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Sump and Riser Calculations for SCA Final Cover Design

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CALCULATION PACKAGE COVER SHEET

Client: Honeywell **Project:** Onondaga Lake SCA Final Cover Design **Project/Proposal #:** GD5497

TITLE OF COMPUTATIONS **SUMP AND RISER CALCUATIONS FOR SCA FINAL COVER DESIGN**

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Client:	**Honeywell**	Project:	**Onondaga Lake SCA Final Cover Design**	Project/ Proposal No.:	**GD5497**	Task No.:	**03**

SUMP AND RISER CALCULATIONS FOR SCA FINAL COVER DESIGN

INTRODUCTION

This package was prepared in support of the final cover design of the Sediment Consolidation Area (SCA) for the Onondaga Lake Bottom Site, located on Wastebed 13 (WB-13). This package presents an analysis of the existing liquid management system (LMS) sumps and risers in the SCA, which collect the liquids from dredged material dewatering and rainfall/infiltration and pump them out of the SCA. The purpose of the analysis presented in this package is to estimate the liquid storage volume and typical pump off and on times for the sump pumps after placement of the final cover.

METHODOLOGY

The sump and riser calculations in this package include estimating the LMS sump pump size and storage volume after placement of the final cover.

Sump Volume and Pump Sizing:

The storage volume of the sump is calculated as the volume between the pump off level and the top of the low permeability soil liner outside the sump area. This volume is a combination of open area inside the riser pipes and pore volume of areas outside the risers that are filled with gravel.

Pump on time is calculated by dividing the storage volume by the selected pumping rate minus the design inflow rate. Pump off time is calculated by dividing the storage volume by the inflow rate to the sump.

INPUT PROPERTIES

As shown in Figure 1, the constructed sumps are each 5 ft in depth and contain four risers. The bottom of each sump has dimensions of approximately 55 ft long by 40 ft wide. Each riser is connected to other lateral collection pipes to collect flow. The existing risers are 5 ft diameter, high density polyethylene (HDPE) manholes with a standard dimension ratio (SDR) of 26. As shown in Figure 2, the risers are located on a 6-inch concrete pad (for anti-flotation purposes),

with a 2-inch HDPE flat stock riser base and a 6-inch working space between the bottom of the riser and the pump bottom.

The existing pumps were designed for the current operational conditions (i.e., each pump is capable of pumping up to approximately 1,600 gallons per minute of leachate flow). These pumps are not considered appropriate for conditions after placement of the final cover with minimal leachate flow, and therefore a lower capacity piston pump can be used.

The calculated liquid inflow rate for the entire SCA after final cover placement was 0.1 gal/min, as presented in the calculation package titled "Evaluation of Hydraulic Performance for SCA Final Cover Design". It is noted that this inflow rate has been computed for conditions after placement of the geomembrane in the final cover system and does not consider leachate flow during final cover placement. Based on information provided by site operations, it is expected that the leachate flows during final cover placement will be relatively minimal and can be handled using the existing pumps or additional temporary pumps, as needed. Liquid inflow due to continued consolidation of the geotextile tubes is expected to be minimal based on observations during the winter shutdown periods in 2012/2013, 2013/2014, and 2014/2015 (i.e., precipitation generally accounted for the liquid flows recorded over the shutdown periods) and was therefore not considered herein. However, leachate flows during final cover installation will be monitored and, if necessary, the inflow rates assumed and calculations performed herein will be modified. It is further noted that although each sump was constructed with four risers, two risers at each sump were cutoff and decommissioned during the 2015 construction season. It was assumed that only one of the remaining two risers per sump would have an operating pump after the final cover has been installed.

As presented in Figure 3, the post-settlement as-built liner contours indicate that the total water infiltration will be split between the western sump area and the eastern sump area. Based on the relative areas, it appears that approximately 60% of the infiltration will drain to the western sump area and approximately 40% to the eastern sump area. Therefore, the volume and pump off and on time calculations use a target liquid inflow rate of 0.06 gal/min for the western sump area and 0.04 gal/min for the eastern sump area (i.e., 60%/40% split of the 0.10 gallons per minute total inflow rate described above).

CALCULATIONS

The calculation worksheets for the sump volume and pump design are provided in Attachment 1.

