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1.0 PURPOSE AND SCOPE

Bell Bend Nuclear Station will be located in the state of Pennsylvania. It is proposed to construct one new Areva EPR unit.

The purpose of this evaluation is to develop a site-specific conceptual water balance for the new Areva EPR unit at Bell Bend. This evaluation will be used to support the Combined Operating License Application (COLA) and serve as a basis for conceptual design.

This evaluation is based upon the standardized water usage configuration and standardized flow requirements for the EPR unit per the Areva design. The water balance was adjusted to suit local conditions of water supply and water chemistry. Specifically, this included use of Susquehanna River water as the water source for cooling water and process water, the use of off-site city water for potable water, and offsite treatment of sanitary waste.

2.0 DESIGN INPUTS

2.1 The standard water balance for the EPR was provided by Unistar Nuclear. This input was provided as a markup of a Water Use Diagram and Anticipated Water Use Table from the CCNPP COLA ER Section 3.3. The input is shown in Attachment 8.1

2.2 The make-up and blowdown flows for the Circulating Water and UHS cooling towers along with raw water treatment flows are site specific, but other flows will be the same as the standard EPR water balance (see Attachment 8.2).

2.3 Service water is supplied from the Susquehanna River. Tabulations of Susquehanna River water quality quarterly data for 2007 were provided in response to RFI #SL-BER-051. (Attachment 8.3)

2.4 Susquehanna River water quality quarterly data for 2006 were obtained from a 2006 Susquehanna River Water Quality and Fishes Report provided with response to RFI #PCR-BER-004 (Attachment 8.4)

2.5 Susquehanna River water is also used at Susquehanna Steam Electric Station (SSES) for makeup to cooling towers. SSES operating experience is typically 3 to 5 cycles of concentration. (Attachment 8.3)

2.6 Essential Service Water System (ESWS) Cooling Tower design parameters were revised per EPR DCD Table 9.2.5-2 (Ref. 7.4). These tabulated values were more conservative than values as shown in the Water Use Diagram given in Input 2.1.

2.7 Design conditions for the Circulating Water System (CWS) Cooling Tower are as follows (Ref. 7.5 and 7.8):

- 2.7.1 Wet bulb temperature = 73 °F
- 2.7.2 Mean coincident relative humidity = 70%
- 2.7.3 Mean coincident dry bulb temperature = 80.6 °F (Per inputs 2.7.1 and 2.7.2)
- 2.7.4 Cooling water approach temperature = 17 °F
- 2.7.5 Cooling water range = 27.556 °F (see also Assumption 3.8)
- 2.7.6 Drift rate = 0.001% of CW flow
- 2.7.7 Circulating flow = 720,000 gpm

2.8 [DELETED]

2.9 Flows for floor wash drains, fire water distribution system (average only), potable water plant user, miscellaneous low volume waste (average only), sanitary waste, and treated liquid radwaste are as tabulated in "Bell Bend Anticipated Water Use" provided in response to RFI # SL-BER-053. (Attachment 8.6)

3.0 ASSUMPTIONS [UNVERIFIED]

3.1 The water balance information received from Areva was marked "Conceptual Discussion Purposes Only". It is assumed that the information is valid for this computation.

3.2 Not used

3.3 Cooling tower evaporation and drift rates were used as shown in the design input without adjustment for any site specific factors.

3.4 Reverse Osmosis with 75% recovery will be used to treat fresh water to supply makeup to demineralizers in the Power Plant.

3.5 CWS cooling tower evaporation rate is assumed to be 0.08 % of the circulating flow per degree F cooling. (Reference 7.5)

3.6 Raw Water Supply System media filter backwash is assumed to be 5% of the filtered water volume.

3.7 Potable water is required for non-plant use including administrative buildings and warehouses (per Design Input 2.1), but specific flow requirements were not provided. An additional 10% of plant use was added to account for non-plant use. Therefore, non-plant potable water flows are conservatively assumed to be 10 gpm average and 20 gpm maximum.

3.8 The design input CW temperature range was derived from an original basis of 24.8 °F and 800,000 gpm CW flow (Ref 7.5) as needed for a constant heat load. The resulting 27.6 °F for a design input CW flow of 720,000 gpm (Ref 7.8) reflects rounding to one decimal place. This input was expanded to three decimal places (to a value of 27.556 °F) for purposes of this calculation in order to maintain consistency with prior use.

4.0 METHODOLOGY and ACCEPTANCE CRITERIA

This evaluation was performed in two stages:

First, the cycles of concentration at the Essential Service Water System (ESWS) Cooling Tower and the Circulating Water Supply System (CWS) Cooling Tower were conservatively determined based on design input water chemistry data. The blowdown rates for the towers were then determined based on the cycles of concentration and evaporation and drift rates from the design input.

Then a mass balance was performed using flows for the cooling tower along with other design input flows to determine the water balance.

There are no acceptance criteria.

5.0 CALCULATIONS

The source of raw water for Bell Bend is the Susquehanna River (Input 2.1 and Input 2.3).

The water chemistry data shown in Attachments 8.3 (Input 2.3) and 8.4 (Input 2.4) indicates the makeup to the cooling towers is a moderately hard, alkaline water. The hardness is carbonate hardness with no non-carbonate hardness. Dissolved solids levels are low. The Langlier Index indicates calcium carbonate scaling tendencies at elevated temperatures and two or more cycles of concentration. Acid treatment along with scale inhibitors will be needed for control of calcite scale.

Based on review of Susquehanna River chemistry, three cycles of concentration were conservatively selected for cooling tower operation. This is consistent with typical cooling tower operation of 3 to 5 cycles of concentration when using surface water makeup. It is also consistent

with Susquehanna Steam Electric Station operating experience. Data for 2007 shows cooling tower operation was at 3 to 4 cycles of concentration.

Blowdown rates are determined by: (blowdown+drift) = evaporation/(cycles-1)

The CWS cooling tower has an evaporation rate (per Inputs 2.7.5 and 2.7.7 and Assumption 3.5) of:

Evaporation = 0.0008 gpm/gpm °F * 720,000 gpm * 27.556 °F = 15,872 gpm

The CWS cooling tower has a drift rate (per Inputs 2.7.6 and 2.7.7) of:

*Drift = 0.00001 * 720,000 gpm = 8 gpm (conservatively rounded up)*

Using 3 cycles of concentration, the total liquid loss is 7,936 gpm. Adjusting for the drift of 8 gpm, the CWS cooling tower blowdown is 7,928 gpm.

The total makeup to the CWS cooling tower is:

(15,872 + 8 + 7,928) = 23,808 gpm

Similarly, the ESWS cooling tower has an average evaporation rate of 1,142 gpm (per Input 2.6 - EPR DCD Table 9.2.5-2). The average ESWS cooling tower blowdown is 569 gpm based on 3 cycles of concentration. The maximum ESWS cooling tower evaporation rate is 2,284 gpm, so the maximum ESWS cooling tower blowdown is 1,138 gpm after accounting for 4 gpm drift.

The total makeup to the ESWS cooling tower is:

(1,142 + 2 + 569) = 1,713 gpm average and
(2,284 + 4 + 1,138) = 3,426 gpm maximum.

Because the input Water Use Diagram was originally prepared based on local conditions elsewhere that utilized desalination, Reverse Osmosis (RO) permeate was supplied as makeup to the demineralizers. At Bell Bend, desalination will not be used. Therefore, the water balance is adjusted to include dedicated RO for makeup water supplied to the demineralizers within the Power Plant. A 75% recovery was assumed, and the flow rates were adjusted accordingly. The required fresh water supply is 107 gpm to yield the design input flow of 80 gpm.

This produces a waste 27 gpm RO brine as a new waste stream from the Power Plant to the Waste Water Retention Basin.

Water used at the Power Plant for makeup to the demineralizer water distribution system, fire water distribution system, and floor wash drains is supplied by the Raw Water Supply system . The Power Plant makeup water flow is:

(107 + 5 + 5) = 117 gpm average and
(107 + 625 + 5) = 737 gpm maximum.

The total Raw Water supplied to the Power Plant and to the ESWS cooling tower is:

(117 + 1,713) = 1,830 gpm average and
(737 + 3,426) = 4,163 gpm maximum.

Water delivered to the Power Plant and the ESWS cooling tower by the Raw Water Supply System (RWSS) is filtered using media filters. Backwash from the filters is discharged to the Waste Water Retention basin at an average flow rate of 5% of the filtered water flow rate per Assumption 3.6 and is:

1,830 * 0.05 = 91 gpm average and
4,163 * 0.05 = 208 gpm maximum

The total wastes collected in the Waste Water Retention Basin and returned to the Susquehanna River are from CWS and ESWS cooling tower blowdowns, miscellaneous low volume waste, RO brine, and RWSS filter backwash. The total flow is:

(7,928 + 569 + 39 + 27 + 91) = 8,654 gpm average and
(7,928 + 1,138 + 55 + 27 + 208) = 9,356 gpm maximum

Water from the Waste Water Retention Basin is discharged to the Susquehanna River along with treated liquid radwaste. The total discharge to the Susquehanna River is:

8,654 + 11 = 8,665 gpm average and
9,356 + 11 = 9,367 gpm maximum

6.0 RESULTS

The results are a water balance as shown in attached drawing 12198-004-WTR-001, rev 1, "Conceptual Anticipated Water Use Diagram – Bell Bend Nuclear Power Plant" (see Attachment 8.5).

7.0 REFERENCES

7.1 Markup of Water Use Diagram and Anticipated Water Use Table from the CCNPP COLA ER, provided by Unistar Nuclear for use as standardized water balance input.
7.2 Response to RFI #SL-BER-051, Susquehanna River data
7.3 Response to RFI #PCR-BER-004, Susquehanna River Water Quality and Fishes Report
7.4 U.S. EPR Final Safety Analysis Report, Table 9.2.5-2 – Ultimate Heat Sink Design Parameters
7.5 Report No. 2008-06824, Rev. 1, "Engineering and Economic Evaluation of the Integrated Heat Rejection Cycle."
7.6 Report No. SL-009442, Rev. 0, "Conceptual Design for Collection System of Sanitary Wastewater"
7.7 Response to RFI #SL-BER-053, Bell Bend Anticipated Water Use
7.8 Report No. SL-009498, Rev. 1, "Conceptual Design of the Circulating Water System Bell Bend Nuclear Power Plant Unistar Nuclear Energy"

ATTACHMENT 8.1

Standardized Water Balance
Water Use Diagram and Anticipated Water Use Table

(Design Input 2.1)

4 pages

"Scholtes, Heather M " <HMScholtes@pplweb .com>
02/27/2008 12:05 PM

To <ROBERT.A.HAMEETMAN@sargentlundy.com>, "Maury A. Pressburger" <maury.a.pressburger@sargentlundy.com>
cc "Cain, Michael" <Michael.Cain@unistarnuclear.com>, <Thomas.E.Roberts@unistarnuclear.com>
bcc
Subject Anticipated Water Use

History This message has been forwarded.

Attached, please find the water use diagram and accompanying documentation. This information was discussed in your phone converstation with Mike Cain and Tom Roberts.

Heather Scholtes
Administrative Assistant
Unistar Nuclear
38 Bomboy Lane, Suite 2
Berwick, PA
570-802-8101

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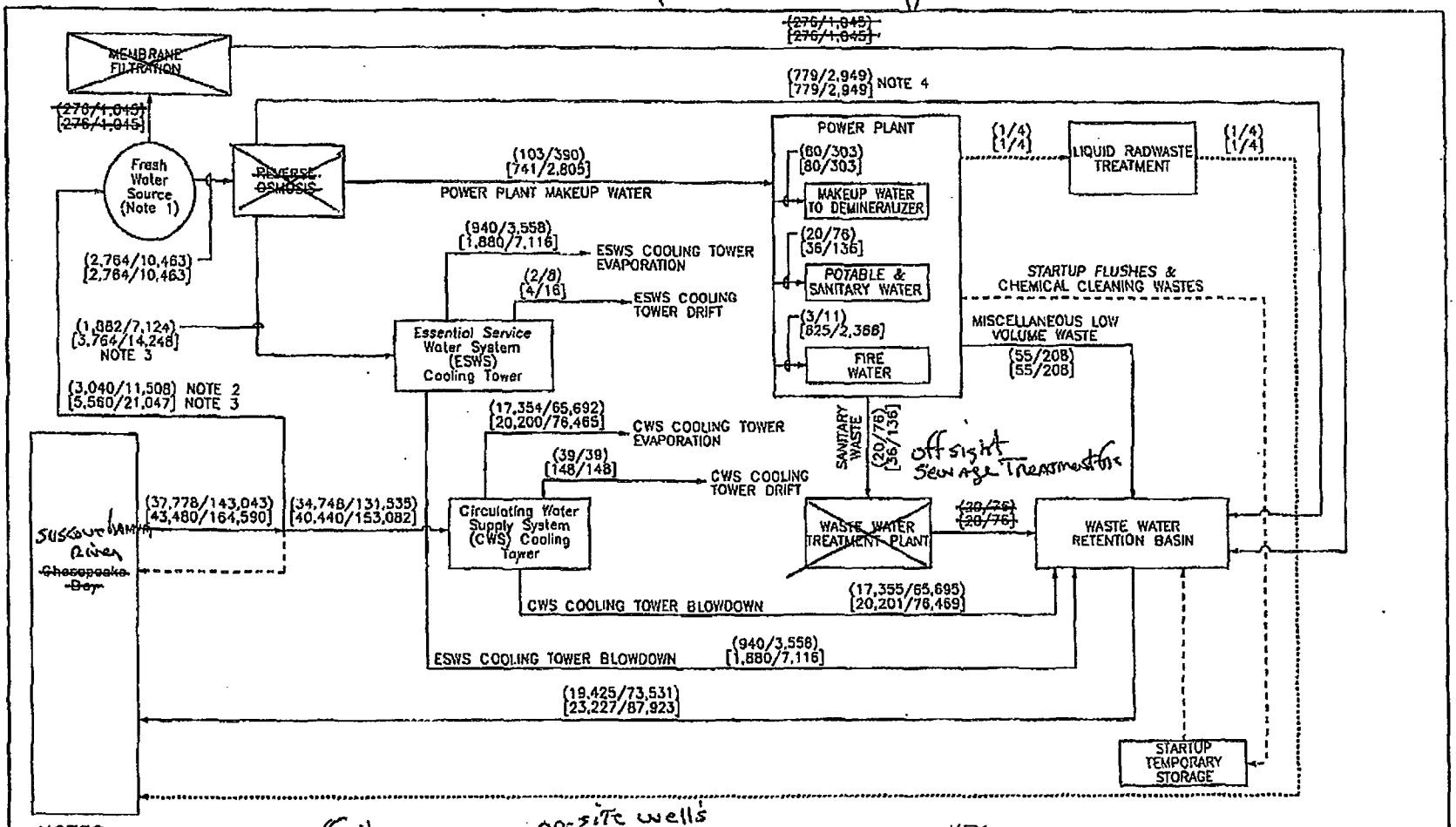
water use diag.pdf

Conceptual discussion purposes only –



NOTES:

1. THE FRESH WATER SOURCE ~~IS DESALINATED CHESAPEAKE BAY WATER.~~ is offsite source or on-site wells
2. ~~MAKEUP WATER TO THE CWS CIRCULATING WATER SYSTEM WILL SUPPLY THE DESALINIZATION PLANT.~~
3. MAXIMUM FLOW WILL BE PROVIDED BY THE ~~DESALINIZATION PLANT~~ PLUS WATER STORED IN THE ESWS COOLING TOWER STORAGE BASINS.
4. SEE TABLE 3.3-1.

offsite source or wells.

LEGEND:

- - - - - - - STARTUP FLOWS
——— NORMAL FLOW
..... FLOW VARIES WITH OPERATING CONDITIONS

KEY:

(AVERAGE FLOWS: GALLONS PER MINUTE/LITERS PER MINUTE)
[MAXIMUM FLOWS: GALLONS PER MINUTE/LITERS PER MINUTE]

~~FIGURE 3.3-7~~ ~~Rev. 0~~

ANTICIPATED WATER USE DIAGRAM

~~CCNPP UNIT 3 ER~~

Bell Bend.

