UniStar NUCLEAR

Conceptual Design of Stormwater Management System
Bell Bend Nuclear Power Plant
UniStar Nuclear Energy

Non-Safety-Related

Report No. SL-009446
Revision 2

August 14, 2008

Sargent & Lundy LLC

Approval Page

Conceptual Design of Stormwater Management System

Non-Safety-Related

Revision Summary

Rev. 0	**Client Comments**
Rev. 1	**CONCEPTUAL DESIGN FOR USE** **Computation revised as per Revised Grading and Drainage Plans**
Rev. 2	**Client Comments**

Prepared By: N. M. Patel — N. M. Patel — Date: 8-14-2008

Reviewed By: Ronald Cook — R. H. Cook — Date:8-14-2008

Approved By: Ronald Cook — R. H. Cook — Date:8-14-2008

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1. PURPOSE/OBJECTIVE

UniStar Nuclear, has proposed the construction of a new nuclear plant with one USEPR unit located immediately west of the Susqahanna power plant. The Susqahanna power plant is about 5 miles north of Berwick, Pennsylvania. The purpose of this report is to describe the methodology used in developing the Conceptual Design for Stormwater Management System to support the Combined License Application (COLA) for the aforementioned plant.

2. ASSUMPTIONS

- Finish floor elevation of the contentment building will be at EL 674.0 feet (NAVD 88 - North American Vertical Datum 1988)(Reference 1)
- Standard Project Flood (SPF) elevation is at EL 671.0 feet (NAVD 88) (Reference 3).
- Undisturbed wetland will not be considered in the detention requirement.
- For this conceptual design, certain coefficients and design factors are assumed based on engineering judgement and experience. These are listed in the text, wherever the assumptions are made. These assumptions need to be verified prior to detailed design.

3. INPUT

Following inputs are used for this conceptual design:

- Overall Grading and Drainage Plan Sketch Drawing (Reference 2).
- Rainfall data for Point Precipitation Frequency Estimates is obtained from NOAA Atlas 14 (Reference 4) and is presented in Attachment 1.
- Grading and Drainage Plan Sketch Drawings (Reference 3).

4. METHODOLOGY AND CRITERIA

4.1 Site Drainage System

The stormwater from all the facilities will be collected through networks of storm sewers and ditches and drained to the stormwater ponds. The stormwater ponds for the site are designed to retain the runoff up to and including a 100-year, 24-hour rainfall. The storm drainage system is designed to carry the peak storm runoff from a 50-year rainfall without flooding the adjacent plant roads and facilities. The relevant rainfall values are shown in Attachment 1.

The plant storm sewer system is conceptually developed for the main plant area to function during 50-year rainfall without flooding plant roads and facilities. Manholes and catch basins are provided as necessary for the storm sewer system. The peak flows for the different sub drainage areas are estimated, and the size of the downstream-most pipe is estimated. The rest of the sizes of storm sewers in that sub-system are estimated by engineering judgement. The storm sewer system presented in this document is conceptual and detailed design shall be performed before issuing the grading and drainage drawings for construction.

The peripheral areas, including the construction parking and laydown areas, are drained by means of ditches and culverts. Ditches will be designed to carry the peak flow from the 50-year storm event. The runoff from these areas drains to the stormwater ponds as shown in the Conceptual Grading and Drainage Plan Drawings (References 2 and 3).

The conceptual storm sewer network for the plant area is presented in Attachment 2. Two stormwater detention ponds are planned to collect the stormwater from plant facilities through network of storm sewers, ditches, and culverts. The conceptual sketch showing the drainage areas for each stormwater detention pond is presented in Attachment 3. The conceptual drainage for the plant area and peripheral area is shown in the Conceptual Grading and Drainage Plan Drawings (References 2 and 3).

4.2 Roof Drains

The stormwater from the roof drains will be drained through the downspouts for each of the plant buildings. The stormwater from the downspouts will be collected and routed to the nearest catch basin or manhole, and then drained through the storm sewer system.