RESULTS OF ANALYSIS

The results of the sump volume and pump sizing calculations are summarized in Table 1. For the conditions after placement of the final cover described previously (i.e., inflow of 0.06 gal/min to the western sump, 0.04 gal/min to the eastern sump, and a pump on level of 6 inches above the automatic off elevation of the pump), the configuration results in a fill time of approximately 56 days for the western sump and 85 days for the eastern sump.

After final cover placement, if a pumping rate of 2 gal/min is selected, the western and eastern sumps will have a pump on time of approximately 42 and 41 hours, respectively. Different pump capacities and on/off times may be used as appropriate based on actual field conditions and recommended pump cycle times from the pump manufacturer.

Tables

Table 1: Pump Design Summary

	Q_{DESIGN} (gal/min)	Pump Off Time[2] (days)	Pump Rate (gal/min)	Pump On Time (hr)
West Sump	0.06	56	2	42
East Sump	0.04	85	2	41

Notes:

1. An automatic on level of 6 inches (0.5 ft) was assumed to minimize the water level within the sump.
2. This is the time taken for the liquid level to go from the minimum to maximum level within the sump area.
3. Different pump capacities and on/off times may be used as appropriate based on actual field conditions and recommended pump cycle times from the pump manufacturer.
4. The pump off and pump on times are calculated in Attachment 1.