Table 3.3-1 Anticipated Water Use
(Page 1 of 2)

Water Streams	Average Flow[a] gpm (lpm)	Maximum Flow[b] gpm (lpm)
Desalinated Water (Fresh Water) Demand [c,d]	3,040 (11,508)	3,040 + [2,520] = 5,560 (11,508 + [9,539] = 21,047)
Membrane Filtration	~~276 (1,045)~~	~~276 (1,045)~~
Reverse Osmosis	~~2,764 (10,463)~~	~~2,764 (10,463)~~
Reverse Osmosis Reject [e]	~~779 (2,949)~~	~~779 (2,949)~~
Essential Service Water System (ESWS)/Ultimate Heat Sink (UHS) Makeup [f]	1,882 (7,124)	1,244 + [2,520] =3,764 (4,709 + [9,539] = 14,248)
ESWS Cooling Tower Evaporation	940 (3,558)	1,880 (7,116)
ESWS Cooling Tower Drift	2 (8)	4 (16)
ESWS Cooling Tower Blowdown	940 (3,558)	1,880 (7,116)
Power Plant Makeup	103 (390)	741 (2,805)
Demineralized Water Distribution System	80 (303)	80 (303)
Potable and Sanitary Water Distribution System	20 (76)	36 (136)
Plant Users	20 (76)	36 (136)
Non-Plant Users	0 (0)	0 (0)
Susquehanna Fire Water Distribution System [h]	3 (11)	625 (2,366)
~~Chesapeake Bay~~ Water Demand	37,788 (143,043)	43,480 (164,590)
~~Desalinization Plant~~	~~3,040 (11,508)~~	~~3,040 (11,508)~~
Circulating Water Supply System (CWS)	34,748 (131,535)	40,440 (153,082)
CWS Cooling Tower Evaporation	17,354 (65,692)	20,200 (76,465)
CWS Cooling Tower Drift [i]	39 (148)	39 (148)
CWS Cooling Tower Blowdown	17,355 (65,695)	20,201 (76,469)
Effluent Discharge ~~to Chesapeake Bay~~ Susquehanna	19,426 (73,535)	23,228 (87,927)
Waste Water Retention Basin Discharge	19,425 (73,531)	23,227 (87,923)
Miscellaneous Low Volume Waste	55 (208)	55 (208)
Treated Sanitary Waste	20 (76)	36 (136)
CWS Cooling Tower Blowdown	940 (3,558)	1,880 (7,116)
CWS Cooling Tower Blowdown	17,355 (65,695)	20,201 (76,469)
~~Desalinization Plant Waste~~	~~1,055 (3,994)~~	~~1,055 (3,994)~~
~~Membrane Filtration~~	~~276 (1,046)~~	~~276 (1,045)~~
~~Reverse Osmosis Reject [e]~~	~~779 (2,949)~~	~~779 (2,949)~~
Startup Temporary Storage Discharge [j]	—	—
Trash Screen Cleaning Water Discharge [j]	—	—
Treated Liquid Radwaste	1 (4)	1 (4)

Key:
gpm – gallons per minute
lpm – liters per minute

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Table 3.3-1 Anticipated Water
(Page 2 of 2)

Notes:

a. Average flow represents the expected water consumptive rates and returns for normal plant operating conditions.

b. Maximum flow represents water consumptive rates and returns during normal shutdown/cooldown.

c. The source for fresh water is ~~desalinated Chesapeake Bay water.~~ off site source.

d. ~~Maximum flow will be provided by the Desalinization Plant (3,040 gpm/11,508 lpm) plus water stored in the ESWS cooling tower storage basins (2,520 gpm/9,539 lpm).~~

e. ~~The desalinated water demand of 3,040 gpm (11,508 lpm) is based on 40% recovery for the preliminary design of the Desalinization Plant. The corresponding production rate for reverse osmosis would be approximately 1,106 gpm (4,187 lpm). Reverse osmosis reject would be approximately 1,658 gpm (6,276 lpm), rather than the value of 779 gpm (2,949 lpm) used for balancing purposes. Referring to the above table, note that a production rate of 1,106 gpm (4,187 lpm) would be less than the makeup demand for the ESWS cooling tower. However, the makeup and evaporation demands for the ESWS cooling towers in the above table are bounding values; actual demands are anticipated to be less. Therefore, the flows will likely change during the detailed design phase. Also, the difference between actual demand and flow anticipated by reverse osmosis equipment will be accommodated by the raw water storage tank.~~

f. Two trains will be operating under normal conditions and four trains during shutdown/cooldown.

g. The average flow for potable water demand is based on projected staffing during normal plant operation. Non-plant water users include potable and sanitary needs for administrative buildings and warehouses, and water required for landscape maintenance. Non-plant water users are not included in the estimated demand; however, water stored in the raw water storage tank(s) should accommodate other station water users since it will be designed for peak load provisions.

h. During normal operating conditions, water consumed by the Fire Water Distribution System is attributed to system leakage and periodic testing. The maximum consumptive rate is based on meeting the National Fire Protection Association's requirement for replenishing fire protection water storage.

i. The average and maximum cooling tower drift losses are considered equivalent and are less than 0.005% of the CWS flow rate.

j. Startup effluents occur during plant startup; the effluents will be stored within tanks or bladders, which will be removed once startup is complete. Makeup flows associated with startup and trash screen cleaning are anticipated to be minimal. Similarly, discharges associated with startup effluents and trash screen cleaning effluents, are also anticipated to be minimal.

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ATTACHMENT 8.2

Areva Correspondence

(Design Input 2.2)

1 page

"GLUCKLER Peter E (AREVA NP INC)"
<Peter.Gluckler@areva .com>

02/28/2008 08:26 AM

To <maury.a.pressburger@sargentlundy.com>

cc "SNOOKS John H (AREVA NP INC)" <John.Snooks@areva.com>, "HUBBARD Barbara Y (AREVA NP INC)" <Barbara.Hubbard@areva.com>, "Wrobel, George" <George.Wrobel@unistarnuclear.com>, "Cain, Michael" <Michael.Cain@unistarnuclear.com>, "BONISOLLI Robert W (AREVA NP INC)" <Robert.Bonisolli@areva.com>, "BELLINI Frank X (AREVA NP INC)" <Frank.Bellini@areva.com>, "THOMSON Stacy T (AREVA NP INC)" <Stacy.Thomson@areva.com>

bcc

Subject RFI SL-NMP-036 - Areva Water Balance

History: This message has been forwarded

Maury,

To follow-up on S&L's request for the Areva water balance for the EPR and our conversation earlier this week, please review the Water Use Diagram and Anticipated Water Use table in the CCNPP COLA ER Section 3.3 along with water use information on the cooling systems in ER 3.4. The CCNPP COLA ER is available on both the NRC website and the Bell Bend FTP site. Make-up and blowdown flows for the Circulating Water and UHS cooling towers along with raw water treatment flows will be site specific, but the Power Plant Makeup, including potable, demineralizer makeup and fire, should be the same along with the associated wastewater discharges. Once you have had a chance to review, please let me know if this is sufficient to meet your needs or if additional information is required.

Thanks,

Peter E. Gluckler, Jr.
AREVA NP Inc.

peter.gluckler@areva.com
400 Donald Lynch Blvd.
Marlboro, MA 01752
Phone: 508-573-6582
Fax: 508-573-6614

ATTACHMENT 8.3

Susquehanna River Water Data for 2007
Response to RFI #SL-BER-051

(Input 2.3)

10 pages

MAURY A PRESSBURGER/Sargentlundy
02/18/2008 03:39 PM

To JERI C PENROSE/Sargentlundy@Sargentlundy
cc
bcc
Subject Fw: Comments on RFI SL-BER-051

---- Forwarded by MAURY A PRESSBURGER/Sargentlundy on 02/18/2008 03:39 PM ----

ROBERT A HAMEETMAN/Sargentlundy
02/15/2008 02:17 PM

To MAURY A PRESSBURGER/Sargentlundy@Sargentlundy
cc
Subject Fw: Comments on RFI SL-BER-051

---- Forwarded by ROBERT A HAMEETMAN/Sargentlundy on 02/15/2008 02:14 PM ----

"Cain, Michael" <Michael.Cain@unistarnuclear.com>
02/15/2008 09:43 AM

To "Wrobel, George" <George.Wrobel@unistarnuclear.com>, "van Noordennen, Gerry" <Gerry.vanNoordennen@constellation.com>
cc "Scholtes, Heather M" <Heather.Scholtes@constellation.com>, <ROBERT.A.HAMEETMAN@sargentlundy.com>, "SELZ Lannis N (AREVA NP INC)" <Lannis.Selz@areva.com>, "Antonio Fernandez" <antonio.fernandez@Rizzoassoc.com>, "Hunter, Mark T" <Mark.T.Hunter@unistarnuclear.com>
Subject FW: Comments on RFI SL-BER-051

Does this get posted to the ftp?

Also this seems to be related to a number of individual RFIs requesting information about water sources and by extension water quality.

The bottom line is that the raw water source at Bell Bend is the river. Water chemistry data is above. Raw water feeds D/I, FP, Circ Water and so on. Potable water is likely to come from another source. The need for treatment of raw water is an engineer's determination on a system by system basis.

It seems like we need to distribute this information broadly to AREVA, S&L and eventually B&V via some form so that they stop writing multiple RFIs each from a slightly different, but equally narrow perspective.

Heather is going to contact all of you about participating in a conference call on Tuesday morning. Please prepare.

MC

From: Fields, Jerome S [mailto:jsfields@pplweb.com]
Sent: Thursday, February 14, 2008 8:40 AM
To: Wrobel, George
Cc: Fehmida.Mesania@Rizzoassoc.com; Harpster, Terry L; Cain, Michael; Hunter, Mark Thomas
Subject: Comments on RFI SL-BER-051

George,

In response to questions on Susquehanna SES station water chemistry, I have the following comments;

Service Water, Circulating Water, and Blowdown are essentially the same water, that is river water usually between 3 to 5 cycles of concentration. Several parameters are measured including total suspended solids (TSS). TSS is of interest because the station's NPDES permit has TSS limits. Total dissolved solids listed in the RFI is not calculated. My source for this information is Jim Wolfer, Plant Chemistry.

Blowdown data is included in Ecology III Annual Water Quality and Fishes reports which you have copies of through 2006. I am attaching the 2007 water sample quarterly data since the annual report is not expected until later this year. These data are in four separate reports instead of combined in one table as in the annual reports.

This is the last open item I had from this week's RFI meeting. If I missed anything please let me know.

Thanks,

Jerry

<<river data 07-11.doc>> <<river data 07-8.doc>> <<river data 07-5.doc>> <<river data 07-3.doc>>

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river data 07-11.doc river data 07-8.doc river data 07-5.doc river data 07-3.doc

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LABORATORY REPORT

LIMS ID		WAT-07-00459	WAT-07-00461	WAT-07-00460
Location / Plant		SSES-ENVIRONMENTAL	SSES-ENVIRONMENTAL	SSES-ENVIRONMENTAL
Sample Date		3/15/07	3/15/07	3/15/07
Sample Time		0839	0719	0847
Sample Description		SSES	Blowdown	Bell Bend
Parameter	Units			
Temperature	C	2.40	23.90	2.40
Dissolved Oxygen	mg/L	13.00	8.30	12.90
River Level	ft	497.0		
pH Lab		7.62	8.75	7.54
Conductivity - Lab	umho	187	646	188
Total Alkalinity	mg/L	39.0	135	38.0
PHT Alkalinity	mg/L	0.0	6.0	0.0
Total Suspended Solids	mg/L	152	63.0	82.0
Ammonia as N by ISE	mg/L	<0.20	<0.20	<0.20
Silicon Dioxide	mg/L	3.31	8.62	3.25
Bicarbonate as CaCO3	mg/L	39.0	123	38.0
Carbonate as CaCO3	mg/L	0.0	7.2	0.0
Chloride	mg/L	22.3	86.4	22.3
Fluoride	mg/L	<0.05	<0.10	N.D.
Nitrate as NO3	mg/L	3.0	10.6	3.0
Nitrate as N	mg/L	0.7	2.4	0.7
Phosphorus as PO4	mg/L	0.736	1.975	0.712
Sulfate	mg/L	12.5	52.3	12.4
Aluminum, Dissolved	ug/L	N.D.	<100	N.D.
Aluminum, Total	ug/L	2740	1430	2700
Barium, Total	ug/L	58	95	55
Beryllium, Total	ug/L	N.D.	N.D.	N.D.
Calcium, Dissolved	mg/L	17.3	62.8	17.7
Calcium, Total	mg/L	17.9	64.6	18.3
Chromium, Total	ug/L	<10	<10	<10
Copper, Dissolved	ug/L	N.D.	<20	N.D.
Copper, Total	ug/L	<20	<20	<20
Iron, Dissolved	mg/L	0.04	0.06	0.04
Iron, Total	mg/L	5.86	3.67	5.58
Magnesium, Dissolved	mg/L	3.45	13.0	3.42
Magnesium, Total	mg/L	4.29	13.7	4.31
Manganese, Dissolved	ug/L	42	43	44
Manganese, Total	ug/L	257	227	231
Nickel, Total	ug/L	<10	<10	<10
Potassium, Dissolved	mg/L	1.46	4.04	1.45
Potassium, Total	mg/L	1.86	4.28	1.83
Silver, Total	ug/L	N.D.	N.D.	N.D.
Sodium, Dissolved	mg/L	12.6	46.8	12.7
Sodium, Total	mg/L	12.3	47.3	12.4
Strontium, Total	ug/L	54	227	54
Vanadium, Total	ug/L	N.D.	N.D.	<10
Zinc, Dissolved	ug/L	<20	<20	<20
Zinc, Total	ug/L	26	24	24

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LABORATORY REPORT

LIMS ID (continued)		WAT-07-00459	WAT-07-00461	WAT-07-00460
Location / Plant		SSES-	SSES-	SSES-
Sample Date		3/15/07	3/15/07	3/15/07
Sample Time		0839	0719	0847
Sample Description		SSES	Blowdown	Bell Bend
Parameter	Units			
Antimony, Total	ug/L	N.D.	N.D.	N.D.
Cadmium, Total	ug/L	N.D.	N.D.	N.D.
Lead, Total	ug/L	5	<5	5
Thallium, Total	ug/L	N.D.	N.D.	N.D.
Arsenic, Total	ug/L	2.9	2.4	2.8
Selenium, Total	ug/L	N.D.	N.D.	N.D.
TMS Corrected	mg/L	99.28	365.58	98.98
Calcium Hardness	mg/L	43.2	156.8	44.2
Total Hardness	mg/L	62.4	218	63.4

Sample notes:

WAT-07-00459 Analysis holding time was exceeded for samples in Silica Batch WAT-07-00459. *for:* silica_l

WAT-07-00460 The relative percent difference for boron on the analysis duplicate of WAT-07-00460 (Batch WAT-07-00428) exceeded acceptable limits.

