REPORT

Run-On and Runoff Control System Plan

Sheldon Station
Nebraska Public Power District

Submitted to:

Nebraska Public Power District

Sheldon Station
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Submitted by:

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1.0 INTRODUCTION

Golder Associates Inc. (Golder), a member of WSP, has prepared the following plan to address the Environmental Protection Agency's (EPA's) Coal Combustion Residuals (CCR) Rule at the Nebraska Public Power District's (NPPD's) Sheldon Station (SS) Ash Landfill No. 4 (Landfill). The CCR Rule, 40 Code of Federal Regulations (CFR) Part 257, Subpart D (EPA 2015), requires the creation and maintenance of an initial Run-On and Runoff Control Plan, as specified in § 257.81, no later than October 17, 2016 for existing or new CCR Landfills or lateral expansions, with renewal every five years thereafter.

2.0 40 CFR 257.81 REQUIREMENTS FOR RUN-ON AND RUNOFF CONTROL SYSTEMS

In accordance with § 257.81(b)(1), the plan must document how the run-on and runoff systems have been designed and constructed to meet the following criteria, as supported by appropriate engineering calculations, for CCR landfills:

- The Run-on Control System must be designed to prevent flow onto the active portion of the CCR unit during the peak discharge from a 24-hour, 25-year storm.
- The Runoff Control System for the active portion of the CCR unit must be designed to collect and control at least the water volume resulting from a 24-hour, 25-year storm, in accordance with § 257.3-3, detailing discharges to surface waters.

Further clarification on the intent of the rule is provided in the text of the Preamble for the CCR Rule:

The owner or operator must design, construct, operate, and maintain the CCR landfill is such a way that any runoff generated from at least a 24-hour, 25-year storm must be collected through hydraulic structures, such as drainage ditches, toe drains, swales, or other means, and controlled so as to not adversely affect the condition of the CCR landfill. EPA has promulgated these requirements to minimize the detention time of runoff on the CCR landfill and minimize infiltration into the CCR landfill, to dissipate storm water runoff velocity, and to minimize erosion of CCR landfill slopes. An additional concern with runoff from CCR landfills is the water quality of the runoff, which may collect suspended solids from the landfill slopes.

Descriptions of the run-on and runoff control systems designed for and operated at SS follow within the following sections.

3.0 RUN-ON CONTROL

Landfill run-on is defined as stormwater that may flow towards the active portions of the Landfill. The Landfill has been designed and operated with a perimeter berm to prevent run-on and divert clean stormwater away from the Landfill. Topographically, the Landfill at SS sits higher than the surrounding features. Consequently, the potential for run-on to the Landfill is considered to be negligible, and run-on calculations were not warranted for this site. The Landfill has been designed and operated with a perimeter berm, drainage features, and a contact water collection system (CWCS) to manage contact water within the lined Landfill footprint and to shed clean stormwater away from the Landfill. These features were designed based on a 24-hour, 25-year storm and will also reduce the risk of run-on into the Landfill. The design of these surface water runoff features is described in the following section of this plan.

4.0 RUNOFF CONTROL

Runoff at SS consists of both contact water (water having directly contacted CCR within the active area of the Landfill) and non-contact stormwater. Contact water runoff is managed within the lined Landfill footprint and a lined evaporation pond.

Within the Landfill, contact water is directed to a sump system through the CWCS and grading of CCRs to slope towards the sump system. The CWCS extends across the floor of the Landfill and was constructed on top of the liner. The CWCS consists of a 1-foot layer of granular material (i.e., sand or bottom ash) with 4-inch high density polyethylene (HDPE) perforated pipe laterals and headers, overlain by an 8-ounce/square yard geotextile. CCRs are placed in a manner to promote contact water flow on the CCR surface towards the sump system. Contact water collected in the CWCS sump or temporarily accumulated on the CCR surface is pumped into the adjacent lined evaporation pond.

The final cover stormwater controls are based on calculations included in Appendix A The calculations for the contact and non-contact stormwater controls are based on a 24-hour, 25-year storm event.

Water from the evaporation pond may be used for dust control within the Landfill area. NPPD operations staff routinely monitor the Landfill, including after significant storm events. Potential erosion or surface water management issues are documented and corrected as necessary to ensure the Landfill operates as designed.

5.0 CERTIFICATION

Jacob Sauer (PE E-15119) attests to the completeness and accuracy of this Run-on and Runoff Control Plan and certifies that the plan meets the requirements detailed in 40 CFR 257.81. Notification of the completion of the plan will be provided to the appropriate regulatory agencies, as the plan will be placed in the operating records and available on NPPD’s publicly accessible website.