4.3 Stormwater Detention Ponds

The stormwater collection and detention is planned in two ponds located one each in the west(Pond-1) and east(Pond-2) of the plant. The ponds are designed to store the stormwater runoff for 100-year, 24-hour precipitation increased due to proposed development in the respective drainage areas. Most of the wetland areas are not disturbed and therefore the undisturbed wetland area is not accounted for detention requirement. Emergency spillways will be provided for both stormwater detention ponds and will be designed to pass the peak runoff flow from a 100-year rainfall. A minimum freeboard of 2 feet is provided for each of the ponds above the spillway crest elevation. The stormwater runoff in the stormwater ponds will be released to a natural stream as per an allowable release rate. Stormwater ponds are provided with higher detention volume so as to accommodate potential increase of drainage area during construction or due to potential changes in grading and drainage. A stormwater outlet structure and necessary piping needs to be sized during detailed design, so that the high water elevation in the pond will be lower than the design high water elevation, and the peak outflow from the developed site does not exceed the pre developed peak runoff for 2-year through 100-year storm events.

5. COMPUTATIONS

5.1 Storm Sewer Network

The following details the peak runoff flow calculation used to size the storm sewer network draining the power block area (Attachment 2). Peak runoff is calculated using the Rational Method, defined by the equation below:

$Qpeak = C * I * A$ Where:

Qpeak = peak runoff from the contributing drainage area (cfs)
C = runoff coefficient
I = intensity (inches/hour)
A = contributing drainage area (acres)

The runoff coefficient for the power block area is assumed to be 0.75. The minimum time of concentration(Tc) is assumed to be 10 minutes. Total system flow travel time for the entire network is conservatively assumed as 15 minutes.

Rainfall intensity for 15 min Tc for 50-year storm = 1.19 inch/15 min (Reference 4, Attachment 1)

Rainfall Intensity = 1.19 x 60/15 = 4.76 inch/hr

Plant drainage area for storm sewer network = 41 Acres

Average runoff coefficient for plant area = 0.75 (conservatively assumed)

Peak runoff = 0.75 x 4.76 x 41 = 146.37 cfs say 150 cfs

Assuming velocity of 8 ft/sec, the required flow area = 150/8 = 18.75 ft^2 say 60-inch diameter CHDPE pipe.

All other pipe sizes in the network shown in Attachment 2 are assumed based on engineering judgment.

These pipes will be 12-inch diameter at the upstream end of the system and are increased in size downstream.

The detailed design of the storm sewer system is not in the scope of the conceptual design, but shall be performed prior to construction issue. The storm sewer network is shown in Attachment 2.

5.2 Stormwater Ponds:

The following illustrates the runoff volume calculations used to determine the storage required in each stormwater pond. Depth of runoff is determined using the SCS method, presented in Technical Release 55 (Reference 5). The total runoff volume is obtained by multiplying runoff depth by the drainage area.

$$Q = \frac{\left(P - 0.2*\left(\frac{1000}{CN} - 10\right)\right)^2}{P + 0.8*\left(\frac{1000}{CN} - 10\right)}$$

Where:

Q = Runoff Depth (inches)
P = Rainfall (inches)
CN = Curve Number

The weighted Curve Number for the developed site is assumed to be 90 (Reference 5) and similarly, the weighted Curve Number for pre-developed site condition is assumed as 60. Rainfall depth for the 100-year, 24-hour storm event is 7.2 inches (Reference 4, Attachment 1). Conceptual pond drainage areas are presented in Attachment 3. Pond 1 and Pond 2 are designed to detain the increased runoff volume from the 100-year, 24-hour storm. Detention storage volume computation for both the ponds is presented in Attachment 4. The following table summarizes the storage volume computation.

Table 1: Pond Storage Volume

Pond	Provided Storage Volume (Up to High Water EL)	Water Storage Depth (ft)	Contributing Area (acres)	Pre-Developed Runoff Volume (ac-ft)	Post-Developed Runoff Volume (ac-ft)	Increased Runoff Volume (ac-ft) (Note 1)
Pond-1	61.9	13	229	52.4	103.3	50.9
Pond-2	55.2	10	249	57.0	98.0	41.0

Note 1: Pond must be sized for a minimum of this volume.