"NR" indicates "not reported"

Approved by _____
Bernard H. Herre, Manager Chemical Laboratory

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LABORATORY REPORT

LIMS ID		WAT-07-00796	WAT-07-00798	WAT-07-00797
Location / Plant		SSES-Environmental	SSES-Environmental	SSES-Environmental
Sample Date		5/21/07	5/21/07	5/21/07
Sample Time		0750	0906	0756
Sample Description		SSES	Blowdown	Bell Bend
Parameter	Units			
Temperature	C	15.50	19.00	15.50
Dissolved Oxygen	mg/L	10.30	9.10	10.30
River Level	ft	489.1		
pH Lab		8.20	8.91	8.13
Conductivity - Lab	umho	279	843	278
Total Alkalinity	mg/L	65.0	213	65.0
PHT Alkalinity	mg/L	0.0	14.0	0.0
Total Suspended Solids	mg/L	6.0	17.5	<4.0
Ammonia as N by ISE	mg/L	<0.20	<0.20	<0.20
Silicon Dioxide	mg/L	0.22	1.82	0.18
Bicarbonate as CaCO3	mg/L	65.0	185	65.0
Carbonate as CaCO3	mg/L	0.0	16.8	0.0
Chloride	mg/L	29.0	96.6	28.7
Fluoride	mg/L	0.07	0.22	0.07
Nitrate as NO3	mg/L	1.3	4.7	1.2
Nitrate as N	mg/L	0.3	1.1	0.3
Phosphorus as PO4	mg/L	0.117	1.702	0.120
Sulfate	mg/L	24.1	83.2	24.0
Aluminum, Dissolved	ug/L	<100	<100	N.D.
Aluminum, Total	ug/L	112	361	<100
Barium, Total	ug/L	28	90	28
Beryllium, Total	ug/L	N.D.	N.D.	N.D.
Calcium, Dissolved	mg/L	28.4	93.6	28.1
Calcium, Total	mg/L	28.3	94.2	28.4
Chromium, Total	ug/L	N.D.	N.D.	N.D.
Copper, Dissolved	ug/L	<20	N.D.	N.D.
Copper, Total	ug/L	N.D.	<20	N.D.
Iron, Dissolved	mg/L	0.03	0.10	0.03
Iron, Total	mg/L	0.58	1.59	0.51
Magnesium, Dissolved	mg/L	6.22	20.1	6.13
Magnesium, Total	mg/L	6.24	20.4	6.26
Manganese, Dissolved	ug/L	53	28	51
Manganese, Total	ug/L	100	193	97
Nickel, Total	ug/L	<10	<10	N.D.
Potassium, Dissolved	mg/L	1.58	4.74	1.41
Potassium, Total	mg/L	1.60	4.74	1.47
Silver, Total	ug/L	N.D.	N.D.	N.D.
Sodium, Dissolved	mg/L	17.2	56.6	16.8
Sodium, Total	mg/L	16.9	56.5	16.9
Strontium, Total	ug/L	103	341	103
Vanadium, Total	ug/L	N.D.	N.D.	N.D.
Zinc, Dissolved	ug/L	<20	<20	N.D.
Zinc, Total	ug/L	<20	<20	N.D.

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LABORATORY REPORT

LIMS ID (continued)		WAT-07-00796	WAT-07-00798	WAT-07-00797
Location / Plant		SSES-	SSES-	SSES-
Sample Date		5/21/07	5/21/07	5/21/07
Sample Time		0750	0906	0756
Sample Description		SSES	Blowdown	Bell Bend
Parameter	Units			
Antimony, Total	ug/L	N.D.	N.D.	N.D.
Cadmium, Total	ug/L	N.D.	N.D.	N.D.
Lead, Total	ug/L	N.D.	N.D.	N.D.
Thallium, Total	ug/L	N.D.	N.D.	N.D.
Arsenic, Total	ug/L	<1.0	1.6	<1.0
Selenium, Total	ug/L	N.D.	N.D.	N.D.
TMS Corrected	mg/L	147.03	489.21	145.58
Calcium Hardness	mg/L	70.9	233.7	70.2
Total Hardness	mg/L	96.4	319	96.7

Sample notes:
"NR" indicates "not reported"

Approved by _____
Bernard H. Herre, Manager Chemical Laboratory

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LABORATORY REPORT

LIMS ID		WAT-07-01344	WAT-07-01346	WAT-07-01345
Location / Plant		SSES-Environmental	SSES-Environmental	SSES-Environmental
Sample Date		08/23/07	08/23/07	08/23/07
Sample Time		0853	0737	0900
Sample Description		SSES	Blowdown	Bell Bend
Parameter	Units			
Temperature	C	19.50	22.60	19.70
Dissolved Oxygen	mg/L	8.00	7.90	8.00
River Level	ft	486.8		
pH Lab		7.74	8.80	7.71
Conductivity - Lab	umho	348	898	365
Total Alkalinity	mg/L	58.0	168	64.0
PHT Alkalinity	mg/L	0.0	13.0	0.0
Total Suspended Solids	mg/L	39.6	24.6	6.0
Ammonia as N by ISE	mg/L	<0.20	<0.20	<0.20
Silicon Dioxide	mg/L	1.96	5.63	2.06
Bicarbonate as CaCO3	mg/L	58.0	142	64.0
Carbonate as CaCO3	mg/L	0.0	15.6	0.0
Chloride	mg/L	38.2	112	39.6
Fluoride	mg/L	0.10	0.25	0.10
Nitrate as NO3	mg/L	1.9	5.1	2.0
Nitrate as N	mg/L	0.4	1.2	0.4
Phosphorus as PO4	mg/L	0.000	3.160	0.092
Sulfate	mg/L	48.8	137	51.2
Aluminum, Dissolved	ug/L	N.D.	<100	N.D.
Aluminum, Total	ug/L	127	359	<100
Barium, Total	ug/L	32	93	34
Beryllium, Total	ug/L	N.D.	N.D.	N.D.
Calcium, Dissolved	mg/L	29.6	79.9	30.6
Calcium, Total	mg/L	29.0	81.8	30.7
Chromium, Total	ug/L	N.D.	N.D.	N.D.
Copper, Dissolved	ug/L	N.D.	N.D.	N.D.
Copper, Total	ug/L	N.D.	N.D.	N.D.
Iron, Dissolved	mg/L	0.06	0.08	0.07
Iron, Total	mg/L	0.71	1.94	0.73
Magnesium, Dissolved	mg/L	10.0	27.0	10.5
Magnesium, Total	mg/L	9.99	27.7	10.6
Manganese, Dissolved	ug/L	145	42	147
Manganese, Total	ug/L	223	446	223
Nickel, Total	ug/L	<10	<10	<10
Potassium, Dissolved	mg/L	2.24	5.80	2.32
Potassium, Total	mg/L	2.24	5.88	2.34
Silver, Total	ug/L	N.D.	N.D.	N.D.
Sodium, Dissolved	mg/L	23.0	66.4	24.2
Sodium, Total	mg/L	22.7	67.2	24.1
Strontium, Total	ug/L	167	457	177
Vanadium, Total	ug/L	N.D.	<10	N.D.
Zinc, Dissolved	ug/L	N.D.	N.D.	N.D.
Zinc, Total	ug/L	N.D.	<20	N.D.

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LABORATORY REPORT

LIMS ID (continued)		WAT-07-01344	WAT-07-01346	WAT-07-01345
Location / Plant		SSES-	SSES-	SSES-
Sample Date		08/23/07	08/23/07	08/23/07
Sample Time		0853	0737	0900
Sample Description		SSES	Blowdown	Bell Bend
Parameter	*Units*			
Antimony, Total	ug/L	N.D.	N.D.	N.D.
Cadmium, Total	ug/L	N.D.	N.D.	N.D.
Lead, Total	ug/L	N.D.	N.D.	N.D.
Thallium, Total	ug/L	N.D.	N.D.	N.D.
Arsenic, Total	ug/L	1.2	2.8	1.1
Selenium, Total	ug/L	N.D.	N.D.	N.D.
TMS Corrected	mg/L	190.50	539.06	200.88
Calcium Hardness	mg/L	73.9	199.5	76.4
Total Hardness	mg/L	114	318	120

Sample notes:
WAT-07-01345 *The relative percent difference for total phosphorus on the analysis duplicate of WAT-07-01345 (Batch WAT-07-01344) exceeded acceptable limits.*

"NR" indicates "not reported"

Approved by _____
Bernard H. Herre, Manager Chemical Laboratory

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LABORATORY REPORT

LIMS ID		WAT-07-01344	WAT-07-01346	WAT-07-01345
Location / Plant		SSES-Environmental	SSES-Environmental	SSES-Environmental
Sample Date		08/23/07	08/23/07	08/23/07
Sample Time		0853	0737	0900
Sample Description		SSES	Blowdown	Bell Bend
Parameter	Units			
Temperature	C	19.50	22.60	19.70
Dissolved Oxygen	mg/L	8.00	7.90	8.00
River Level	ft	486.8		
pH Lab		7.74	8.80	7.71
Conductivity - Lab	umho	348	898	365
Total Alkalinity	mg/L	58.0	168	64.0
PHT Alkalinity	mg/L	0.0	13.0	0.0
Total Suspended Solids	mg/L	39.6	24.6	6.0
Ammonia as N by ISE	mg/L	<0.20	<0.20	<0.20
Silicon Dioxide	mg/L	1.96	5.63	2.06
Bicarbonate as CaCO3	mg/L	58.0	142	64.0
Carbonate as CaCO3	mg/L	0.0	15.6	0.0
Chloride	mg/L	38.2	112	39.6
Fluoride	mg/L	0.10	0.25	0.10
Nitrate as NO3	mg/L	1.9	5.1	2.0
Nitrate as N	mg/L	0.4	1.2	0.4
Phosphorus as PO4	mg/L	0.000	3.160	0.092
Sulfate	mg/L	48.8	137	51.2
Aluminum, Dissolved	ug/L	N.D.	<100	N.D.
Aluminum, Total	ug/L	127	359	<100
Barium, Total	ug/L	32	93	34
Beryllium, Total	ug/L	N.D.	N.D.	N.D.
Calcium, Dissolved	mg/L	29.6	79.9	30.6
Calcium, Total	mg/L	29.0	81.8	30.7
Chromium, Total	ug/L	N.D.	N.D.	N.D.
Copper, Dissolved	ug/L	N.D.	N.D.	N.D.
Copper, Total	ug/L	N.D.	N.D.	N.D.
Iron, Dissolved	mg/L	0.06	0.08	0.07
Iron, Total	mg/L	0.71	1.94	0.73
Magnesium, Dissolved	mg/L	10.0	27.0	10.5
Magnesium, Total	mg/L	9.99	27.7	10.6
Manganese, Dissolved	ug/L	145	42	147
Manganese, Total	ug/L	223	446	223
Nickel, Total	ug/L	<10	<10	<10
Potassium, Dissolved	mg/L	2.24	5.80	2.32
Potassium, Total	mg/L	2.24	5.88	2.34
Silver, Total	ug/L	N.D.	N.D.	N.D.
Sodium, Dissolved	mg/L	23.0	66.4	24.2
Sodium, Total	mg/L	22.7	67.2	24.1
Strontium, Total	ug/L	167	457	177
Vanadium, Total	ug/L	N.D.	<10	N.D.
Zinc, Dissolved	ug/L	N.D.	N.D.	N.D.
Zinc, Total	ug/L	N.D.	<20	N.D.

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LABORATORY REPORT

LIMS ID	(continued)	WAT-07-01687	WAT-07-01689	WAT-07-01688
Location / Plant		SSES-Environmental	SSES-Environmental	SSES-Environmental
Sample Date		11/7/07	11/7/07	11/7/07
Sample Time		0658	0746	0649
Sample Description		SSES	Blowdown	Bell Bend
Parameter	Units			
Antimony, Total	ug/L	N.D.	N.D.	N.D.
Cadmium, Total	ug/L	N.D.	N.D.	N.D.
Lead, Total	ug/L	N.D.	<5	N.D.
Thallium, Total	ug/L	N.D.	N.D.	N.D.
Arsenic, Total	ug/L	<1.0	2.6	<1.0
Selenium, Total	ug/L	N.D.	N.D.	N.D.
TMS Corrected	mg/L	145.81	426.66	146.26
Calcium Hardness	mg/L	68.9	203.5	69.4
Total Hardness	mg/L	93.6	277	95.6

Sample notes:
WAT-07-01689 The matrix spike percent recovery for phosphorus on WAT-07-01689 (Batch WAT-07-01689) exceeded acceptable limits.

"NR" *indicates "not reported"*

Approved by _____
Bernard H. Herre, Manager Chemical Laboratory

ATTACHMANT 8.4

Susquehanna River Water Data for 2006
Response to RFI #PCR-BER-004 (excerpt)

(Input 2.4)

8 pages

George Wrobel
Licensing Director

UniStar NUCLEAR

February 7, 2008

Fehmida Mesania
Project Engineer
Paul C. Rizzo Associates, Inc.
105 Mall Blvd, Suite #270
Monroeville, PA 15146

RFI #08-045

Subject: Response to RFI PCR-BER-004, transmitted from Fehmida Mesania to George Wrobel, dated December 4, 2007.

Attached is the subject RFI, as well as the UniStar Nuclear response. Attachments include the 1) Supplemental Laboratory Accreditation Form, 2) Susquehanna River Basin Data, and 3) the Susquehanna River Water Quality and Fishes Report.

Sincerely,

George Wrobel

xc: R. Krich, w/o
D. Green, w/o
B. Perdue
M. Hunter, w/o
S. Strout, w/o
K. Scopelliti, PPL
F. Eisenhuth, PPL
J. Fields, PPL, w/o
M. Cain, w/o
J. Morris, AREVA
G. van Noordennen, w/o
R. Hameetman, S&L, w/o

UniStar NUCLEAR

REQUEST FOR INFORMATION (RFI)

RFI NUMBER: PCR-BER-004	**DATE:** 12/4/07
PROJECT NUMBER: 073891	**PROJECT NAME:** Berwick Unit 1
ORIGINATOR: Fehmida Mesania	**PHONE/FAX:** 412-856-9700 x 1096/412-856-9749
PROJECT MANAGER APPROVAL: Antonio Fernandez	
SUPERVISOR APPROVAL: George Wrobel	
TO: UniStar	
REFERENCE SECTION(S): ER 2.3	**REV.:** N/A
SPECIFICATION(S): N/A	**REV.:** N/A

INFORMATION REQUESTED:

Describe existing Water Quality Monitoring Program for Susquehanna Unit 1 & 2. What parameters are being monitored? At what frequency? If data and maps are available please provide those.

RESPONSE REQUIRED BY: February 01, 08

IMPACTS:
ER 2.3.1

RESPONSE INFORMATION

TO: FEHMIDA MESANIA	**FROM:** GEORGE WROBEL
OF: RIZZO	**OF:** UNISTAR NUCLEAR

RESPONSE INFORMATION: See attached: Supplemental Laboratory Accreditation Form
: Susquehanna River Basin Data
: Susquehanna River Water Quality + Fishes Report

Prepared by: Mark Hunter by telecon 1/24/08

Approved by: George Wrobel [signature], UniStar Nuclear 2/6/08

APPROVED FOR USE: N/A GW **DATE:** 2/6/08

FI 063624/06

Att. 2

Wrobel, George

From: Hunter, Mark T
Sent: Thursday, January 24, 2008 5:23 PM
To: Wrobel, George
Subject: FW: Susquehanna River Water Quality and Fishes Report
Attachments: DOC000.PDF

More for PCR-BER-004

Mark T. Hunter
Director of Design Standardization
38 Bomboy Lane,Suite 2
Berwick,PA 18603
410-610-8200 (c)
570-802-8102 (Berwick Site)

From: Fields, Jerome S [mailto:jsfields@pplweb.com]
Sent: Monday, January 14, 2008 11:12 AM
To: fehmida.mesania@rizzoaccoc.com
Cc: john.snooks@areva.com; Hunter, Mark T; Scopelliti, Karen T
Subject: Susquehanna River Water Quality and Fishes Report

Fehima,

Attached is the 2006 Ecology III Water Quality and Fishes Report. Tables 1 - 7 provide Susquehanna River water quality data from 2006 and historical data back to 1975 in some cases. Figure 1 shows the upstream or control monitoring location above the SSES's intake structure and also the indicator location below the SSES's discharge in the Bell Bend area. This downstream location may also be in the vicinity of the Berwick plant's cooling tower discharge. Finally, Figures 2 - 5 provide historical river data.

Please me know if you need additional river data and I will check to see if it is available.