6.0 REFERENCES

EPA (Environmental Protection Agency). 2015. Environmental Protection Agency, Code of Federal Regulations Title 40 Part 257: Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities. April 17, 2015, amended July 30, 2018.

APPENDIX A

Surface Water Controls

Golder Associates					
Subject	Sheldon Station	Made by	DG-L	Job	003-2168
Landfill – Final Cover		Checked by	JW/	Date	8/21/00
Hydrology & Hydraulics		Approved by	DLD	Sheet	1 of 1

OBJECTIVE:
Design a surface water control plan for final cover configuration at the Sheldon Station Landfill in Lancaster County Nebraska. This includes design and details for terrace channels, perimeter channels, and down-slope channels designed to convey the 25-year, 24-hour storm event.

METHOD:
The surface water parameters as described below were used to model the Sheldon Station Landfill site. The landfill was delineated into 18 subbasins (Figure A-1 for top of landfill, and Figure A-2 for lower areas of the landfill). HEC-1 modeling software (Ref. 1) was used to route surface water and calculate peak flows for each subbasin. The kinematic wave transform was used to develop hydrographs for landfill subbasins. Peak flows were used to size the landfill terrace, perimeter, and down-slope channels assuming normal depth.

ASSUMPTIONS:
- The 25-year, 24-hour storm event was used to size all structures.
- 25-year, 24-hour rainfall event equals 5.3 inches (Ref 2).
- Kinematic Wave factor for Roughness, N = 0.35, Table 2.1 for Pasture (Ref 3)
- NRCS (formerly SCS) Type II synthetic rainfall distribution.
- Landfill final cover SCS Curve Numbers (CN):

Location	Hydrologic Soil Group	Assumed Cover	SCS CN
Landfill Final Cover	C	Pasture, fair cover	79
Haul Road	C	Bare	89

- Channel Lining Manning's roughness Coefficients:

Channel Lining	Manning's n for Stability	Manning's n for Capacity
Grass	0.030	0.035
Trilock (4")	0.026	0.026
Riprap	0.035	0.040

- All Terrace channel slopes = 0.5%

CALCULATIONS:
All channel sizing calculations were performed using a spreadsheet to calculate normal depth for both stability and capacity.