Figures

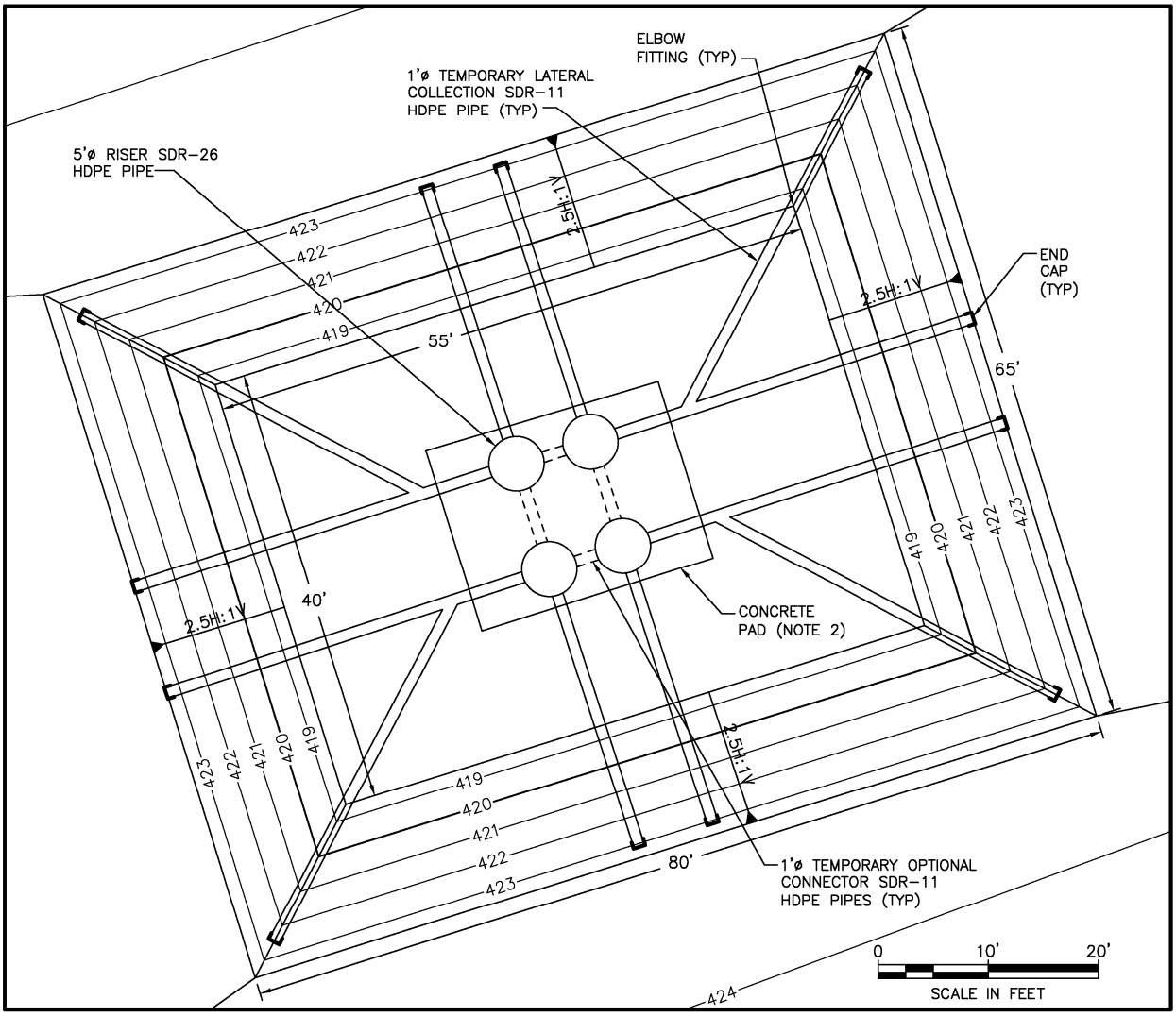

Figure 1: Sump Design

Note:

1. Actual as-built dimensions and elevations of the sumps may vary slightly from the values shown herein.

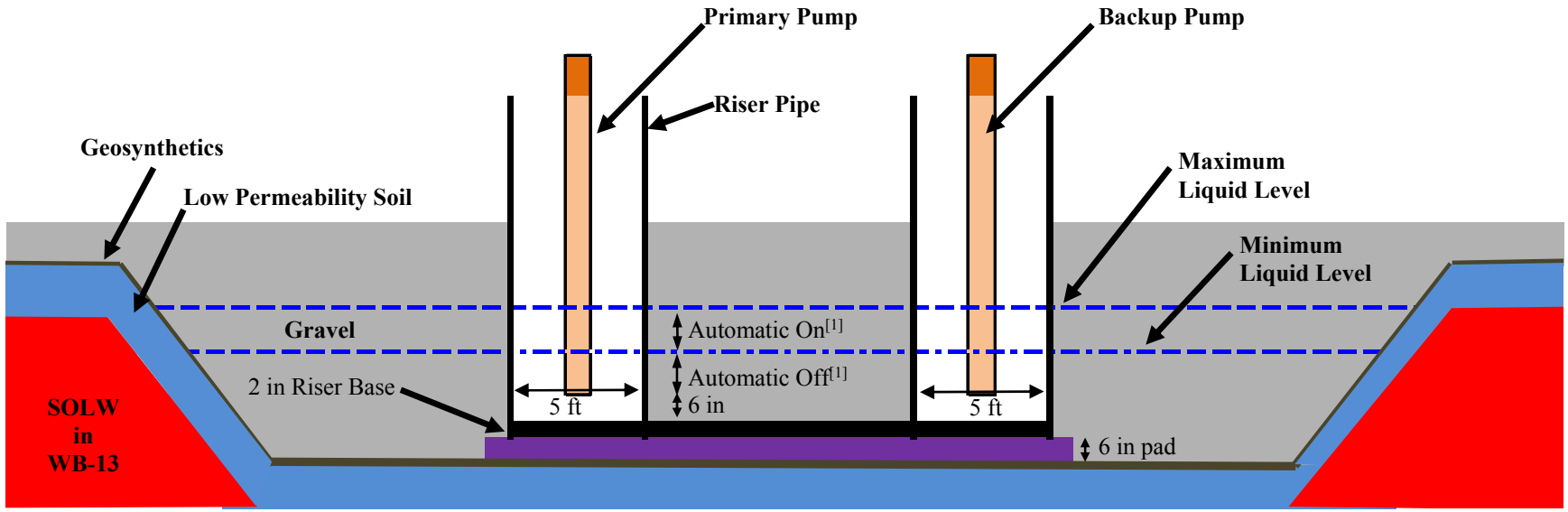

Figure 2: Conceptual View of Sump Area (not to scale)

Notes:

1. An automatic off height of 6 inches is sufficient for several commercially available piston pumps. An automatic on height of 6 inches is assumed, in order to minimize water buildup.
2. The side slopes of the sump area are 2.5 horizontal:1 vertical (2.5H:1V).
3. The width of the as-built sump bottom is approximately 40 ft, and the length of the as-built sump bottom is approximately 55 ft.
4. The geosynthetics near the sump include a geotextile, geomembrane, and geosynthetic clay liner. It is noted that the thickness of the geosynthetics is negligible for purposes of the sump and riser calculations.