Thanks,

Jerry Fields

610-774-7889
610-295-2372 (cell)

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ENVIRONMENTAL STUDIES IN THE VICINITY OF THE SUSQUEHANNA STEAM ELECTRIC STATION

2006
WATER QUALITY AND FISHES

Prepared by

Ecology III, Inc.
Susquehanna SES Environmental Laboratory
804 Salem Boulevard
Berwick, Pennsylvania 18603

For

PPL Susquehanna, LLC
769 Salem Boulevard
Berwick, PA 18603-0467

July 2007

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Table 4

Water quality data collected quarterly from the Susquehanna River and the Susquehanna SES blowdown, 2006. River sites were SSES (control) and Bell Bend (indicator). Analyses were performed by the PPL Chemical Laboratory, Hazleton, PA.
N.D. = Not Detected

PARAMETER	UNITS	SSES	BLOW DOWN	BELL BEND	SSES	BLOW DOWN	BELL BEND
Date		2/23/2006	2/23/2006	2/23/2006	5/18/2006	5/18/2006	5/18/2006
Time		845	733	851	722	832	716
River level	ft	489.4			489.6		
Temperature	C	2	18.8	2	16.1	19.8	15.7
Dissolved oxygen	mg/L	12.8	7.3	12.8	10.2	8.2	10.5
pH, lab		7.61	8.8	7.64	8.04	8.93	7.98
Conductivity, lab	µmho	248	932	248	243	874	243
Total alkalinity	mg/L	56	223	56	62	230	61
Phenolphthalein alkalinity	mg/L	0.0	14.0	0.0	0.0	16.0	0.0
Total suspended solids	mg/L	4.3	27.3	4	8	32	7
Ammonia as N	mg/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Silicon dioxide	mg/L	3.9	15.4	3.9	0.2	2.3	0.2
Bicarbonate as CaCO3	mg/L	68.3	238	68.3	75.6	242	74.4
Carbonate by calculation	mg/L	0	16.8	0	0	19.2	0
Chloride	mg/L	23.1	105	23.2	22.6	99.7	22.7
Fluoride	mg/L	0.05	0.21	0.06	0.06	0.21	0.06
Nitrate as NO3	mg/L	3.4	15.4	3.4	1.2	5.4	1.3
Nitrate ion as N	mg/L	0.8	3.5	0.8	0.3	1.2	0.3
Phosphorus as PO4	mg/L	0.092	3.006	0.092	0.135	3.175	0.147
Sulfate	mg/L	23.7	97.5	23.7	21.6	87	21.7
Aluminum, dissolved	ug/L	N.D.	N.D.	N.D.	N.D.	<100	N.D.
Aluminum, total	ug/L	<100	533	<100	104	378	110
Barium, total	ug/L	25	110	25	30	105	30
Calcium, dissolved	mg/L	25.9	103	25.6	24.4	93.1	24.3
Calcium, total	mg/L	25.6	105	25.5	24.3	93.3	24.3
Copper, dissolved	ug/L	N.D.	N.D.	N.D.	<20	<20	N.D.
Copper, total	ug/L	N.D.	N.D.	N.D.	N.D.	<20	N.D.
Iron, dissolved	mg/L	0.17	0.39	0.18	0.07	0.31	0.06
Iron, total	mg/L	0.56	2.48	0.55	0.51	1.76	0.5
Magnesium, dissolved	mg/L	5.56	21.4	5.49	5.15	19.9	5.15
Magnesium, total	mg/L	5.52	21.8	5.49	5.19	20.1	5.18
Manganese, dissolved	ug/L	88	30	92	26	36	23
Manganese, total	ug/L	95	159	94	113	347	112
Nickel, total	ug/L	N.D.	<10	N.D.	N.D.	<10	N.D.
Potassium, dissolved	mg/L	1.13	4.78	1.07	1.28	5.33	1.26
Potassium, total	mg/L	1.1	4.87	1.08	1.31	5.4	1.29
Silver, total	ug/L	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Sodium, dissolved	mg/L	13.3	59.6	13.3	13	57.4	13.1
Sodium, total	mg/L	13.3	60.1	13.2	12.9	57.1	12.9
Strontium, total	ug/L	88	335	88	79	321	79
Vanadium, total	ug/L	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Zinc, dissolved	ug/L	<20	N.D.	<20	<20	N.D.	<20
Zinc, total	ug/L	N.D.	<20	N.D.	N.D.	<20	N.D.
Beryllium, total	ug/L	N.D.	<0	N.D.	N.D.	N.D.	N.D.
Cadmium, total	ug/L	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Chromium, total	ug/L	N.D.	<10	N.D.	N.D.	<10	N.D.
Lead, total	ug/L	N.D.	N.D.	N.D.	N.D.	<5	N.D.
Thallium, total	ug/L	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Arsenic, total	ug/L	<1.0	1.9	<1.0	<1.0	2.2	<1.0
Selenium, total	ug/L	N.D.	<2.0	N.D.	N.D.	N.D.	N.D.
Antimony, total	ug/L	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Total mineral solids	mg/L	133.55	556.06	133.17	126.68	508.06	126.29
Calcium hardness (C)	mg/L	64.7	257.2	63.9	60.9	232.5	60.7
Total hardness (C)	mg/L	86.7	352	86.3	82	316	82

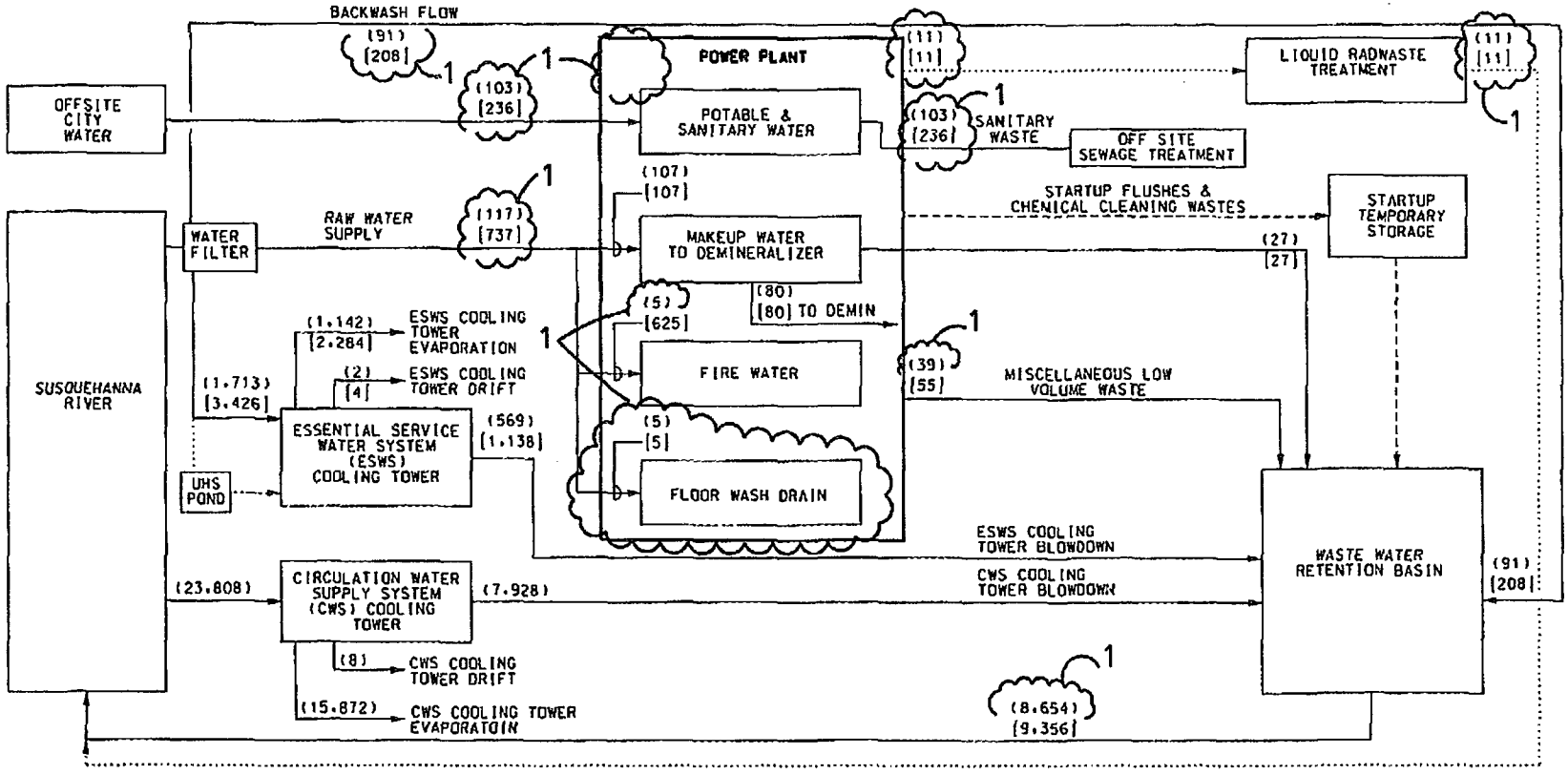
Table 4 (cont.)

PARAMETER	UNITS	SSES	BLOW DOWN	BELL BEND	SSES	BLOW DOWN	BELL BEND
Date		8/16/2006	8/16/2006	8/16/2006	11/16/2006	11/16/2006	11/16/2006
Time		609	719	615	725	845	730
River level	ft	487.4			493.3		
Temperature	C	23.80	25.20	23.70	9.50	24.70	9.50
Dissolved oxygen	mg/L	7.50	7.40	7.40	10.70	8.10	10.90
pH, lab		7.9	8.71	7.88	7.72	8.91	7.70
Conductivity, lab	µmho	366	1030	366	172	733	173
Total alkalinity	mg/L	94	216	94	44	201	46
Phenolphthalein alkalinity	*mg/L*	*0.0*	*10.0*	*0.0*	*0.0*	*15.0*	*0.0*
Total suspended solids	mg/L	7.6	27.3	6.4	14.0	84.0	15.2
Ammonia as N	mg/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Silicon dioxide	mg/L	3.77	11.06	3.69	4.69	18.73	4.75
Bicarbonate as CaCO3	mg/L	94.0	198	94.0	44.0	171	46.0
Carbonate by calculation	mg/L	0.0	12.0	0.0	--	--	--
Chloride	mg/L	30.5	98.6	31.4	13.4	72.8	13.3
Fluoride	mg/L	0.09	0.23	0.11	0.06	0.22	0.07
Nitrate as NO3	mg/L	1.8	5.9	1.8	2.0	9.4	2.0
Nitrate ion as N	mg/L	0.4	1.3	0.4	0.4	2.1	0.4
Phosphorus as PO4	mg/L	0.104	2.929	0.101	0.353	4.175	0.310
Sulfate	mg/L	35.7	185	35.8	14.8	9.4	15.1
Aluminum, dissolved	ug/L	N.D.	<100	N.D.	N.D.	<100	N.D.
Aluminum, total	ug/L	124	489	113	308	1860	338
Barium, total	ug/L	34	113	34	25	112	24
Calcium, dissolved	mg/L	38.5	120	38.7	19.1	85.9	19.2
Calcium, total	mg/L	38.5	120	38.8	19.0	88.8	18.9
Copper, dissolved	ug/L	N.D.	N.D.	N.D.	N.D.	<20	N.D.
Copper, total	ug/L	N.D.	N.D.	N.D.	N.D.	<20	N.D.
Iron, dissolved	mg/L	0.07	0.17	0.07	0.11	0.37	0.11
Iron, total	mg/L	0.61	1.87	0.59	0.81	4.59	0.86
Magnesium, dissolved	mg/L	8.52	25.7	8.53	3.82	16.9	3.86
Magnesium, total	mg/L	8.56	25.8	8.60	3.89	18.0	3.84
Manganese, dissolved	ug/L	48	28	44	37	41	34
Manganese, total	ug/L	120	274	118	53	250	55
Nickel, total	ug/L	N.D.	<10	<10	<10	<10	N.D.
Potassium, dissolved	mg/L	1.69	5.64	1.68	1.50	6.13	1.42
Potassium, total	mg/L	1.73	5.68	1.72	1.54	6.34	1.38
Silver, total	ug/L	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Sodium, dissolved	mg/L	18.8	59.3	18.7	8.60	45.3	8.64
Sodium, total	mg/L	18.7	59.3	18.7	8.48	46.3	8.45
Strontium, total	ug/L	152	450	152	56	280	55
Vanadium, total	ug/L	N.D.	N.D.	N.D.	N.D.	<10	N.D.
Zinc, dissolved	ug/L	<20	N.D.	N.D.	<20	<20	<20
Zinc, total	ug/L	N.D.	<20	N.D.	<20	24	<20
Beryllium, total	ug/L	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Cadmium, total	ug/L	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Chromium, total	ug/L	N.D.	N.D.	N.D.	N.D.	<10	N.D.
Lead, total	ug/L	N.D.	N.D.	N.D.	N.D.	<5	N.D.
Thallium, total	ug/L	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Arsenic, total	ug/L	<1.0	2.8	<1.0	<1.0	3.2	<1.0
Selenium, total	ug/L	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Antimony, total	ug/L	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Total mineral solids	mg/L	195.74	642.13	196.79	94.28	385.13	95.78
Calcium hardness (C)	mg/L	96.1	299.6	96.6	47.7	214.5	47.9
Total hardness (C)	mg/L	131	406	132	63.5	296	63.0

ATTACHMENT 8.5

Calculation Results
Bell Bend Water Balance

1 page



KEY:
(AVERAGE FLOWS: GALLONS PER MIN.)
[MAXIMUM FLOWS: GALLONS PER MIN.]

NOTES:
1. COOLING TOWERS OPERATE AT 3 CYCLES OF CONC.
2. ESWS COOLING TOWER BASED ON EPR TABLE 9.2.5-2 PARAMETERS

LEGEND:
- STARTUP FLOWS
- NORMAL FLOW
- FLOW VARIES WITH OPERATION CONDITIONS
- DBA SHUTDOWN FLOW

DRAWING RELEASE RECORD						
REV.	DATE REL'D	PREPARED	REVIEWED	APPROVED	PURPOSE	FILM

SCALE NONE

PROJECT NUMBER

CONCEPTUAL ANTICIPATED WATER USE DIAGRAM
BELL BEND NUCLEAR POWER PLANT
UNISTAR NUCLEAR
PENNSYLVANIA

Sargent & Lundy

DRAWING NO. 12198-004-WTR-001

REV. 1

SHEET OF

FORM GDS 2.6.4

ATTACHMENT 8.6

Bell Bend Anticipated Water Use
Response to RFI #SL-BER-053
(Design Input 2.9)

7 pages

UniStar
NUCLEAR ENERGY

July 28, 2008

Robert Hameetman
Sargent & Lundy Engineers
55 E. Monroe Street
Chicago, IL 60603

RFI #08-278

Subject: Response to RFI SL-BER-053, from Robert Hameetman to George Wrobel, dated February 12, 2008.

Attached is the subject RFI and the UniStar Nuclear response.