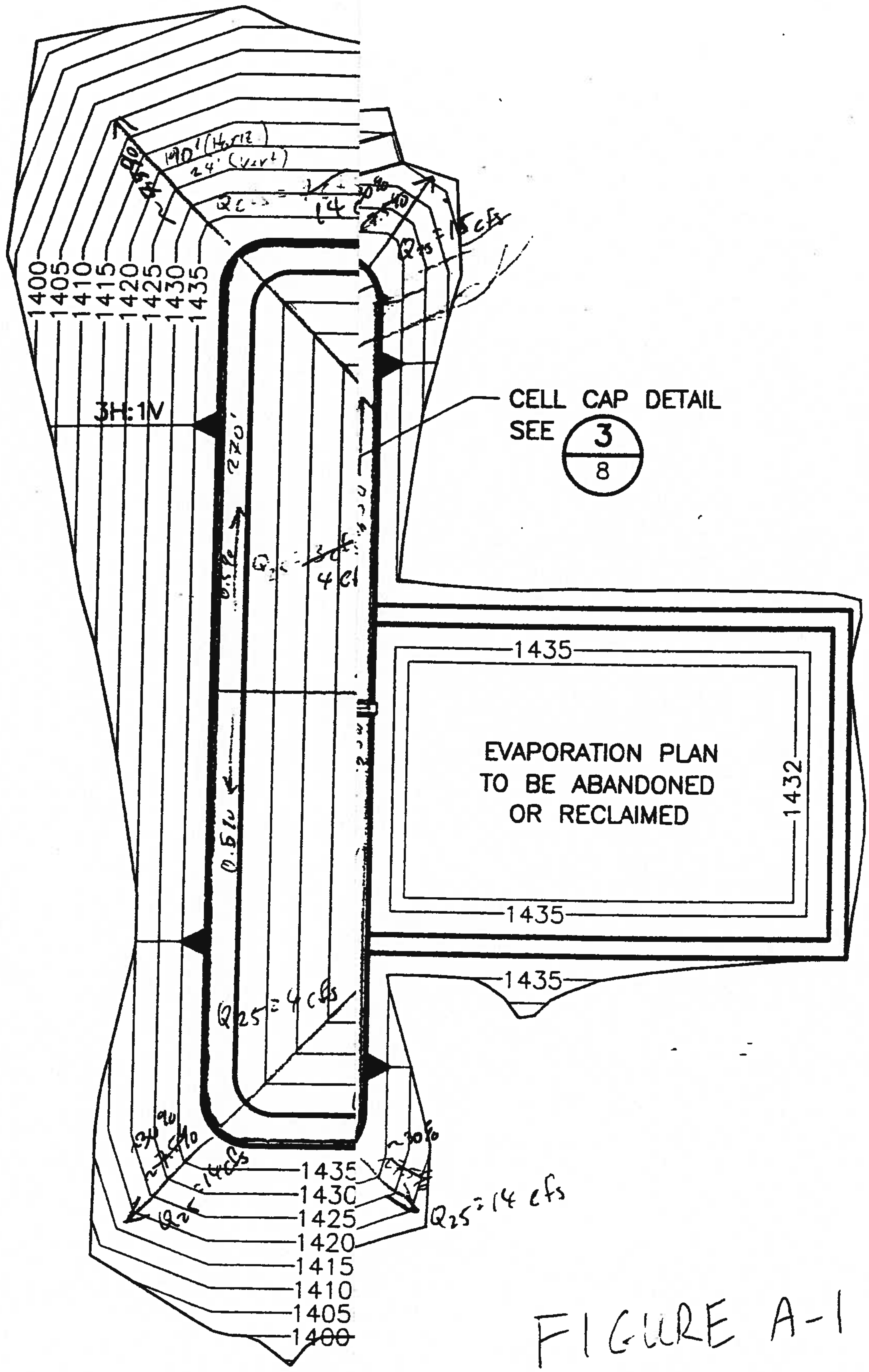
CONCLUSIONS/RESULTS:
A surface water control plan for the Sheldon Station Landfill final cover was designed to convey the 25-year, 24-hour storm event. This plan includes design and details for terrace, perimeter, and down-slope channels. A summary of terrace, perimeter, and down-slope channel sizes can be found in Table 1. HEC-1 output has been included as Attachment 1.

REFERENCES:

1) Haestad Methods. 1989. *HEC-1* [computer software]. Waterbury CT : Haestad Methods Inc.
2) Hershfield, David M. TP40 *Rainfall Frequency Atlas of the United States* (SCS). 1961
3) US Army Corps of Engineers, *Introduction and Application of Kinematic Wave Routing Techniques Using HEC-1*, 1979