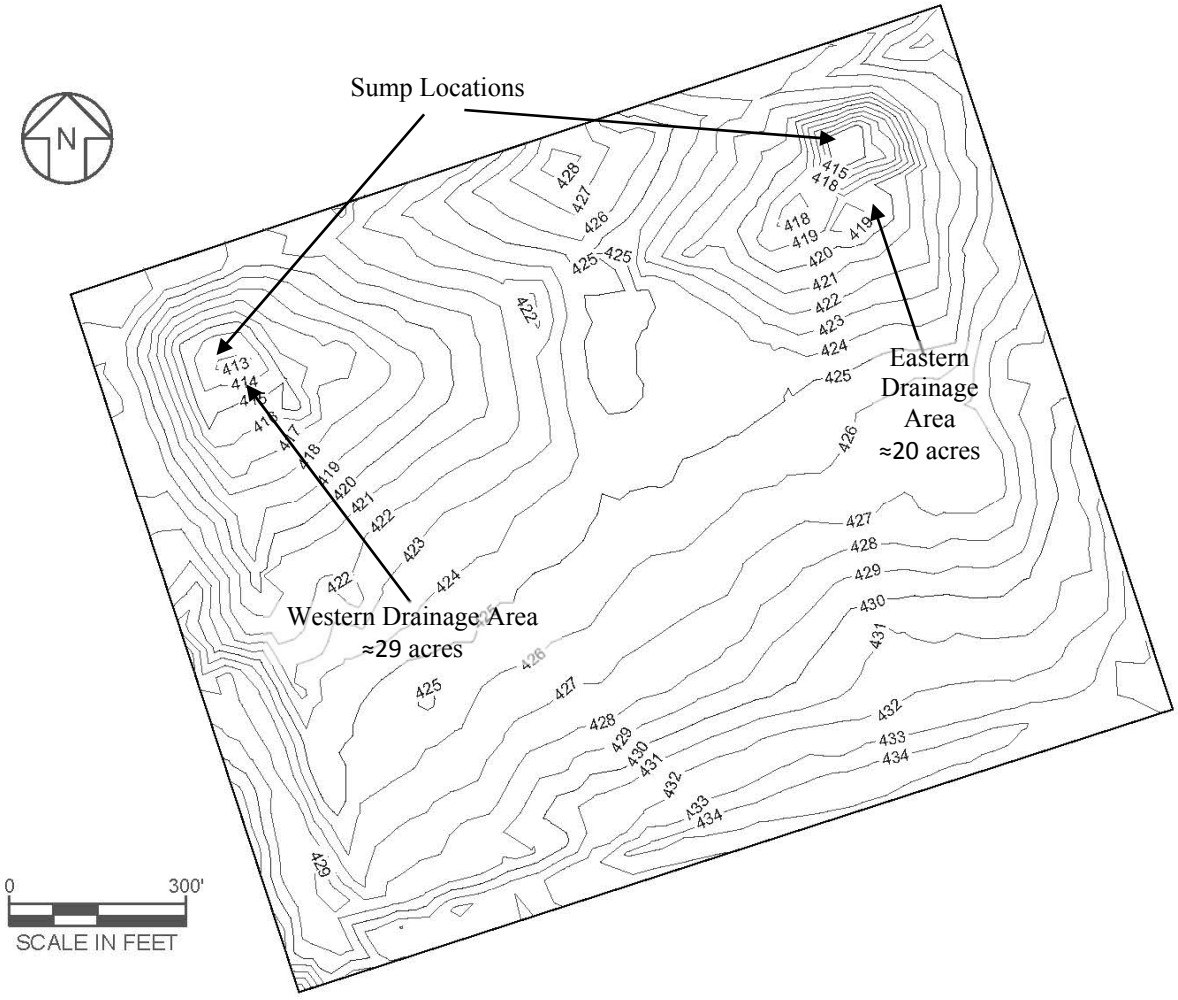

Figure 3: Estimated Post-Settlement Contour Map of the Top of Clay Liner
(30 years after placement of the final cover)

Notes:

1. The post-settlement contour map shown here is based on estimated elevations from settlement calculations, as described in the calculation package titled "Settlement Analyses for the SCA Final Cover Design."
2. Approximately 60% of the SCA area will drain to the western sump area, and approximately 40% of the SCA area will drain to the eastern sump area.