Sincerely,

G. van Noordennen

G. van Noordennen

xc: J. Price, w/o
B. Perdue
R. Hameetman, S&L
T. Barnett, S&L

UniStar NUCLEAR

REQUEST FOR INFORMATION (RFI)

RFI NUMBER: SL-BER-053	DATE: February 12, 2008
PROJECT NUMBER: 759	PROJECT NAME: Berwick
SCHEDULE ACTIVITY ID: PL231045310	
ORIGINATOR: Richard Pospiech (S&L)	PHONE/FAX: 312-269-2207
PROJECT MANAGER APPROVAL:	
SUPERVISOR APPROVAL:	
TO: George. Wrobel@unistarnuclear.com CC Michael.cain@unistarnuclear.com, Bob Hameetman (S&L), Jeff Saltarelli (S&L), Maury Pressburger (S&L), Jas Devgun (S&L), Howard Anderson (S&L)	
REFERENCE SECTION(S):	REV.: N/A
SPECIFICATION(S): N/A	REV.: N/A

INFORMATION REQUESTED:

Please confirm that it is acceptable to use the following flows listed in the Calvert Cliffs Unit 3 ER Section 3.3 Plant Water Use for our conceptual designs:

1) 20 gpm (max) into Waste Water Retention Basin from Waste Water Treatment Plant
2) 55 gpm (max) into Waste Water Retention Basin from Miscellaneous Low Volume Waste
3) 779 gpm (max) into Waste Water Retention Basin from Reverse Osmosis
4) 276 gpm (max) into Waste Water Retention Basin from Membrane Filtration
5) 80 gpm (max) for the makeup water to the Demineralizer
6) 625 gpm (max) to the Fire Water Storage Tanks from Raw Water
7) 1,880 gpm (max) from ESWS Blowdown. We are currently routing this flow to the Waste Water Retention Basin per the standard design. If the ESWS blowdown should be routed to the 30-day UHS pond, please notify us.
8) 3,764 gpm (max) for the non-safety related makeup water to the ESWS Cooling Towers from the Raw Water System.
9) 36 gpm (max) for the Potable and Sanitary Water Systems

Please, confirm that the UHS pond supply makeup water is for all four UHS cooling tower basins, simultaneously under LOCA conditions; and the UHS pond is sized to contain the safety related ESWS makeup water inventory required for 30 days under LOCA conditions.

Please provide the required makeup flow rate to the 30-day UHS pond.

We are currently routing the CWS and ESWS blowdowns to the wastewater retention basin per the standard design with the water from the retention basin ultimately discharged to the river. Please confirm.

RESPONSE REQUIRED BY:	February 25, 2008
IMPACTS:	Conceptual Designs

RESPONSE INFORMATION

TO:	Bob Hameetman	FROM:	Gwan Noordenne
OF:	S+L	OF:	UniStar

RESPONSE INFORMATION:

Please see the attached table with information on water flows.

Flow information for the following water streams, which appear on the table, has been provided from either the most current revision to the Calvert Cliffs RCOLA or the USEPR FSAR:

- ESWS Cooling Tower Evaporation (USEPR FSAR)
- ESWS Cooling Tower Drift
- Demineralized Water Distribution System Makeup
- Fire Water Distribution System Makeup
- Floor Wash Drains
- Potable and Sanitary Water Distribution System (Plant Users only) Makeup
- Miscellaneous Low Volume Waste
- Start-up Temporary Storage Discharge
- Treated Liquid Radwaste
- Sanitary Waste (plant users only)

Sargent & Lundy is responsible for providing flow information for the following combined or component water streams, which also appear in the attached table:

- Susquehanna River Water Demand
- River Intake Screen Cleaning Water
- Raw Water Supply System Makeup
  - RWSS Pump Strainer Cleaning Water
  - RWSS Filter Backwash
  - ESWS Makeup
  - ESWS Blowdown
  - Power Plant Makeup
  - UHS Storage Pond Makeup
- Circulating Water System (makeup, evaporation, drift and blowdown)
- Potable and Sanitary Water Distribution System (non-plant users only) Makeup
- Effluent Discharge to Susquehanna River
- Waste Water Retention Basin Discharge
  - RWSS Filter Backwash Discharge
  - Demineralizer Feed RO Reject
  - ESWS and CWS CT Blowdown
- River Intake Screen Cleaning Water Discharge
- RWSS Pump Strainer Cleaning Water Discharge
- Sanitary Waste (non-plant users only)

Prepared by : Gwan Noordenne

Reviewed by : N/A

APPROVED FOR USE: T. Demitrack per conf call w/GVN	DATE: 7-29-08

UniStar Response for RFI SL-BER-053

Please use the attached table to calculate the revised water balance for plant operations.

Bell Bend Anticipated Water Use

Water Streams	Average Flow [a] gpm (lpm)	Maximum Flow [b] gpm (lpm)	Source of Information
Susquehanna River Water Demand	25,729 (97,384)	28,179 (106,656)	S&L
River Intake Screen Cleaning Water	—	—	S&L
Raw Water Supply System (RWSS)	1,921 (7,271)	4,371 (16,544)	S&L
RWSS Pump Strainer Cleaning Water	—	—	S&L
RWSS Filter Backwash	91 (344)	208 (787)	S&L
Essential Service Water System(ESWS)/Ultimate Heat Sink (UHS) Makeup	1,713 (7,124)	3,426 (12,967)	S&L
ESWS Cooling Tower Evaporation	1,142 (4,322)	2,284 (8,645)	USEPR FSAR Table 9.2.5-2
ESWS Cooling Tower Drift[f]	2 (8)	4 (15)	Calvert Cliffs RCOLA/Bechtel
ESWS Cooling Tower Blowdown	569 (2,154)	1,138 (4,307)	S&L based on 3 cycles of concentration
Power Plant Makeup	117 (443)	737 (2,790)	S&L
Demineralized Water Distribution System	107 (405)	107 (405)	Calvert Cliffs RCOLA/Bechtel + 27 gpm for RO (S&L)
Fire Water Distribution System	5 (19)	625 (2,366)	Calvert Cliffs RCOLA/Bechtel
Floor Wash Drains	5 (19)	5 (19)	Calvert Cliffs RCOLA/Bechtel
UHS Storage Pond	—	—	S&L
Circulating Water Supply System (CWS)	23,808 (90,113)	23,808 (90,113)	S&L
CWS Cooling Tower Evaporation	15,872 (60,076)	15,872 (60,076)	S&L based on 3 cycles of concentration
CWS Cooling Tower Drift	8 (30)	8 (30)	S&L based on 3 cycles of concentration
CWS Cooling Tower Blowdown	7,928 (30,007)	7,928 (30,007)	S&L based on 3 cycles of concentration
Municipal Water Demand (PA American Water)	103 (390)	236 (893)	S&L
Potable and Sanitary Water Distribution System	103 (390)	236 (893)	S&L
Plant Users	93 (352)	216 (818)	Calvert Cliffs RCOLA/Bechtel
Non-Plant Users	10 (38)	20 (76)	S&L
Effluent Discharge to Susquehanna River	8,665 (32,797)	9,367 (35,454)	S&L
Waste Water Retention Basin Discharge	8,654 (32,755)	9,356 (35,412)	S&L

Water Streams	Average Flow [a] gpm (lpm)	Maximum Flow [b] gpm (lpm)	Source of Information
RWSS Filter Backwash Discharge	91 (344)	208 (787)	S&L
Miscellaneous Low Volume Waste	39 (148)	55 (208)	Calvert Cliffs RCOLA/Bechtel
Demineralizer Feed Reverse Osmosis Reject	27 (102)	27 (102)	S&L
ESWS Cooling Tower Blowdown	569 (2,154)	1,138 (4,307)	S&L
CWS Cooling Tower Blowdown	7,928 (30,007)	7,928 (30,007)	S&L
Start-up Temporary Storage Discharge	—	—	Calvert Cliffs RCOLA/Bechtel
Treated Liquid Radwaste	11 (42)	11 (42)	Calvert Cliffs RCOLA/Bechtel
River Intake Screen Cleaning Water Discharge	—	—	S&L
RWSS Pump Strainer Cleaning Water Discharge	—	—	S&L
Effluent Discharge to Municipal Sewer (Berwick Area Joint Sewer Authority)			
Sanitary Waste	103 (390)	236 (893)	Calvert Cliffs RCOLA/Bechtel + non-plant (S&L)

a. Average flow represents the expected water consumptive rates and returns for normal plant operating conditions.

b. Maximum flow represents water consumptive rates and returns during normal shutdown/cooldown.

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Building a world of difference.

CALCULATION COVER SHEET

Client Name:	Unistar	Project No.:	161642
Project Name:	Bell Bend UHS	Calculation No.:	161642.51.2001
Calculation Title:	ESWEMS Retention Pond Sizing	File No.:	51.2000
		Page	1 of 116

Calculation Type	☐ Preliminary	☒ Final	
Seismic Classification	☒ I	☐ II	
Quality Classification	☒ S	☐ R	☐ G

Objective Determine the volume of water necessary to provide 27 days of make-up water to the Essential Service Water System (ESWS) of the proposed US-EPR at the Bell Bend site.

Unverified Assumptions Requiring Subsequent Verification

No.	Assumption	Verified By	Date
1	The ground water depth is 20 feet. See assumption 2 below.		
2	The coefficient of permeability is 10^{-8} m/s. The 3 ft. liner thickness is a function of the coefficient of permeability. See assumption 3 below.		

Refer to page 7 of this calculation for additional assumptions.

This Section Used for Computer Calculations

Software Program Name/Number: N/A Version:

Number of Pages:

Evidence of or reference to computer program verification, if applicable:

Bases or reference thereto supporting application of the computer program to the physical problem:

Review and Approval

Rev.	Prepared By: Print and Sign	Prepared By: Date	DVR No.*	Approved By: Print and Sign	Approved By: Date
0	David B. Schwenk	6/26/08	DVR-0011	A.D. Bockelman	6/26/08

Revision Description
Initial Issue.

*Indicate Design Verification Review (DVR) Checklist number.

This calculation supersedes Calculation Number:

This calculation is superseded by Calculation Number:

Table of Contents

Section	Description	Page(s)
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4.0	Design	4 – 7
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1.0 Purpose and Scope

The purpose of this calculation is to determine the volume of water necessary in a makeup pond to provide 27 days of make-up to the ESWS at the Bell Bend Nuclear Power Plant. The proposed unit is a US-EPR, which already has a 3 day make-up supply in its ESWS cooling tower basins; therefore, this makeup pond only needs to furnish 27 days to meet the NRC requirement of 30 days. The total volume will include the makeup requirements of the US-EPR unit (i.e. evaporation and drift from the ESWS cooling towers); 30 days of seepage; the volume required to provide the Net Positive Suction Head (NPSH) for the make-up pumps; and the greater of either 30 days of evaporation, or the volume of water lost to an ice cover.

2.0 References

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2. Ashton, George D. (editor), River and Lake Ice Engineering, Water Resources Publications, Littleton, Colorado, 1986.
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21. National Climatic Data Center (NCDC), "Hourly United States Weather Observations 1991-1995," CD-ROM, Hourly Data for Wilkes-Barre/Scranton International Airport, September 1997.
22. National Climatic Data Center (NCDC), "Integrated Surface Hourly Data 1996-2005," Hourly Data for Wilkes-Barre/Scranton International Airport, 2005.

3.0 Summary and Conclusion

Pond Volume at Normal Water Level:	$3.34 \times 10^6\ ft^3$
Minimum Volume:	$2.03 \times 10^6\ ft^3$
Minimum Depth:	12 ft.
Margin over Minimum Volume at Normal Water Level:	64.81%

4.0 Design

4.1 Design Inputs

Define units and constants for MathCad

Bars	$bar := 10^5 Pa$	Ref. 6, Table A-2M
Millibars	$mb := bar \cdot 10^{-3}$	
Celcius	$degC := K$	
Fahrenheit	$degF := \frac{5}{9}K$	
Gallons per Minute	$gpm := 1\frac{gal}{min}$	
Langley	$langley := 1\frac{tcal}{cm^2}$	Ref. 17

Inputs

Time period of ESW Makeup	$t := 27day$	Ref. 12
Time period post-accident (for evaporation and seepage)	$t_s := 30day$	Ref. 11
Pond At-Grade Width	$w_g := 400ft$	Assumption 1
Pond At-Grade Length	$l_g := 700ft$	Assumption 1
Pond Water Depth	$d := 17ft$	Assumption 1

Side Slope	$S_{slope} := \frac{1}{3}$	Assumption 1
Radius of Corner Fillets @ the pond bottom	$r_2 := 20ft$	Assumption 1
Pond Excavation Total Depth	$d_t := 22ft$	Assumption 1
Cooling Tower Circulating Water Flow	$Q_T := 19000gpm$	Ref. 14
Drift loss, % of Circulating Flow	$r_T := 0.0010\%$	Ref. 14
Latent Heat of Fusion of Ice	$L_{ice} := 333.4 \frac{J}{gm}$	Ref. 2, Page 45
High Air Temperature for Pond Evaporation	$T_a := 52.42degF$	Ref. 15, Attachment 3
Water Vapor Pressure @ T_a	$e_a := 3.12mb$	Ref. 15, Attachment 3
Water Vapor Pressure @ Average Dewpoint Temperature for 30 Day Period	$e_s := 13.42mb$	Ref. 15, Attachment 3
Solar Insulation	$R_{sun} := 5.51 \frac{kW \cdot hr}{m^2 \cdot day}$	Ref. 7
	$R_{sun} = 474.092 \frac{langley}{day}$	
Average Windspeed	$U_p := 20.3 \frac{mi}{hr}$	Ref. 9
	$U_p = 487.2 \frac{mi}{day}$	

Density of Ice @ 0C	$\rho_{ice} := 916.59 \frac{kg}{m^3}$	Ref. 8, Table 39.17
Specific Weight of Water @ 39 F	$\gamma_{H2O} := 62.426 \frac{lbf}{ft^3}$	Ref. 16
Atmospheric Pressure	$P_{atm} := 14.7psi$	
Vapor Pressure of Water @ 94F	$P_{94VP} := .7914psi$	Ref. 6, Table A-12
Vapor Pressure of Water @ 96F	$P_{96VP} := .8416psi$	Ref. 6, Table A-12
Temperature of Ice/Water Interface	$T_i := 0degC$	
Minimum Average Daily Low Air Temperature	$T_{min} := -6.92degC$	Attachment 2
Time frame of Ice Formation	$t_{ice} := 31day$	Attachment 2
Volume of water for ESWEMS makeup	$V_{uhs} := 1.115 \cdot 10^7 gal$	Ref. 10
Depth of water table	$d_{wt} := 20ft$	Assumption 2
Thickness of clay liner	$t_{liner} := 3ft$	Assumption 3
Coefficient of permeability for clay	$k := 10^{-8} \frac{m}{s}$	Assumption 3

4.2 Design Margins

Client Margin: No specific client margin is applied.
Safety Margin: No specific safety margin is applied.
Design Margin: No specific design margin is applied.
Operation Margin: No specific operation margin is applied.
Other Margin: No other margins are applied.

4.3 Acceptance Criteria

The retention pond is sized to meet the requirements of Reg. Guide 1.27.

5.0 Assumptions

1. The pond excavation will be 700 feet long, 400 feet wide, 22 feet deep, the side slope will be 3:1, the corner radius on the bottom of the pond will be 20 feet, and the normal water depth will be 17 feet to be identical in size to the ESWEMS pond at the Callaway Nuclear Station, Unit 2.
2. Based off of Reference 18 and Reference 19, the ground water depth is conservatively set at 20 feet. This is dependent on the final revision of Reference 19.
3. Based off of Reference 5, the coefficient of permeability of the liner will be 10^{-8} m/s. This property will need to be verified by an ITAAC commitment. To ensure an acceptable seepage rate, the 3 foot thickness of the liner is based off of this property. The liner thickness is a function of the coefficient of permeability.

6.0 Analysis

6.1 Total UHS Required Volume

The total UHS Required Volume will consist of the water for ESWEMS makeup and water lost to drift in the cooling towers. The volume of water lost to drift is calulated as follows:

$$V_{drift} := Q_T \cdot r_T \cdot t \qquad V_{drift} = 987.525\,ft^3 \qquad V_{drift} = 0.023\,acre \cdot ft$$

Where V_{drift} is volume of drift, Q_T is flowrate of circulation water through the cooling tower, r_T is % drift loss, and t is days

Total UHS Required Volume is then calculated as follows:

$$V_{UHS} = V_{uhs} + V_{drift}$$

6.2 NPSH Available

Net positive suction head will be calculated at a water elevation of zero feet above the eye of the pump. If a vertical pump is used, then there will be no additional head requirements from a suction pipe due to the eye of the pump being submerged to an elevation near the bottom of the retention pond.