An emergency spillway for each pond shall be provided for the safe release of the post-developed peak runoff for the 100-year rainfall event. The detailed design of spillways is not in the scope of the conceptual design, but shall be performed prior to construction issue. Higher storage volume for ponds are provided to accommodate the sediment storage as well as the potential increase of drainage area during the construction period. In addition, ponds are provided with higher detention volume to reduce the post developed peak runoff from 2-year to 100-year storm event, so that they do not exceed the peak runoff of pre developed site condition for respective storm event as specified in Pennsylvania Stormwater Best Management Practices Manual (Reference 6).

Salient features of the stormwater ponds based on the drawings listed in References 2 and 3 are presented in Attachment 5.

6. EVALUATION AND RESULTS

The power block facility area drains to Pond-1 through a storm sewer network consisting of catch basins, manholes and CHDPE pipes. The pipes in the storm sewer network have diameters ranging from 12 inches at upstream catch basins to 66 inches at the outlet near the ponds. The conceptual storm sewer network is presented in Attachment 2.

Most of the construction and laydown area facilities on the west side of the site area drains to Pond-1 through ditches and culverts, as shown in the drawings in References 2 and 3. The drainage ditches will have side slopes of 2H:1V and will be appropriately sized to carry the peak runoff from a 50-year storm event.

Most of the construction and laydown area facilities on the east side of the site area drains to Pond-2 through ditches and culverts, as shown in the drawings in References 2 and 3. The drainage ditches will have side slopes of 2H:1V and will be appropriately sized to carry the peak runoff from a 50-year storm event.

The stormwater from the roof drains will be drained through the downspouts for each of the plant buildings and will be collected and routed into the storm sewer system through the nearest catch basin or manhole.

Detailed design for the emergency spillways, storm sewers, pond outlets, ditches and culverts, etc. shall be performed according to guidelines given in the Pennsylvania Stormwater Best Management Practice Manual (Reference 6).

7. LIMITATIONS

This conceptual evaluation is conducted to support COL Application and shall provide the basis for the detailed design prior to construction. Verification of the inputs, assumptions, and limitations shall be performed during the detailed design stage.

8. CONCLUSIONS

The power block and peripheral areas of the plant are graded to drain the stormwater runoff to stormwater detention ponds through a system of storm sewers, ditches and culverts. The stormwater drainage system meets the conceptual design criteria set forth in section 4 of this document. The conceptual grading and drainage plans for plant and peripheral areas are shown in References 2 and 3.

9. REFERENCES

1. S&L Report for Conceptual Grading and Earthowrk, SL-009450, Rev 4, August 2008.

2. Overall Grading and Drainage Plan, Bell Bend Nuclear Power Plant, S&L Conceptual Sketch Drawing No. CSK-001, Revision 6

3. Grading and Drainage Plan, Bell Bend Nuclear Power Plant, S&L Conceptual Sketch Drawing No. CSK-002 through CSK-005, CSK-008, CSK-010 through CSK-014 Revision 6 and CSK-006, 007,009 Rev 7, CSK-016 Rev 2.

4. Precipitation-Frequency Atlas of United States, National Oceanic and Atmospheric Administration (NOAA) Atlas 14, National Weather Service, Maryland, 2004

5. Technical Release 55: Urban Hydrology for Small Watersheds (TR-55), Second Edition, U.S. Department of Agriculture, Natural Resources Conservation Service (NRCS). June 1986.

6. Pennsylvania Stormwater Best Management Practices Manual, December 2006.

POINT PRECIPITATION FREQUENCY ESTIMATES FROM NOAA ATLAS 14

UniStar Nuclear
Bell Bend Nuclear Power Plant - Unit 1
Conceptual Design of Stormwater Management System

BERWICK, PENNSYLVANIA (36-0611) 41.0667 N 76.25 W 587 feet
from "Precipitation-Frequency Atlas of the United States" NOAA Atlas 14, Volume 2, Version 3
G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley
NOAA, National Weather Service, Silver Spring, Maryland, 2004
Extracted: Thu Mar 27 2008

