING FULL
n = 0.012

CHART 11



HEAD FOR
STANDARD
C. M. PIPE CULVERTS
FLOWING FULL
n = 0.024

CHART 16



CRITICAL DEPTH
CIRCULAR PIPE

TABLE 1 - ENTRANCE LOSS COEFFICIENTS

Outlet Control, Full or Partly Full

Entrance head loss $H_e = k_e \frac{V^2}{2g}$

Type of Structure and Design of Entrance	Coefficient k_e
Pipe, Concrete	
Projecting from fill, socket end (groove-end) . . .	0.2
Projecting from fill, sq. cut end	0.5
Headwall or headwall and wingwalls	
Socket end of pipe (groove-end)	0.2
Square-edge	0.5
Rounded (radius = 1/12D)	0.2
Mitered to conform to fill slope	0.7
*End-Section conforming to fill slope	0.5
Beveled edges, 33.7° or 45° bevels	0.2
Side-or slope-tapered inlet	0.2
Pipe, or Pipe-Arch, Corrugated Metal	
Projecting from fill (no headwall)	0.9
Headwall or headwall and wingwalls square-edge . .	0.5
Mitered to conform to fill slope, paved or unpaved slope	0.7
*End-Section conforming to fill slope	0.5
Beveled edges, 33.7° or 45° bevels	0.2
Side-or slope-tapered inlet	0.2
Box, Reinforced Concrete	
Headwall parallel to embankment (no wingwalls)	
Square-edged on 3 edges	0.5
Rounded on 3 edges to radius of 1/12 barrel dimension, or beveled edges on 3 sides . . .	0.2
Wingwalls at 30° to 75° to barrel	
Square-edged at crown	0.4
Crown edge rounded to radius of 1/12 barrel dimension, or beveled top edge	0.2
Wingwall at 10° to 25° to barrel	
Square-edged at crown	0.5
Wingwalls parallel (extension of sides)	
Square-edged at crown	0.7
Side-or slope-tapered inlet	0.2

*Note: "End Section conforming to fill slope," made of either metal or concrete, are the sections commonly available from manufacturers. From limited hydraulic tests they are equivalent in operation to a headwall in both <u>inlet</u> and <u>outlet</u> control. Some end sections, incorporating a <u>closed</u> taper in their design have a superior hydraulic performance. These latter sections can be designed using the information given for the beveled inlet, p. 5-13.

Vegetation Information

√BLB 10/6/98

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       NORTH AMERICAN GREEN - ECMDS VER.IV - SLOPE PROTECTION - ENGLISH
              USER SPECIFIED - PERMANENT PROTECTION RESULTS
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PROJECT NAME: Dairyland Power Coop. PROJECT NO.: 3081.33
COMPUTED BY: BJK DATE: 10-06-1998
SLOPE DESCRIPTION: 2:1 Slopes

Slope Gradient: 2.00:1 ✓ Slope Length: 50 feet ✓
Soil Type: Clay Loam (K= 0.21) ✓ Annual R Factor: 125.0 ✓

Slope Reach feet	Material	Type	Density	LS	C
0 - 30	Est. Veg.	Mix	75-95%	4.10	.020
30 - 50	P300	Mix	75-95%	7.35	.002

Slope Reach feet	Material	Type	Density	ASLbare inch	ASLmat inch	SLT inch	Sf	Recommend
0 - 30	Est. Veg.	Mix	75-95%	0.641	0.013	0.03	2.3	STABLE ← For Slope's 0'-30' Use Mix No. 20 Vegetation
30 - 50	P300	Mix	75-95%	1.149	0.002	0.03	13.1	STABLE ← For slopes >30', use permanant erosion matting on bottom portion of slope (below 30') And No. 20 Vegetation on upper portion
0 - 50	Composite			0.844	0.009			

Vegetation Density=Percentage of soil coverage provided by vegetation
C=Cover material performance factor (Fraction of soil loss of unprotected)
ASLbare=Average Soil Loss potential of unprotected soil (uniform inches)
ASLmat=Average Soil Loss potential w/material (uniform inches)
SLT=Soil Loss Tolerance for slope segment (uniform inches)
Sf=Safety Factor
Composite=Average soil loss from total slope length (uniform inches)