TABLE 1
SHELDON STATION CHANNEL SIZING

		CHANNEL DESIGN									HYDRAULIC PARAMETERS						
REACH	Q25 (cfs)	CHANNEL MATERIAL	STD RIPRAP TYPE [(1)]	LENGTH (ft)	VERT. DROP (ft)	SLOPE (ft/ft)	LEFT SIDE SLOPE (H:1V)	RIGHT SIDE SLOPE (H:1V)	CHANNEL DEPTH (ft)	BOTTOM WIDTH (ft)	MANNING n FOR CAPACITY	MANNING n FOR STABILITY	MAX VELOCITY (fps)	MAX NORMAL FLOW DEPTH (ft)	SHEAR STRESS (lb/ft^2)	AVAILABLE FREEBOARD (ft)	TOP WIDTH OF FLOW (ft)
R-A	10.0	Grass-lined	-	478	2.4	0.005	6.7	3.0	1.5	0	0.035	0.030	2.1	1.0	0.32	0.5	10.1
R-B	4.0	Grass-lined	-	270	1.4	0.005	3.0	6.7	1.5	0	0.035	0.030	1.7	0.7	0.23	0.8	7.1
R-C	4.0	Grass-lined	-	270	1.4	0.005	6.7	3.0	1.5	0	0.035	0.030	1.7	0.7	0.23	0.8	7.1
R-D	10.0	Grass-lined	-	478	2.4	0.005	3.0	6.7	1.5	0	0.035	0.030	2.1	1.0	0.32	0.5	10.1
R-E	10.0	Grass-lined	-	478	2.4	0.005	6.7	3.0	1.5	0	0.035	0.030	2.1	1.0	0.32	0.5	10.1
R-F	4.0	Grass-lined	-	270	1.4	0.005	3.0	6.7	1.5	0	0.035	0.030	1.7	0.7	0.23	0.8	7.1
R-I	7.0	Grass-lined	-	450	2.3	0.005	3.0	6.7	1.5	0	0.035	0.030	2.0	0.9	0.28	0.6	8.8
R-H	4.0	Grass-lined	-	360	15.2	0.040	10	6.7	1.5	0	0.035	0.030	3.3	0.4	1.01	1.1	8.8
R-G	4.0	Grass-lined	-	380	1.9	0.005	6.67	3	1.5	0	0.035	0.030	1.7	0.7	0.23	0.8	7.1
R-ABdown	14.0	Trilock	-	-	-	0.300	3	3	1.0	2	0.026	0.026	12.7	0.4	6.70	0.6	4.1
R-CDdown	14.0	Trilock	-	-	-	0.300	3	3	1.0	2	0.026	0.026	12.7	0.4	6.70	0.6	4.1
R-EFdown	14.0	Trilock	-	-	-	0.300	3	3	1.0	2	0.026	0.026	12.7	0.4	6.70	0.6	4.1
R-GHIdown	15.0	Trilock	-	-	-	0.300	3	3	1.0	2	0.026	0.026	13.0	0.4	6.95	0.6	4.2
R-T	8.0	Grass-lined	-	520	26.0	0.050	3.0	3.0	1.5	0	0.035	0.030	5.0	0.7	2.09	0.8	4.0
R-J	5.0	Grass-lined	-	580	46.4	0.080	3.0	3.0	1.5	10	0.035	0.030	3.6	0.1	0.73	1.4	10.9
R-K	1.0	Grass-lined	-	220	15.4	0.070	3.0	3.0	1.5	0	0.035	0.030	3.6	0.3	1.41	1.2	1.9
R-L	16.0	Grass-lined	-	220	13.2	0.060	3.0	3.0	1.5	10	0.035	0.030	5.0	0.3	1.17	1.2	12.3
R-M	8.0	Grass-lined	-	755	30.2	0.040	3.0	3.0	1.5	0	0.035	0.030	4.9	0.8	1.95	0.7	4.7
R-N	2.0	Grass-lined	-	376	7.5	0.020	3.0	3.0	1.5	0	0.035	0.030	2.7	0.5	0.66	1.0	3.2
R-P	9.0	Grass-lined	-	260	20.8	0.080	3.0	3.0	1.5	10	0.035	0.030	4.5	0.2	1.04	1.3	11.3
R-Q	16.0	Grass-lined	-	260	10.4	0.040	3.0	3.0	1.5	10	0.035	0.030	4.6	0.4	0.96	1.1	12.3
R-R	3.0	Grass-lined	-	250	5.0	0.020	3.0	3.0	1.5	0	0.035	0.030	3.0	0.6	0.77	0.9	3.7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1405
1410
1415
1420
1425
1430
1435
3H:1V
CELL CAP DETAIL
SEE 3/8
1435
EVAPORATION PLAN
TO BE ABANDONED
OR RECLAIMED
1432
1435
1435
1435
1430
1425
1420
1415
1410
1405
1400
Q_{25} = 4 cfs
Q_{25} = 14 cfs

FIGURE A-1

OBJECTIVE:
Design energy dissipators for the downchute channels at Sheldon Station.

METHODS:
The design flows and downchutes were determined in a previous calculation (Golder 2001). Energy dissipators were designed as hydraulic jump stilling pools (USBR 1978). The stilling pool dimensions were estimated from the following equations:

$$F = \frac{V_1}{\sqrt{gd_1}} \qquad \text{(Eq. 1)}$$

Where:
F = Froude number,
V_1 = downchute channel velocity (ft/s),
g = acceleration of gravity (ft/s^2),
d_1 = downchute channel flow depth (ft).

and:

$$b = \frac{360\sqrt{Q}}{Q+350} \qquad \text{(Eq. 2)}$$

Where:
b = stilling pool width (ft),
Q = downchute channel flow (ft^3/s).

and:

$$d_2 = -\frac{d_1}{2} + \sqrt{\frac{2V_1^2 d_1}{g} + \frac{d_1^2}{4}} \qquad \text{(Eq. 3)}$$

Where:
d_2 = stilling pool conjugate flow depth (ft),
other variables as defined above.