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Confidence Limits | Seasonality | Location Maps | Other Info. | GIS data | Maps | Help | Docs

Precipitation Frequency Estimates (inches)

ARI* (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day	45 day	60 day
1	0.34	0.52	0.64	0.84	1.03	1.21	1.32	1.66	2.04	2.41	2.84	3.18	3.75	4.33	5.90	7.34	9.28	11.17
2	0.40	0.62	0.76	1.01	1.25	1.46	1.58	1.98	2.44	2.89	3.40	3.80	4.47	5.14	6.96	8.62	10.83	12.98
5	0.47	0.72	0.89	1.22	1.53	1.80	1.96	2.43	3.01	3.58	4.21	4.65	5.43	6.19	8.14	9.92	12.26	14.58
10	0.52	0.80	0.98	1.36	1.74	2.08	2.27	2.82	3.50	4.20	4.92	5.41	6.28	7.09	9.15	11.02	13.46	15.93
25	0.58	0.89	1.10	1.55	2.01	2.50	2.74	3.40	4.25	5.18	6.07	6.61	7.61	8.48	10.68	12.66	15.23	17.91
50	0.63	0.96	1.19	1.70	2.23	2.85	3.15	3.91	4.92	6.08	7.12	7.72	8.82	9.74	12.02	14.08	16.73	19.59
100	0.69	1.03	1.28	1.85	2.47	3.26	3.63	4.50	5.69	7.16	8.37	9.03	10.24	11.19	13.54	15.64	18.36	21.39
200	0.74	1.10	1.37	2.00	2.72	3.72	4.17	5.17	6.59	8.43	9.87	10.58	11.91	12.86	15.25	17.38	20.13	23.34
500	0.82	1.21	1.50	2.23	3.08	4.42	5.02	6.24	8.01	10.51	12.29	13.08	14.57	15.48	17.86	19.98	22.72	26.17
1000	0.88	1.28	1.61	2.41	3.38	5.05	5.77	7.19	9.29	12.45	14.55	15.39	17.01	17.84	20.14	22.21	24.90	28.53

Text version of table

* These precipitation frequency estimates are based on a partial duration series. **ARI** is the Average Recurrence Interval.
Please refer to the documentation for more information. NOTE: Formatting forces estimates near zero to appear as zero.