Per Reference 13, the following equation is used to determine available NPSH:

$$NPSH_A = \frac{P_{atm} - P_{VP}}{\gamma_{H2O}}$$

Where $NPSH_A$ is available net positive suction head, P_{atm} is atmopheric pressure, γ_{H2O} is the specific weight of water, and P_{VP} is the vapor pressure of water.

6.3 Seepage Volume

The rate of seepage from the make-up pond is a function of the composition of the pond liner and the surface area of the wetted surface. The composition of the pond liner will be clay with a permeability of 10^{-8} m/s, and this will be validated with an ITAAC commitment following construction. The volume will be calculated based on the wetted surface area of the pond, the discharge velocity through the liner, and the time period post accident. The wetted surface area will include the rectangle at the bottom of the pond plus the rectangles that make up each side of the pond (two (2) on each side for a total of four (4)) and the surface area of a truncated cone to account for the corners. See Figure 1 for clarification.

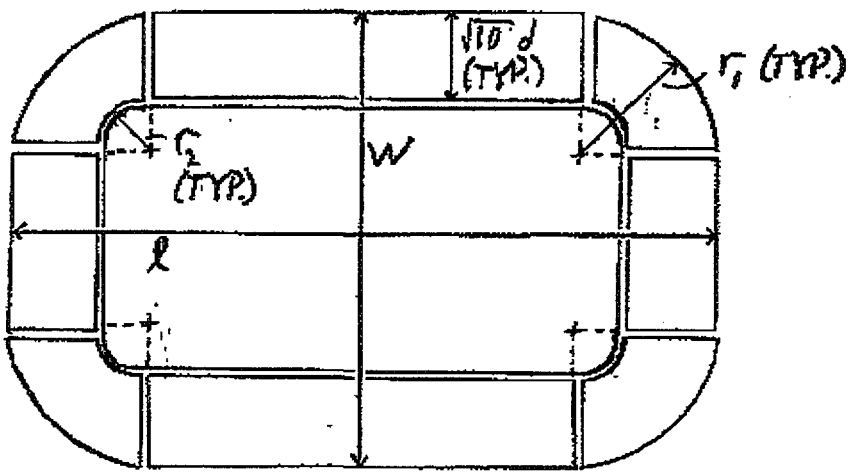

Figure 1

The equation for the surface area of a truncated cone is of the following form:

$$SA_{truncated} = \pi(r_1 \cdot s_1 - r_2 \cdot s_2)$$

Where: r_1 = major radius (surface of water)

r_2 = minor radius (bottom of pond)

s_n = slant height of cone with radius $r_n = [r_n^2 + (r_n \times S_{slope})^2]^{.5}$

The major radius of the conical sections is defined by the following equation:

$$r_1 := \frac{d}{S_{slope}} + r_2 \qquad r_1 = 71\,ft$$

To determine the surface area of the proposed pond, the dimensions of the normal water surface will need to be calculated as follows:

$$d_{fb} := d_t - d \qquad d_{fb} = 5\,ft$$

Where d_{fb} is freeboard depth, d_t is pond excavation total depth, and d is pond water depth.

$$l := l_g - 2\frac{d_{fb}}{S_{slope}} \qquad l = 670\,ft$$

$$w := w_g - 2\frac{d_{fb}}{S_{slope}} \qquad w = 370\,ft$$

Where: l_g and w_g = At grade length and width, respectively
d_{fb} = Depth of freeboard
S_{slope} = Side Slope

The wetted surface area of the proposed pond is then calculated by the following, where l, w, and d represent surface length, surface width, and depth, respectively:

$$SA := \left[\left(l - 2\cdot\frac{d}{S_{slope}}\right)\cdot\left(w - 2\cdot\frac{d}{S_{slope}}\right) - 4r_2^2 + \left[\left(l - 2\cdot\frac{d}{S_{slope}} - 2r_2\right) + \left(w - 2\cdot\frac{d}{S_{slope}} - 2r_2\right)\right]\cdot 2\cdot 10^{.5}d \ldots \right.$$
$$\left. + \pi\left[r_2^2 + \left[r_1\cdot\left[r_1^2 + \left(r_1\cdot S_{slope}\right)^2\right]^{.5} - r_2\left[r_2^2 + \left(r_2\cdot S_{slope}\right)^2\right]^{.5}\right]\right]\right]$$

$$SA = 2.485 \times 10^5\,ft^2$$

The discharge velocity through the liner is calculated by the following equation:

$$v = k\cdot i$$ Ref. 5, Page 72

Where: v = discharge velocity
k = coefficient of permeabilty
i = hydraulic gradient

The hydraulic gradient is the rate of loss of total head through the soil and is calculated by the following equation:

$$i = -\lim_{\Delta s \to 0}\frac{\Delta h}{\Delta s} = \frac{d}{ds}h$$ Ref. 5, Page 72

Where: Δh = head loss through the soil
Δs = macroscopic flow distance through the soil

For this calculation, the value of i will be conservatively set as:

$$i := -\frac{(d_{fb} - d_{wt})}{t_{liner}} \qquad i = 5$$

Where: d_{fb} = depth of freeboard
d_{wt} = depth to water table
t_{liner} = thickness of clay liner

The volume of seepage is then calculated by the equation:

$$V_{seepage} = v \cdot SA \cdot t_s$$

6.4 Evaporation or Freezing Volume

Since evaporation and an ice cover can not occur simultaneously, this calculation will only factor into the total volume the worst of the two cases. Similarly, since frazil ice can only occur in open water, it can not occur simultaneously with an ice cover, and it is assumed that the volume of water lost to an ice cover will be substantially greater than the volume of water lost to frazil ice because frazil ice is a mixture of ice and water. It is therefore assumed that the volume of water lost to any potential frazil ice formation, such as could occur in a partial ice cover, will be bounded by the calculation for the volume of water lost to a full ice cover.

The equation for depth of water lost daily to evaporation is:

$$R_{evap} := \frac{\left[e^{\left[\left[\frac{(T_a)}{degF} - 212\right]\left(0.1024 - 0.01066 \cdot \ln\left(R_{sun} \cdot \frac{day}{langley}\right)\right)\right]} - 0.0001 \ldots + 0.0105\left(\frac{e_s}{in_Hg} - \frac{e_a}{in_Hg}\right)^{.88} \cdot \left(0.37 + 0.0041 U_p \cdot \frac{day}{mi}\right) \right]}{\left[(0.015) + \left[\frac{(T_a)}{degF} + 398.36\right]^{-2} \cdot 6.8554 \cdot 10^{10} \cdot e^{\left[\frac{-7482.6}{\frac{(T_a)}{degF} + 398.36}\right]} \right]} \cdot \frac{in}{day}$$

Ref. 3, Page 1.190 Equation 3.12

$$R_{evap} = 0.32 \frac{in}{day}$$

Where: R_{evap} = depth of water lost per day
T_a = High Air Temperature for Pond Evaporation
e_s = water vapor pressure at the saturation (dew point) temperature
e_a = water vapor pressure at T_a
R_{sun} = solar radiation
U_p = Average wind speed for 30 day period

The total evaporation is dependent on the surface area of the pond. This calculation will assume the pond is at its maximum operating level, which is the most conservative approach. The maximum operating level is the at grade level minus the depth of freeboard. The inputs for the parameters listed above are the worst case gleened from the data analyzed from Reference 15, Reference 7, and Reference 9. The lowest day of average relative humidity from Reference 15 is combined with the highest average monthly insolation from Reference 7, and the 1% exceedance extreme annual windspeed from Reference 9 to create a synthetic day for worst case pond evaporation. The windspeed from Reference 9 is more conservative than the average monthly windspeeds found in Reference 7. This synthetic day is then repeated for 30 consecutive days to create a conservative 30 day period.

The total volume of water lost to an ice cover is dependent on the maximum surface area of the pond and maximum depth of the ice. The maximum depth of the ice is dependent on the thermal conductivity of ice, the temperature difference between the ice/water interface and the ambient air, the time period of ice formation, the density of ice, and the latent heat of fusion of ice. The time period of ice formation is the period before the design basis event occurs. Historic climactic data found in References 20, 21, and 22 was analyzed to determine the average monthly daily lows. Only the winter months of November, December, January, February, and March were analyzed because freezing temperatures are only expected during those months. This analysis is displayed in Attachment 2., and the coldest average daily low temperature at BBNPP between 1961 and 2005 occured during the month of January, so the time period of ice formation used in the maximum ice thickness calculation will be 31 days. The depth of ice is defined by the following equation from Reference 2, page 234:

$$h_{ice} = \left(\frac{2 \cdot k_i (T_i - T_{min}) t_{ice}}{\rho_{ice} \cdot L_{ice}} \right)^{.5}$$

The thermal conductivity of ice, k_i, is defined by the following equation, also from Reference 2, page 47:

$$k_i = 2.21 - 0.011(T_{min})$$

This method is conservative for the following reasons. First, the volume of ice is greater than the associated volume of water; therefore, the volume of water lost to ice will be less than the volume of ice formed. Second, the minimum temperature used in the analysis is the average daily low, which means the temperature will rise throughout the day, thus slowing (or in some cases reversing) the formation of ice. Third, per Reference 2, the equation for the depth of ice assumes heat transfer across the ice/water interface is negligible. In reality, heat will conduct from the water to the ice, slowing the formation of ice.

6.5 Total Volume

The total volume of the pond will be the area inside the liner. If ITAAC testing indicates the liner needs to be thicker than 3 feet, the entire excavation should increase in size accordingly. The total volume of the proposed Unit 2 pond will include a trapezoidal cross section extrusion for the main body of the pond, two (2) other trapezoidal cross section extrusions for the ends of the pond, and four (4) quarter truncated conical sections for the corners of the pond.

The volume of a trapezoidal extrusion is the area of the cross section times the length of the extrusion. The area of the cross section is as follows:

$$A_{trapezoid} = \frac{1}{2}(b_1 + b_2)h$$

Where:
b_n is the length of the base
h is the height of the trapezoid.

The volume of a truncated cone is the difference in the volume of two similar cones:

$$V_{conic} = V_{cone1} - V_{cone2}$$

The volume of a cone is as follows:

$$V_{cone} = \frac{\pi}{3} r^2 \cdot d$$

Where:
r is the axis
d is the depth of the cone.

It can be determined that:

$$V_{conic} = \frac{\pi}{3}\left(r_1^2 + r_2^2 + r_1 \cdot r_2\right) \cdot d$$

The minimum volume is the UHS volume plus the volumes calculated in sections 6.2, 6.3, and 6.4. The pond margin is calculated by the following equation:

$$\frac{V_{total} - V_{min}}{V_{min}}$$

7.0 Calculation and Results

7.1 Total UHS Required Volume

The total UHS required volume is as follows:

$V_{UHS} := V_{uhs} + V_{drift}$ $\quad V_{UHS} = 1.492 \times 10^{6}\,ft^{3}$ $\quad V_{UHS} = 34.241\,acre \cdot ft$

7.2 NPSH Available

The saturation vapor pressure for 95 degree F water will be determined by averaging the vapor pressure at 94 and 96 degrees F from existing saturation tables in Reference 6.

$$P_{VP} := \frac{P_{94VP} + P_{96VP}}{2}$$

$$P_{VP} = 0.816\,psi$$

The NPSH available is determined by the following equation:

$$NPSH_A := \frac{P_{atm} - P_{VP}}{\gamma H2O}$$

$$NPSH_A = 32.026\,ft$$

Based on this analysis, no additional pond volume is needed to account for NPSH if a submerged vertical pump with a required NPSH less than 32 feet is used.

7.3 Seepage Volume

The discharge velocity through the liner is calculated by the following equation:

$v := k \cdot i$ $\quad v = 5 \times 10^{-8}\,\frac{m}{s}$

The seepage volume is as follows:

$$V_{seepage} := v \cdot SA \cdot t_s$$

$V_{seepage} = 1.057 \times 10^{5}\,ft^{3}$ $\quad V_{seepage} = 2.426\,acre \cdot ft$

7.4 Evaporation or Freezing Volume

7.4.1 Evaporation

Maximum Surface Area

$A_{max} := w \cdot l$

$A_{max} = 2.479 \times 10^5 \, ft^2$

Evaporation Volume

$V_{evap} := A_{max} \cdot R_{evap} \cdot t_s$

$V_{evap} = 1.983 \times 10^5 \, ft^3$ $\quad V_{evap} = 4.553 \, acre \cdot ft$

7.4.2 Freezing

Thermal Conductivity of Ice

$$k_i := 2.21 \frac{W}{m \cdot degC} - 0.011 \frac{W}{m \cdot degC^2} (T_{min})$$

$$k_i = 2.286 \frac{W}{m \cdot degC}$$

Thickness of Ice Cover

$$h_{ice} := \left[\frac{\left[2 \cdot k_i \cdot (T_i - T_{min}) \, t_{ice} \right]}{\rho_{ice} \cdot L_{ice}} \right]^{.5}$$

$h_{ice} = 20.732 \, in$

Volume of Ice

$V_{ice} := A_{max} \cdot h_{ice}$

$V_{ice} = 4.283 \times 10^5 \, ft^3$ $\quad V_{ice} = 9.832 \, acre \cdot ft$

Since the volume of water lost to evaporation is less than the volume of water lost to ice cover, the total volume required in the make-up pond will account for an ice cover.

7.5 Available Usable Pond Volume

7.5.1 First Trapezoidal Extrusion

The area of a trapezoid is one half the sum of the bases times the height:

$$A_{trapezoid1} := \frac{1}{2}\left[w + \left(w - 2\cdot\frac{d}{S_{slope}}\right)\right]\cdot d$$

The volume is found by multiplying the Area by the length of the extrusion as follows:

$$V_{trapezoidal1} := A_{trapezoid1}\cdot(l - 2\cdot r_1)$$

$$V_{trapezoidal1} = 2.863 \times 10^6\,ft^3$$

7.5.2 Second Trapezoidal Extrusions

$$A_{trapezoid2} := \frac{1}{2}\cdot(r_2 + r_1)\cdot d$$

The total trapezoidal volume is found by multiplying two times the area, to account for both ends, by the length of the extrusion as follows:

$$V_{trapezoidal2} := 2A_{trapezoid2}\cdot(w - 2\cdot r_1)$$

$$V_{trapezoidal2} = 3.527 \times 10^5\,ft^3$$

7.5.3 Volume of Corners

The volume of the corners is found by calculating the volume of a truncated cone, to account for all four corners, with its major radius at water level and its minor radius at the bottom of the pond. The volume is as follows:

$$V_{conic} := \frac{\pi}{3}\cdot\left(r_1^2 + r_2^2 + r_1\cdot r_2\right)\cdot d$$

$$V_{conic} = 1.221 \times 10^5\,ft^3$$

7.5.4 Total Pond Volume

The total pond volume is then:

$$V_{total} := V_{trapezoidal1} + V_{trapezoidal2} + V_{conic}$$

$$V_{total} = 3.34 \times 10^6 \, ft^3 \qquad V_{total} = 76.635 \, acre \cdot ft$$

The minimum required pond volume is then:

$$V_{min} := V_{UHS} + V_{ice} + V_{seepage}$$

$$V_{min} = 2.03 \times 10^6 \, ft^3 \qquad V_{min} = 46.499 \, acre \cdot ft$$

A summary table of pond water depth to corresponding pond volume and margin is shown in Attachment 1. The volumes for First Trapezoidal, Second Trapezoidal, Cone Volumes and Margin are calculated using the equations described in Section 6.5 above.