The conjugate depth (in the stilling pool) and the downstream outlet channel flow depth (calculated assuming normal depth using Manning's equation in a spreadsheet application) must balance (i.e. have the same water surface elevation) (USBR 1978). This was accomplished by setting the bottom elevation of the stilling pool lower than the water surface elevation in the stilling pool outlet channel by the difference in flow depths (i.e. $D_P = D_2 - D_3$; See Figure 1). The length of the stilling pool is three times D_2. The equations above are applicable to rectangular channels, but provide a reasonable approach to sizing stilling pools for trapezoidal channels.

ASSUMPTIONS:

- Manning's numbers of 0.030 and 0.035 were used for natural channel stability and capacity.
- Manning's number of 0.026 was used for both stability and capacity in Tri-lock channels.
- Design flows are based on the 100-year, 24-hour recurrence interval storm.

CALCULATIONS:

Stilling pool calculation summaries are presented in Table 1. Because the Froude number is less than 4.5 (e.g. 3.7) the pool depth should be increased by ten percent (USBR 1987).

CONCLUSIONS/RESULTS:

The recommended stilling pools are roughly 5.25 feet long, 1.40 feet deep and 3.75 feet wide. Each should be lined with Tri-lock to reduce the potential for scour. Recommended outlet channel dimensions needed for proper function of the stilling pools are also presented in Table 1.

REFERENCES:

Golder Associates, Inc.. 2001. *Permit application/operation plan to operate the NPPD Sheldon Station fly/bottom ash landfill no. 4, Attachment 1*. Lakewood Colorado, March 2001.

U. S. Bureau of Reclamation (USBR). 1978. *Design of small canal structures, 3rd edition*. (A Water Resources Technical Publication). Denver CO : United States Department of the Interior.

U. S. Bureau of Reclamation (USBR). 1987. *Design of small dams, 3rd edition*. (A Water Resources Technical Publication). Denver CO : United States Department of the Interior.

TABLE 1

NPP C:_Project\0032168_NPP\[Energy Dissptr.xls]Hydraulic Jump

Sheldon Station Energy Dissipators **DATE: 5/1/2001**

PROJECT NO.: 003-2168 **TIME: 4:19 PM**

Down Chute Channel Properties

Location	ABdown	CDdown	EFdown	GHIdown
Design Flow, Q (cfs):	14	14	14	15
Ch. Bottom Width, w_1 (ft):	2.0	2.0	2.0	2.0
Design Depth (ft):	1.0	1.0	1.0	1.0
R. Side Slope, z_RH:1V:	3.0	3.0	3.0	3.0
R. Side Slope, z_LH:1V:	3.0	3.0	3.0	3.0
Ch. Slope, S_1 (ft/ft:	0.300	0.300	0.300	0.300
Manning's n (stability):	0.026	0.026	0.026	0.026
Velocity, V_1 (fps):	12.7	12.7	12.7	13.0
Normal Depth, D_1 (ft):	0.36	0.36	0.36	0.37