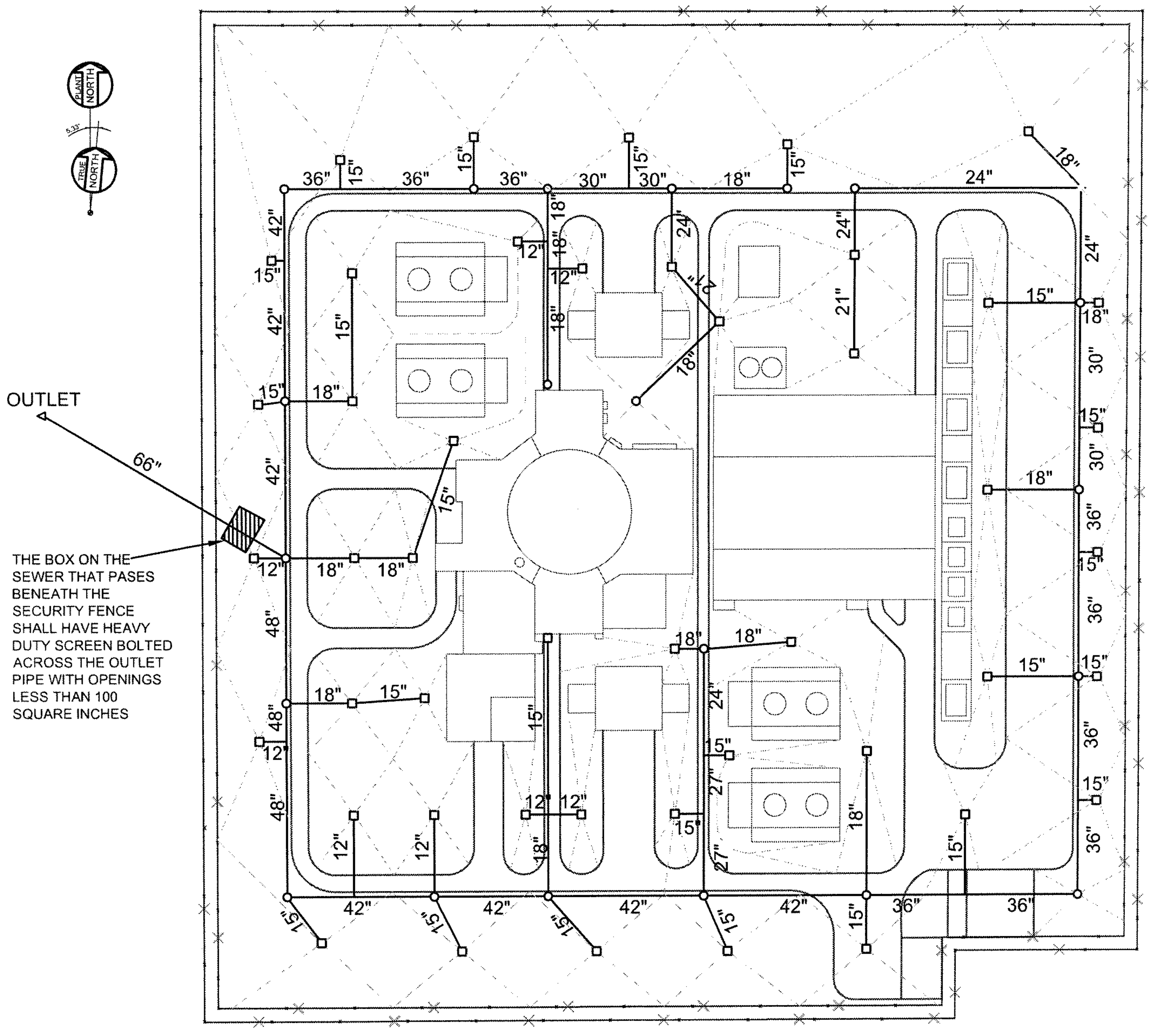
*** Upper bound of the 90% confidence interval**
Precipitation Frequency Estimates (inches)

ARI** (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day	45 day	60 day
1	0.37	0.58	0.71	0.94	1.15	1.35	1.48	1.87	2.31	2.69	3.23	3.59	4.23	4.83	6.45	7.99	10.04	11.99
2	0.44	0.69	0.84	1.13	1.38	1.63	1.78	2.24	2.76	3.23	3.88	4.28	5.05	5.74	7.60	9.36	11.71	13.94
5	0.52	0.81	0.99	1.35	1.70	2.01	2.20	2.74	3.40	4.00	4.79	5.24	6.12	6.90	8.87	10.77	13.25	15.65
10	0.57	0.89	1.09	1.51	1.93	2.33	2.54	3.17	3.94	4.67	5.59	6.08	7.06	7.89	9.96	11.96	14.55	17.10
25	0.65	0.99	1.22	1.72	2.23	2.79	3.07	3.82	4.77	5.73	6.86	7.38	8.52	9.41	11.60	13.71	16.45	19.21
50	0.70	1.07	1.32	1.89	2.48	3.19	3.54	4.39	5.52	6.70	8.02	8.59	9.85	10.77	13.02	15.22	18.07	20.97
100	0.76	1.15	1.42	2.06	2.75	3.65	4.07	5.05	6.39	7.85	9.40	10.01	11.41	12.34	14.63	16.89	19.81	22.88
200	0.82	1.23	1.53	2.23	3.03	4.17	4.69	5.83	7.41	9.21	11.03	11.69	13.22	14.14	16.46	18.76	21.70	24.98
500	0.92	1.35	1.68	2.49	3.45	4.98	5.67	7.06	9.05	11.42	13.69	14.39	16.11	17.00	19.23	21.55	24.45	28.03
1000	0.99	1.44	1.80	2.71	3.80	5.72	6.56	8.17	10.56	13.44	16.16	16.88	18.77	19.56	21.68	23.94	26.79	30.57

* The **upper** bound of the confidence interval at 90% confidence level is the value which 5% of the simulated quantile values for a given frequency are **greater** than.
** These precipitation frequency estimates are based on a partial duration series. **ARI** is the Average Recurrence Interval.
Please refer to the documentation for more information. NOTE: Formatting prevents estimates near zero to appear as zero.