8.0 Attachments

Attachment 1: Pond Volume to Depth Table (1 page)
Attachment 2: Mean Monthly Daily Lows, 1961-2005 (97 pages)
Attachment 3: Design Conditions for Wilkes-Barre (1 page)

Attachment 1:
Pond Volume to Depth Table

Depth (ft)	Freeboard (ft)	Elevation (MSL)	Total Volume (ft^3)	Total Volume (acre-ft)	First Trapezoidal Volume (ft^3)	Second Trapezoidal Volume (ft^3)	Cone Volume (ft^3)	Margin
0	22	653	0.000E+00	0.000	0.000E+00	0.000E+00	0.000E+00	-100.00%
1	21	654	1.543E+05	3.543	1.431E+05	9.804E+03	1.455E+03	-92.38%
2	20	655	3.137E+05	7.201	2.893E+05	2.098E+04	3.343E+03	-84.51%
3	19	656	4.780E+05	10.973	4.388E+05	3.352E+04	5.721E+03	-76.40%
4	18	657	6.474E+05	14.863	5.914E+05	4.742E+04	8.646E+03	-68.04%
5	17	658	8.220E+05	18.870	7.471E+05	6.270E+04	1.217E+04	-59.42%
6	16	659	1.002E+06	22.997	9.060E+05	7.934E+04	1.636E+04	-50.54%
7	15	660	1.187E+06	27.244	1.068E+06	9.736E+04	2.127E+04	-41.41%
8	14	661	1.377E+06	31.614	1.233E+06	1.167E+05	2.694E+04	-32.01%
9	13	662	1.573E+06	36.106	1.402E+06	1.375E+05	3.345E+04	-22.35%
10	12	663	1.774E+06	40.723	1.573E+06	1.596E+05	4.084E+04	-12.42%
11	11	664	1.980E+06	45.465	1.748E+06	1.831E+05	4.918E+04	-2.22%
12	10	665	2.193E+06	50.335	1.926E+06	2.079E+05	5.851E+04	8.25%
13	9	666	2.410E+06	55.333	2.107E+06	2.342E+05	6.890E+04	19.00%
14	8	667	2.634E+06	60.461	2.292E+06	2.617E+05	8.040E+04	30.03%
15	7	668	2.863E+06	65.719	2.479E+06	2.907E+05	9.307E+04	41.33%
16	6	669	3.098E+06	71.110	2.670E+06	3.210E+05	1.070E+05	52.93%
17	5	670	3.338E+06	76.635	2.863E+06	3.527E+05	1.221E+05	64.81%
18	4	671	3.585E+06	82.294	3.060E+06	3.858E+05	1.387E+05	76.98%
19	3	672	3.837E+06	88.089	3.260E+06	4.202E+05	1.566E+05	89.44%
20	2	673	4.096E+06	94.022	3.464E+06	4.560E+05	1.759E+05	102.20%
21	1	674	4.360E+06	100.094	3.670E+06	4.932E+05	1.968E+05	115.26%
22	0	675	4.631E+06	106.306	3.880E+06	5.317E+05	2.192E+05	128.62%

At grade length:	700
At grade width:	400
Slope:	0.33
Bottom Radius:	20
Minimum Volume: (ft^3)	2.03E+06

UniStar
NUCLEAR ENERGY

Conceptual Design of the Circulating Water System
Bell Bend Nuclear Power Plant
Unistar Nuclear Energy

Non-Safety-Related

Report No. SL-009498
Revision 3

November 20, 2008

Sargent & Lundy LLC

APPROVAL PAGE

Conceptual Design of the Circulating Water System

Non-Safety-Related

REVISION SUMMARY

Rev. 0	For Issue – No Comments Received
Rev. 1	Added Cooling Tower, I&C, and Chemical Treatment information.
Rev. 2	Retention basin discharge flowrate was made consistent with Rev. 1 of S&L Calculation 2008-08550. Fire Protection information revised. Cooling tower information added. Revisions made due to S&L Calculation 2008-09135 pipe routing wetlands avoidance. Diffuser information revised.
Rev. 3	Issue for record. No comments received from OAR. Revision level change only.

Prepared By: Richard Pospiech Date: 11/20/08

Reviewed By: Jeffery Saltarelli Date: 11/20/08

Approved By: Date: 11/20/08

Unistar Nuclear
Conceptual Design of the Circulating Water System
Bell Bend Nuclear Power Plant

Report No. SL-009498 Rev. ~~0~~
Project No. 12198-004

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Multi-discipline Signatures: ☒ Applicable ☐ Not Applicable

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Reviewer: L. Anderson L. ANDERSON — Date: 8/20/08

Civil

Preparer: Ronald Cook — Date: 06/04/08

Reviewer: DANIEL. C. KOCOPIK — Date: 06/04/08

Structural

Preparer: Julio R. Hernandez — Date: 08/20/08

Reviewer: N. KLAIC — Date: 08-20-2008

Electrical

Preparer: SYED M. HUSSAIN — Date: 06/04/08

Reviewer: A.K. Chatterji — Date: 06/04/08

I&C

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Reviewer: Joseph W. DeMarco — Date: 06/24/08

HVAC

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1.0 PURPOSE

The purpose of this report is to provide a conceptual design for the Circulating Water System (CWS) of the proposed Bell Bend Nuclear Power Plant. This evaluation will be used in support of the Combined Operating Licensing Application (COLA) and serve as a basis for the detailed design of this system. This system includes:

- The intake structure, which houses the CWS makeup pumps, Raw Water Supply System (RWSS) pumps, traveling screens, and screenwash pumps.
- The CWS pumphouse at the cooling tower basin, which houses the CWS pumps.
- CWS makeup from the intake structure to the CWS cooling tower basin.
- CWS flow from the CWS pumps, located in the CWS pumphouse, to the main condenser and auxiliary cooling water system (ACWS) and back to the CWS cooling towers.
- CWS blowdown from the CWS cooling tower basin to the common retention basin.
- The common retention basin which collects plant wastewater flows and allows any sediment to settle before the water is discharged to the environment.
- Retention basin discharge to the diffuser structure in the Susquehanna River.

The scope of this report includes the following:

- System design bases.
- System general description.
- Pumps, cooling towers, piping, and valves description.
- Structural and geological design considerations for pipe trenches.
- Vacuum priming system.
- Description of the intake structure, including: civil, structural, electrical, I&C, HVAC, and fire protection design considerations.
- Description of CWS pumphouse including: civil, structural, electrical, I&C, HVAC, and fire protection design considerations.
- Description of the common retention basin including: civil, structural, and I&C design considerations.
- Information on the retention basin discharge, including a description of the diffuser structure in the Susquehanna River and structural design considerations.
- System chemical treatment.

2.0 ASSUMPTIONS

2.1 The main condenser tubes are assumed to be constructed of 304/316 stainless steel (Ref 6.2) (Unverified).

3.0 DESIGN INPUTS

3.1 CWS main headers are 132-inch concrete pipe underground and 132-inch carbon steel above ground per Reference 6.4.
3.2 CWS pumps consist of four 25% vertical shaft pumps per Reference 6.4.
3.3 CWS makeup is 23,808 gpm and CWS blowdown is 7,928 gpm based on 3 cycles of concentration per Reference 6.30 (Attachment T) (Unverified).
3.4 The maximum retention basin discharge flow is 9,356 gpm and an additional 11 gpm is added to the discharge pipe from the liquid radwaste system based on Reference 6.5 (Unverified).
3.5 The maximum temperature of the CWS blowdown is 90°F (Ref. 6.2).
3.6 The maximum temperature of the ESWS blowdown is 95°F (Ref. 6.7).
3.7 The maximum allowable discharge temperature is 87°F based on protection of warm water fishes in Susquehanna River (Ref. 6.2).
3.8 The rise-to-shutoff head of conventional vertical turbine pumps is approximately 150% of the normal operation pressure (Ref. 6.9).

3.9 Unistar will be selecting two natural draft cooling towers with a 720,000 gpm circulating water flowrate described in Report 2008-06824, "Engineering and Economic Evaluation of the Integrated Heat Rejection Cycle" (Ref 6.2).

4.0 EVALUATION

4.1 DESIGN BASES

The CWS performs no safety-related function and therefore has no nuclear safety-related design basis.

The CWS is designed to meet the following functional criteria:

- Supply cooling water from the normal heat sink to the turbine condensers and auxiliary cooling water system (ACWS).
- Discharge heated water from the turbine condensers and ACWS to the normal heat sink.
- Cool the discharged heated water in the normal heat sink to an acceptable temperature.

4.2 GENERAL DESCRIPTION

The CWS is a non-safety-related interface system that provides a continuous supply of cooling water to the turbine condensers and ACWS and rejects heat to the environment via the normal heat sink.

CWS components and equipment are classified Quality Group E and non-seismic (Ref. 6.4).

The CWS consists of CWS pumps, CWS makeup pumps, two natural draft cooling towers, the main condenser, the retention basin, the discharge diffuser, and associated piping, valves and instrumentation. A general flowchart of the CWS is shown in Figure 4.2-1, below:

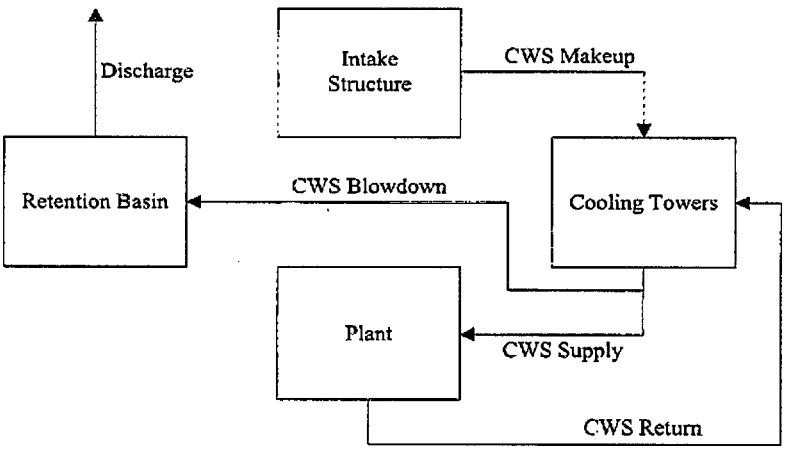


Figure 4.2-1 CWS Flowchart.

The CWS pumps, housed in the CWS pumphouse (discussed in Section 4.6 of this Report) adjacent to the cooling tower, deliver 720,000 gpm (Design Input 3.9) of circulating water to the turbine building and through the main condenser to remove latent heat from the turbine exhaust steam. The circulating water also flows through the ACWS. The circulating water then returns to the CWS cooling towers and discharges through the spray headers.

The CWS uses two natural draft cooling towers for heat dissipation. The cooling towers are discussed in Section 4.3.1 of this Report.

Evaporation in the cooling towers increases the level of solids in the circulating water. To control solids, a portion of the recirculated water is removed through the CWS blowdown and replaced with water through the CWS makeup. The CWS makeup also replaces the losses from cooling tower evaporation (15,872 gpm, Ref. 6.2) and drift (8 gpm, Ref. 6.2).

The CWS makeup to the cooling tower basin is taken from the Susquehanna River. The makeup pumps are housed in the intake structure and provide a total maximum makeup flowrate of 23,808 gpm (Design Input 3.3). The intake structure is discussed in Section 4.5 of this Report.

The CWS blowdown branches off the discharge headers of the CWS pumps. The maximum blowdown flowrate is 7,928 gpm (Design Input 3.3). The blowdown then enters the common retention basin, along with other plant flows, to provide time for settling of suspended solids and to permit further chemical treatment of the discharge water, if required. The retention basin is discussed in Section 4.7 of this Report.

Discharge from the retention basin is routed to the discharge diffuser in the Susquehanna River. The maximum retention basin discharge flowrate is 9,356 gpm and an additional 11 gpm is added to the discharge pipe from the liquid radwaste system (Design Input 3.4). The discharge diffuser is discussed in Section 4.8 of this Report.

The CWS blowdown with a maximum temperature of 90°F (Design Input 3.5) and the ESWS blowdown with a maximum temperature of 95°F (Design Input 3.6) are the two largest contributors to the retention basin discharge. The maximum allowable discharge temperature is 87°F based on protection of warm water fishes in Susquehanna River (Design Input 3.7); therefore, a heat exchanger will be utilized to reduce the temperature of the CWS blowdown before the flow enters the retention basin and discharges to the diffuser in the Susquehanna River.

4.3 PUMPS, COOLING TOWER, PIPING, AND VALVES

4.3.1 Circulating Water System

The CWS piping and components shall be designed to withstand the shutoff pressure of the circulating water pumps. This includes the condenser water boxes and tube bundles, butterfly valves and expansion joints.

The CWS pumps are composed of four 25% capacity constant speed, vertical shaft pumps (Design Input 3.2). The pumps are designed to operate under normal plant operating load conditions. The pumps are designed to permit reverse flow. Each pump size is approximately 200,180 gpm at a total developed head of 126 ft (55 psi). The horsepower of each pump is approximately 9,000 HP (Ref. 6.1). The CWS pumps flow capacity includes the blowdown flowrate. These design criteria can be met by the Flowserve VTP vertical turbine, wet-pit pump shown in Attachment J.

The CWS pipelines are concrete underground and carbon steel above ground. The diameter of the CWS pipe is 96 inches at the discharge of the CWS pumps and 132 inches in the two main headers that are routed to the turbine building and back to the cooling tower (Design Input 3.1). The rise-to-shutoff head of conventional vertical turbine pumps is approximately 150% of the normal operation pressure (Design Input 3.8). The rise-to-shutoff head in this system is 189 ft (83 psi); therefore, the CWS piping nominal design pressure is 100 psi.

The two non-plume abated natural draft cooling towers are each approximately 350 ft in diameter and 475 ft tall. The towers have a design range of 27.6°F and a design approach of 17°F to maintain a CW design outlet temperature of 90°F. The towers' design wet bulb temperature and relative humidity are 73°F and 70%, respectively. The heat dissipated by the CWS cooling towers is approximately 1.0×10^{10} BTU/hr (Ref. 6.2). The air flow rate through the cooling towers is approximately 54,850,000 cfm (Ref. 6.31). Internal construction materials include polyvinyl chloride (PVC) for piping laterals, polypropylene for spray nozzles,

and PVC for fill material. The noise levels generated by each CWS cooling tower is approximately 67 dBA or less at the distance of approximately 200 ft from the cooling tower (Ref. 6.32). The cooling tower basin is located below the cooling tower structures and serves as the collection point for the CWS cold water after it has fallen through the towers. The basin drains through a flume to the bays of the CWS pumphouse. An air release valve and a butterfly valve are installed downstream of each circulating water pump. Each cooling tower riser also has a butterfly valve that serves to isolate the cooling tower during maintenance activities. Gate valves will be installed to allow the circulating water to bypass the cooling towers and discharge to the cooling tower basin during cold weather operation. The opening and closing of motor operated valves located at each pump's discharge, on the cooling tower bypass, and at various other points within the process system can be manually operated via valve mounted hand wheels. The valves contained in the CWS are designed to operate under normal plant operating load conditions. Valve opening and closing times are chosen to reduce water hammer effects. The CWS Piping and Instrumentation Diagram (Ref. 6.13) is shown in Attachment A.

Details related to the main condenser are provided in Section 10.4.1 of the U.S. EPR Final Safety Analysis Report.

4.3.2 CWS Makeup

The CWS makeup pumps are composed of three 50% capacity vertical turbine pumps. Each pump size is approximately 13,100 gpm at a total developed head of 421 ft (182 psi). The horsepower of each pump is approximately 1,800 HP (Ref. 6.1). These design criteria can be met by the Flowserve VTP vertical turbine, wet-pit pump shown in Attachment J.

The main CWS makeup header is 30-inch diameter carbon steel (Ref. 6.1). The rise-to-shutoff head of conventional vertical turbine pumps is approximately 150% of the normal operation pressure (Design Input 3.8). The rise-to-shutoff head in this system is 632 ft (273 psi); therefore, the nominal design pressure of the pipe is 275 psi.

A check valve and butterfly valve are installed downstream of each CWS makeup pump. A control valve is installed in the CWS makeup line to control the flow to the CWS cooling tower basin. Isolation valves are installed on either side of the control valve and a bypass line exists for when maintenance is being performed on the control valve. The CWS Piping and Instrumentation Diagram (Ref. 6.13) is shown in Attachment A.