- See Attached For Vegetation Types

Species Common Name	Species Botanical Name	Acceptable Varieties
Kentucky Bluegrass	Poa pratensis	
Red Fescue	Festuca rubra	Creeping
Hard Fescue	Festuca ovina var. duriuscula	Improved
Tall Fescue	Festuca arundinacea	Improved turf type
Salt Grass	Puccinella distans	Fult's
Redtop	Agrostis alba	
Timothy	Phleum pratense	
Little Bluestem*	Andropogon scoparius	
Sideoats Grama*	Bouteloua curtipendula	
Canada Wild Rye*	Elymus canadensis	
Perennial Ryegrass	Lolium perenne	
Perennial Ryegrass	Lolium perenne	Improved Fine
Annual Ryegrass	Lolium multiflorum	
Alsike Clover	Trifolium hybridum	
Red Clover	Trifolium pratense	
White Clover	Trifolium repens	
Birdsfoot Trefoil	Lotus corniculatus	Empire
Japanese Millet	Echinochola crusgalli var. frumentacea	
Annual Oats	Avena sativa	
Alfalfa	Medicago sativa	
Bromegrass	Bromus inermis	
Orchardgrass	Dactylis glomerata	
Ladino Clover	Trifolium repens var. latum	Ladino
Agricultural Rye	Secale cereale	
Winter Wheat	Triticum aestivum	

*Pure Live Seed

Species	Purity Min. %	Germination min. %	Mixture Proportions, Percent No. 10 (Ditches)	No. 20 (Slopes)	No. 30	No. 40	No. 50	No. 60	No. 70
Kentucky Bluegrass	85	80	40	6	10	35			
Red Fescue	97	85	25		30	20			
Hard Fescue	97	85		24	25	20			10
Tall Fescue	98	85		40					25
Salt Grass	98	85			10				
Redtop	92	85	5						
Timothy	98	90						12	
Little Bluestem		PLS*							15
Sideoats Grama		PLS*							15
Canada Wild Rye		PLS*						12	5
Perennial Ryegrass	97	90	20	30					30
Improved Fine Perennial Ryegrass	96	85			15	25			
Annual Ryegrass	97	90						35	
Alsike Clover	97	90						4	
Red Clover	98	90						4	
White Clover	95	90	10						
Birdsfoot Trefoil	95	80			10		100		
Japenese Millet	97	85						8	
Annual Oats*	98	90						25	

* Substitute winter wheat for annual oats in fall plantings started after September 1.

630.2.1.5.1.1.2 Mixture to be Used. The selection of the seed mixture or mixtures for use on the project shall meet with the approval of the engineer, and unless otherwise provided in the contract, shall be in accordance with the following:

Seed Mixture No. 10 is intended for use on projects where average loam, heavy clay or moist soils predominate.

Seed Mixture No. 20 is intended for use on projects where light, dry, well-drained, sandy or gravelly soils predominate and shall be used for all high cut and fill slopes (generally exceeding 1.8 to 2.4 m), except where No. 70 is used.

STATE OF WISCONSIN
DEPARTMENT OF TRANSPORTATION

STANDARD SPECIFICATIONS

FOR

HIGHWAY AND STRUCTURE CONSTRUCTION

1996 EDITION

****
*****   VEGETATION SELECTION   *****
*****   North American Green   *****
****

Region Number: 1

Predominant Soil Type: Clay - Clay Loam

Moisture Regime Conditions: Normal Moisture

Planned Maintenance: Medium - High Maintenance

	Longevity	Growth Habit	Seed Rate lb/ac	Seed Rate kg/ha	
Grasses					
Tall Fescue (Festuca arundinacea)	P	B	200	224	(No. 20)
Chewings Fescue (Festuca rubra, commutata)	P	B	120	134	(No. 10)
Kentucky Bluegrass (Poa pratensis)	P	S	80	90	(No 10, No. 20)
Perennial Ryegrass (Lolium perenne)	P	B	160	179	(No. 10, No 20)
Annual Ryegrass (Lolium multiflorum)	A	B	160	179	
Orchardgrass (Dactylis glomerata)	P	B	40	45	
Timothy (Phleum pratense)	P	B	80	90	
Creeping Red Fescue (Festuca rubra)	P	S	120	134	
Legumes					
Alsike Clover (Trifolium hybridum)	P		15	17	
White Dutch Clover (Trifolium repens)	P		5	6	
White Sweet Clover (Melilotus alba)	P		15	17	