*** Lower bound of the 90% confidence interval**
Precipitation Frequency Estimates (inches)

ARI** (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day	45 day	60 day
1	0.30	0.47	0.57	0.76	0.93	1.09	1.19	1.48	1.83	2.18	2.54	2.87	3.38	3.94	5.44	6.82	8.67	10.50
2	0.36	0.56	0.68	0.91	1.12	1.31	1.43	1.78	2.19	2.61	3.04	3.43	4.04	4.68	6.41	7.99	10.11	12.21
5	0.42	0.65	0.80	1.09	1.37	1.61	1.76	2.17	2.70	3.23	3.75	4.19	4.89	5.62	7.48	9.18	11.43	13.70
10	0.47	0.72	0.88	1.23	1.56	1.86	2.03	2.51	3.12	3.77	4.38	4.87	5.63	6.41	8.39	10.18	12.54	14.95
25	0.52	0.80	0.98	1.39	1.80	2.22	2.43	3.00	3.76	4.61	5.36	5.90	6.79	7.63	9.76	11.67	14.16	16.78
50	0.56	0.85	1.06	1.51	1.99	2.52	2.78	3.43	4.32	5.37	6.24	6.85	7.82	8.72	10.95	12.95	15.52	18.31
100	0.61	0.91	1.13	1.64	2.19	2.86	3.17	3.91	4.95	6.27	7.27	7.96	9.02	9.96	12.26	14.32	16.99	19.94



CONNECTIONS TO BUILDING ROOF DRAINS ARE NOT SHOWN.

- O MANHOLE
- —— PIPE W/ FLOW DIRECTION & SIZE
- □ CATCH BASIN
- ······ GRADING

Attachment 2 : Conceptual Storm Sewer Network for The Plant Area
UniStar Nuclear
Bell Bend Nuclear Power Plant, Unit 1
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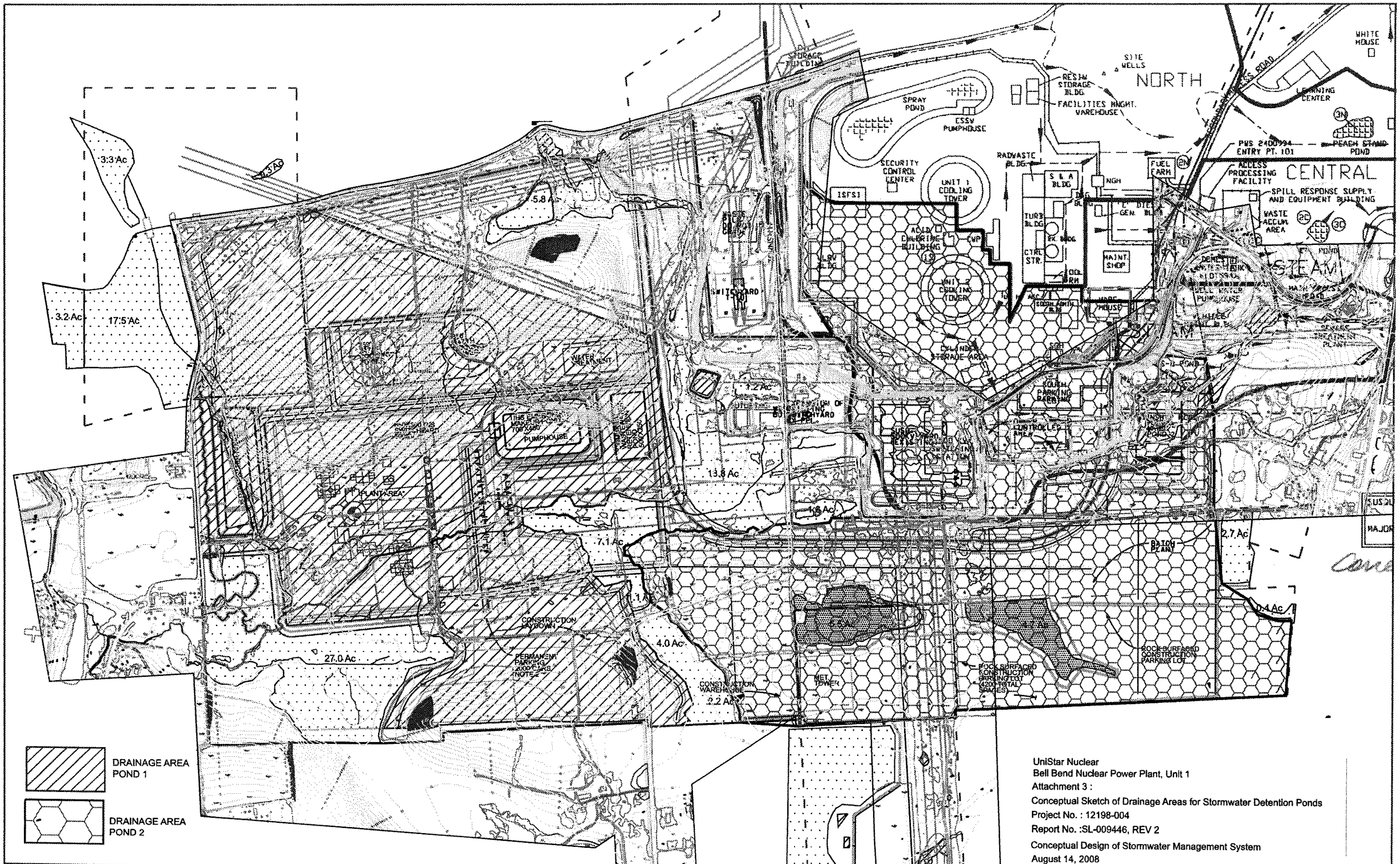