Attachment 1: Calculation Spreadsheets

Written by: **Ray Wu** Date: **09/11/2015** Reviewed by: **Sowmya Bulusu / Jay Beech** Date: **09/11/2015**

Client: **Honeywell** Project: **Onondaga Lake SCA Final Cover Design** Project/ Proposal No.: **GD5497** Task No.: **03**

Sump Volume Calculations:

Input Parameters[1,2]

	West Sump	East Sump
Gravel Porosity n =	0.4	0.4
Distance between sump bottom and Automatic Off (ft)	1.67	1.67
Length between Automatic Off and On L (ft)	0.50	0.50
Target Inflow Rate Q_{IN} (gal/min) =	0.06	0.04
Pumping rate Q_{PUMP} (gal/min) =	2	2
Riser Nominal Diameter D_R (ft)=	5	5
Length of Sump at Maximum Liquid Level a (ft) =	65.83	65.83
Length of Sump at Minimum Liquid Level b (ft) =	63.33	63.33
Width of Sump at Maximum Liquid Level c (ft) =	50.83	50.83
Width of Sump at Minimum Liquid Level d (ft) =	48.33	48.33

Volume Calculations[3,4]

Vol. of Sump from W_{MIN} to W_{MAX} (gal) =	$V_{PYRAMID}$	
$V_{PYRAMID}$ (gal) =	$(L/6)*(ad+bc+2ac+2bd)/0.134$	
$V_{PYRAMID}$ (gal) =	11950.7	11950.7
Storage Vol. inside Riser V_{RISER} (gal) =	$((\pi/4*D_R^2*L)/.134)$ * 2 risers	
V_{RISER} (gal)=	146.5	146.5
Total Storage Vol. (gal) $V_{STORAGE}$ =	$(V_{PYRAMID}-V_{RISER})*n+V_{RISER}$	
Total Storage Vol. (gal) $V_{STORAGE}$ =	4868.2	4868.2

Pump On and Pump Off Time Calculations[5]

Pump off time (hr)=	$V_{STORAGE}/Q_{IN}$	
Pump off time (hr)=	1352.3	2028.4
Pump off time (days)=	56.3	84.5
Pump on time (hr)=	$V_{STORAGE}/(Q_{PUMP}-Q_{IN})$	
Pump on time (hr)=	41.8	41.4

Notes:

1. The distance between the sump bottom and the automatic off elevation is considered to be 20 inches (i.e., 6-inch concrete pad, 2-inch riser base, 6-inch distance working area beneath pump and 6-inch automatic off elevation). The distance between the automatic off elevation (i.e., minimum liquid level) and the automatic on elevation (i.e., maximum liquid level) is assumed to be 6 inches.
2. The lengths and widths of sump at minimum and maximum liquid levels are calculated assuming a 2.5H:1V side slope, an as-built sump bottom length of 55 ft, and an as-built sump bottom width of 40 ft (based on Figure 2). The calculated lengths and widths are as follows:
   - a = 55 ft + 2*2.5*(1.667+0.50 ft) = 65.83 ft
   - b = 55 ft + 2*2.5*(1.667 ft) = 63.33 ft
   - c = 40 ft + 2*2.5*(1.667+0.50 ft) = 50.83 ft
   - d = 40 ft + 2*2.5*(1.667 ft) = 48.33 ft
3. Two risers at each sump were cutoff and decommissioned during the 2015 construction season.
4. The sump volume is calculated based on a truncated rectangular pyramid. The riser pipe volume is calculated based on a cylindrical pipe. The volume occupied by the riser pipe wall thickness is small relative to the overall storage volume and is ignored.
5. Pump off time represents the amount of time necessary for the sump area to fill from the minimum water level to the maximum water level. The pump on time represents the amount of time that the pump runs to remove the liquid.