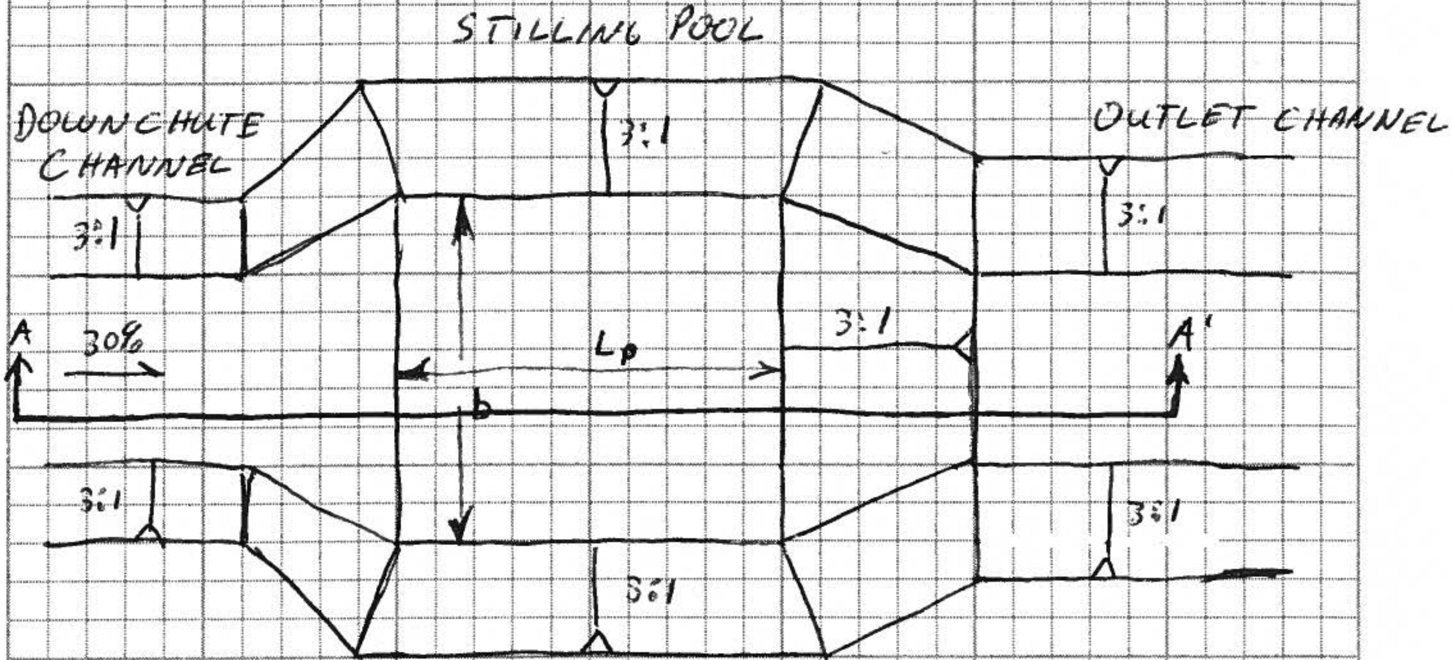
Stilling Pool Design Summary

Location	ABdown	CDdown	EFdown	GHIdown
Flows are: (1) intermittent or (2) constant:	1	1	1	1
Width of pool, b (ft)	**3.7**	**3.7**	**3.7**	**3.8**
Froude No. (stability)	3.75	3.75	3.75	3.75
Conjugate Depth, D_2 (stability, ft):	1.73	1.73	1.73	1.79
Pool Length, L_P (stability, ft):	**5.18**	**5.18**	**5.18**	**5.38**
Depth of Pool - below Outlet channel invert, D_P(ft)	**1.26**	**1.29**	**1.30**	**1.39**

Stilling Pool Outlet Channel Design

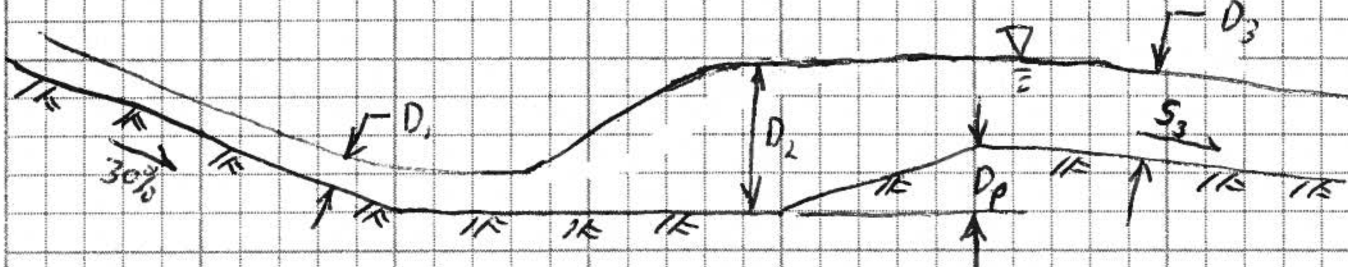
Location	ABdown	CDdown	EFdown	GHIdown
Design Flow, Q (cfs):	14	14	14	15
Ch. Bottom Width, w_3 (ft):	2.0	2.0	2.0	2.0
Design Depth (ft):	1.5	1.5	1.5	1.5
R. Side Slope, z_RH:1V:	3.0	3.0	3.0	3.0
R. Side Slope, z_LH:1V:	3.0	3.0	3.0	3.0
Ch. Slope, S_3 (ft/ft:	0.059	0.071	0.081	0.100
Manning's n (stability):	0.030	0.030	0.030	0.030
Velocity, V_3 (fps):	6.4	6.8	7.2	7.9
Normal Depth, D_3 (ft):	0.58	0.56	0.54	0.53

Golder Associates	Subject NPP	Made by FE	Job No. 003-2168
	Sheldon Station	Checked by MEM	Date 4/30/01
	Stilling Pools	Approved by DLO	Sheet No. 1



STILLING POOL PLAN

N.T.S



SECTION A-A'

N.T.S

FIGURE 1

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