UniStar Nuclear
Bell Bend Nuclear Power Plant, Unit 1
Attachment 3 :
Conceptual Sketch of Drainage Areas for Stormwater Detention Ponds
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Detention Storage Volume Computation Sheet for Ponds

Pond	Development Condition Pre/Post	Surface Type	Curve Number CN	100-Year, 24-Hour Rainfall Depth (Inches)	Computed S $S=(1000/CN)-10$	Runoff Depth (inches) $Q=(P-0.2S)^2/(P+0.8S)$	Contributing Area (acres)	Runoff Volume (ac-ft)
Pond 1	Pre		60	7.2	6.67	2.75	229.0	52.4
	Post	Impervious	98	7.2	0.20	6.96	47.0	27.3
		Gravel area	85	7.2	1.76	5.44	146.0	66.2
		Grass/Pervious	65	7.2	5.38	3.26	36.0	9.8
	Total						229.0	103.3
	Increase							50.9
Pond 2	Pre		60	7.2	6.67	2.75	249.0	57.0
	Post	Impervious	98	7.2	0.20	6.96	30.0	17.4
		Gravel area	85	7.2	1.76	5.44	116.0	52.6
		Grass/Pervious	65	7.2	5.38	3.26	103.0	28.0
	Total						249.0	98.0
	Increase							41.0

Salient Features of the Stormwater Detention Ponds			
Pond	Parameter	Value	Unit
Pond-1	Bottom Elevation	655	ft
	Top Elevation	671	ft
	Low Water Level	656	ft
	High Water Level	669	ft
	Area at Low Water Level	3.8	ac
	Area at water surface	5.8	ac
	Water Storage Depth	13	ft
	Storage Volume at Water Surface Elevation	61.9	ac-ft
Pond-2	Bottom Elevation	610	ft
	Top Elevation	625	ft
	Low Water Level	612	ft
	High Water Level	622	ft
	Area at Low Water Level	4.86	ac
	Area at water surface	6.2	ac
	Water Storage Depth	10	ft
	Storage Volume at Water Surface Elevation	55.2	ac-ft