4.3.3 CWS Blowdown

The CWS blowdown is pumped by the CWS pumps as described above.

The CWS blowdown pipeline is 18-inch diameter carbon steel (Ref. 6.1). The rise-to-shutoff head of conventional vertical turbine pumps is approximately 150% of the normal operation pressure (Design Input 3.8). Because the CWS blowdown is pumped by the CWS pumps, the rise-to-shutoff head in this system is 189 ft (83 psi); therefore, the nominal design pressure of the pipe is 100 psi.

A control valve is installed on the blowdown line to control the CWS blowdown flow to the retention basin. Isolation valves are installed on either side of the control valve and a bypass line exists for when maintenance is being performed on the control valve. The CWS Piping and Instrumentation Diagram (Ref. 6.13) is shown in Attachment A.

4.3.4 Retention Basin Discharge

The retention basin discharge flows by gravity. Three pipe materials are analyzed as options for the retention basin discharge line. These options are: 24-inch carbon steel, 24-inch concrete, and 26-inch HDPE (Ref. 6.1). The design pressure of the pipe is 50 psi for all three piping options

A butterfly valve is installed on the retention basin discharge pipeline. A branch off the main header also exists to circulate the retention basin discharge to the intake structure forebay to prevent ice formation on the bar grating and traveling screens. The CWS Piping and Instrumentation Diagram (Ref. 6.13) is shown in Attachment A.

4.3.5 Pipe Trenches

The underground portion of non-safety related piping, discussed above, is placed at the bottom of an open trench excavation and backfilled in accordance with Drawing No. 12198-004-TREN-001 (Ref. 6.10, Attachment E) and Drawing No. 12198-004-TREN-002 (Ref. 6.11, Attachment F) and their details and notes. The notes provide instructions to assist in selecting the depth of the trench and the minimum width of the trench bottom, as well as the selection of bedding and backfill materials. The design for buried piping conforms to design methodology and acceptance criteria provided in S&L Standard SDS-E24, Rev. 1 (Ref. 6.12). The buried piping is designed for internal, soil overburden and surcharge pressure loads. For surcharge pressure, H-20 and Cooper E-80 live loads are considered since some pipes are routed under roads and/or railroad tracks.

The pipelines from the intake structure to the cooling towers and between the cooling towers and the retention basin will generally be founded in the sand and gravel soils. However, some sections of the pipelines will be founded in the bedrock where they are adjacent to structures founded in the bedrock.

Due to acidic soil conditions at the site (Ref 6.22, Attachment R), an external protective coating system and/or cathodic protection will be required for buried carbon steel pipe.

Any flooding exiting the Turbine Building at grade is directed away from structures that house safety-related systems, structures, and/or components (SSCs) by site grading, so external flooding resulting from a failure in the CWS does not adversely affect safety-related SSCs.

4.4 VACUUM PRIMING SYSTEM

A vacuum priming system is used to allow the highest tubes in the condenser tube bundle to be filled with water. The connections to the vacuum priming system are at the condenser water boxes. The air from the circulating water is discharged via the vacuum priming system to the water and air separator and from there to the atmosphere.

4.5 INTAKE STRUCTURE

The layout of the intake structure is shown on Drawing No. 12198-004-RWSS-004 (Ref. 6.14, Attachment B).

The intake structure is on the bank of the Susquehanna River. It houses the CWS makeup pumps and RWSS pumps. There are three bays for these pumps; each bay contains both a CWS makeup pump and an RWSS pump. Each bay also includes a traveling screen and a screenwash pump.

The bays are sized based on the recommended sump dimensions versus flow specified in the Hydraulic Institute Standards (Ref. 6.23, Attachment H). The bays and pumphouse are also sized to physically contain all of the equipment and to allow access for maintenance. The spacing between pumps in the same bay is also based on the requirements specified in the Hydraulic Institute Standards (Ref. 6.23, Attachment H).

The intake structure utilizes a bar grating, a trash rake, and stop logs. The trash rake is on a track to clean the bar grating. Stop logs can be installed to allow a bay or an intake tunnel to be closed off for maintenance. Installation and removal of the equipment inside the pumphouse is through the roof hatches via a jib crane.

A curtain wall protrudes into the pumphouse bays to prevent any floating debris that passes the bar grating from approaching the pumps. The curtain wall extends below the minimum water level in the forebay.

The inlet area limited by the curtain wall and each bay width is large enough to maintain a flow velocity of less than 0.5 fps during maximum flow through the bay (i.e., all pumps in the bay operating at full capacity).

The dual flow traveling screens shall be designed to have a "through-screen" velocity less than 0.5 fps per EPA Rule 316(b) (Ref. 6.15). Trash basins are installed to collect the debris washed off of the traveling screens. A Siemens traveling water screen is shown in Attachment K.

4.5.1 Civil Design Considerations

The intake structure has a floor elevation of 528 feet. Grade adjacent to the pumphouse is at elevation 525'-6". Twenty feet of flat area is provided on the north and south sides of the building. Eighty feet is provided on the west side of the building to provide space for a crane to sit during initial construction. A 20 foot wide road provides access to the flat pad.

The geologic profile in the vicinity of the intake structure on the Susquehanna River consists of sand and gravel from existing grade at approximately elevation 505 ft down to the bedrock surface. The top of the bedrock surface varies from approximately elevation 462 ft at the river's edge to approximately elevation 480 ft on the back side of the structure (Figures 2.4-41, 2.4-42, 2.4-48, and 2.4-52 from Ref. 6.3). The intake structure will be founded directly on the bedrock at approximately elevation 460 feet. The construction of the pumphouse will require a seepage cutoff structure along the river to provide dry working conditions.

4.5.2 Structural Design Considerations

Flow into the intake structure forebay is by gravity. The area from the river bed to the forebay is designed to allow for gradual transition without excessive turbulence.

The intake structure will be designed for the applicable design basis loads and load combinations that include but are not limited to: dead weight and live loads including wind, soil pressure, ice, and snow, as well as hydrostatic loads due to a flooding condition.

The intake structure is classified as a non-safety-related structure; therefore the following evaluations are not required:

- Seismic evaluation based on site-specific seismic response spectra.
- Dynamic loads from soil and water.
- Tornado winds and tornado generated missiles.
- Impact of high energy line breaks and internally-generated missiles.

The substructure (the portion of the pumphouse between the basemat and main operating floor) is a reinforced concrete structure that consists of three-foot-thick reinforced concrete walls and basemat and two-foot-thick reinforced concrete slab at the grade elevation.

The following design parameters have been utilized for the conceptual design:

- Floor live load of 100 psf (floors without pumps).
- Pump weight of 3 kips per pump.
- Soil dry unit weight of 126 pcf.
- Minimum soil surcharge pressure of 1,000 psf.
- Angle of internal friction of 35°.
- Minimum concrete compressive strength of 4,000 psi.

The design of the substructure concrete walls is governed by:

- The soil lateral pressure and surcharge loading pressure at the exterior walls.
- The hydrostatic loads due to the postulated single interior compartment flooding condition, with adjacent compartments empty.

The shear stress is the governing stress condition for the wall thickness determination.

The design of concrete walls and slabs is in accordance with ACI 318-05 & ACI 318R-05 (Ref. 6.19). The superstructure above the main floor is a steel-framing structure that consists of steel columns, beams, insulated metal siding, and concrete on metal deck roof. The design of steel columns, beams, and welded and bolted connections is in accordance with AISC (Ref. 6.20).

4.5.3 Electrical Design Considerations

Non-safety-related AC sources are required to power the CWS makeup pumps, valves, and other miscellaneous loads in the pump house.

The CWS makeup pumps are supplied by the 6.9 KV switchgear located in the intake structure. Two pumps are fed from one bus, and the third is fed from the opposite bus for redundancy and to even electrical load distribution. The 6.9 KV switchgear buses are supplied by two 13.8 KV/6.9 KV transformers energized by separate 13.8 KV underground feed cables from the station. The two buses have a cross tie breaker and each transformer is capable of carrying the load of both buses. All 480V loads (such as valves, HVAC, etc.) in the pumphouse are supplied by the 480V MCC located in the pumphouse. The MCC is equipped with a stepdown transformer and a 120V distribution panel to feed process-related 120V loads. The pumphouse indoor and outdoor lights are supplied by the local lighting cabinet. The pumphouse has an independent 250V DC ungrounded system for switchgear control and other DC loads in the pumphouse.

The remote control, indication, and alarms are transmitted by the supervisory panel in the pumphouse.

The intake structure is provided with a grounding system. The electrical equipment and instrument panels are provided with grounding connections in accordance with industry practice. A cathodic protection system is provided to protect buried metal pipes and structures.

Refer to the Intake Structure Electrical One-Line Diagram (Ref. 6.25, Attachment L).

4.5.4 I&C Design Considerations

Local and remote (main control room) monitoring and control of CWS related features located in the intake structure are provided. Local controls are located in the intake structure on a supervisory panel that communicates with the main control room (MCR) monitoring and control equipment. Monitoring and control in the MCR is via a process information and control system.

Cooling tower basin level is displayed locally and in the MCR. Alarms are provided in the MCR for low and high level in the basin. The cooling tower basin level is input to the control for the CWS makeup pumps and CWS makeup control valve. Indication of makeup flow to the cooling tower basin is provided to the MCR by a flow meter located downstream of the makeup control valve.

MCR capability is provided for operational control of each CWS makeup pump and the associated discharge butterfly valve. Each valve is controlled in tandem with the associated pump and sequenced in accordance with pump manufacturer recommendations such that the pump is automatically tripped if the valve is not in the full-open position within a short period after starting the pump. An interlock with the traveling screens is provided such that the screens must be operating for the CWS makeup pump to be placed in operation. Pump operating status and valve position are provided in the MCR.

Discharge pressure for each of the CWS makeup pumps is indicated locally and in the MCR and a low pressure alarm is provided in the MCR.

Operational control of the traveling screens and associated screenwash pumps is provided locally and in the MCR. Screenwash pump operation is based on differential pressure across the traveling screens. An interlock is provided for each traveling screen such that if the associated screenwash pump discharge pressure

does not achieve a setpoint within a specified time, an alarm is provided in the MCR. Operating status of the traveling screens and screenwash pumps, and pump discharge pressure are provided in the MCR. Differential pressure across the screens is monitored and alarmed on high pressure in the MCR.

Temperature monitoring is provided in the intake structure forebay. The temperature of the forebay is provided to the MCR.

Available status and alarm indications are provided to the MCR for equipment located in the intake structure, including: valve position, area temperature, power distribution equipment, HVAC, etc.

4.5.5 HVAC Design Considerations

The intake structure Heating and Ventilation (HV) system serves the pumphouse and the battery room. The HV system consists of an outside air intake louver, supply air fan, ductwork, duct accessories, back draft damper exhaust louver, and instrumentation and controls. A temperature controller located downstream of the supply air fan will modulate the outside air control damper and the return air control damper to limit the supply air temperature at a minimum of 50°F. The air supply to the pump house in conjunction with the electric unit heaters will limit the pumphouse temperature to a minimum of 50°F in the winter and a maximum of 122°F in the summer. The excess air that is not recirculated is relieved to the outside via the backdraft damper exhaust louver. A portion of the air is supplied to the battery room where it is exhausted to the outside by its exhaust fan. The exhaust air is slightly more than the supply air so the battery room is always at a slightly negative pressure with respect to the adjacent area (the pumphouse). Air supply to the battery room will limit the room temperature to a maximum of 104°F in the summer, and a battery room thermostat will control the electric duct heater to limit the room temperature to a minimum of 65°F in the winter. Air supplied to the battery room is more than adequate to limit the hydrogen concentration in the battery room below 1% as required by standard NFPA 70.

High and low temperature alarms for the pumphouse and the battery room shall be annunciated in the main control room.

The conceptual design for the intake structure HVAC is shown on the Intake Structure HVAC P&ID (Ref. 6.28, Attachment P).

4.5.6 Fire Protection Design Considerations

Fire Area FA-UPE-01 is the open area on the upper level of the intake structure that contains the electrical control equipment, three CWS makeup pumps, three RWSS pumps, and three screenwash pumps. The adequacy of the fire protection features provided is sufficient to prevent a fire originating within Fire Area FA-UPE-01 from affecting adjacent fire areas. This fire area is not normally occupied during normal plant operations. The egress route from this area is via two exits to the exterior. This fire area utilizes automatic fire detection, manual fire alarms, and portable fire extinguishers. It does not utilize manual fixed fire protection.

Refer to S&L Calculation No. 2008-08861, "Fire Protection Plan for Yard and Outlying Buildings" (Ref. 6.6) for more information on fire protection.

4.6 CWS PUMPHOUSE

The layout of the CWS pumphouse is shown in Drawing No. 12198-004-CWS-002 (Ref. 6.16, Attachment C).

The circulating water pumphouse is adjacent to the CWS cooling towers. The bays of the CWS pumphouse are connected to the cooling tower basin via a flume. There is one bay for each of the four CWS pumps. A bar grill and trash rake are installed to prevent any debris from entering the CWS pump bays.

The bays are sized based on the recommended sump dimensions versus flow specified in the Hydraulic Institute Standards (Ref. 6.23, Attachment H). The bays and pumphouse are also sized to physically contain all of the equipment and to allow access for maintenance.

The CWS pumphouse utilizes a bar grating, a trash rake, and stop logs. The trash rake is on a track to clean the bar grating. Stop logs can be installed to allow a bay to be closed off for maintenance. Installation and removal of the equipment inside the pumphouse is through the roof hatches via a jib crane.
A curtain wall protrudes down into the pumphouse bays to prevent any floating debris that passes the bar grating from approaching the pumps. The curtain wall is suspended low enough to be deeper than the minimum water level in the cooling tower basin.

The inlet area limited by the curtain wall and each bay width is large enough to maintain a flow velocity of less than 0.5 fps during maximum flow through the bay (i.e., pumps operating at full capacity).

The chemical treatment room is located inside the CWS pumphouse. Access into the chemical treatment room is from the outside to prevent a chemical leak from affecting other equipment inside the pumphouse.

4.6.1 Civil Design Considerations

The grade elevation at the cooling tower and CWS pumphouse is at 694 feet. The CWS pumphouse floor elevation is 695 feet. The area between the CWS pumphouse and the road around the towers is paved. A crane can approach this area and sit during initial construction.

The geologic profile in the vicinity of the cooling towers consists of generally granular soils (silty sand and sandy silt) overlying siltstone and shale bedrock (Ref. 6.8). The top elevation of the bedrock varies from elevation 690 ft to 774 feet. Considering a foundation elevation at approximately elevation 663 ft, the structure will be founded directly on the bedrock.

4.6.2 Structural Design Considerations

Flow through the flume is by gravity. The areas from the flume to the bays are designed to allow for gradual transition without excessive turbulence.

The CWS pumphouse structure will be designed for the applicable design basis loads and load combinations that include but are not limited to: dead weight and live loads including soil, wind, ice, and snow loads, as well as hydrostatic loads due to ground water and/or a flooding condition.

The CWS pumphouse structure is classified as a non-safety-related structure; therefore the following evaluations are not required:

- Seismic evaluation based on site-specific seismic-response spectra.
- Dynamic loads from soil and water.
- Tornado winds and tornado generated missiles.
- Impact of high energy line breaks and internally generated missiles.

The subtructure (the portion of the structure between the base mat and main operating floor) is a reinforced concrete structure that consists of two-foot-thick reinforced concrete walls and two-foot-thick reinforced concrete slabs at the base and main operating floor elevations.

The following design parameters have been utilized for the conceptual design:

- Floor live load of 500 psf (floors without pumps).
- Soil dry unit weight of 127.4 pcf (submerged weight of 65 pcf).
- Minimum soil surcharge pressure of 1,000 psf.
- Angle of internal friction of 35°.
- Minimum concrete compressive strength of 4,000 psi.

The design of the substructure concrete walls is governed by:

- The soil lateral pressure and surcharge loading pressure at the exterior walls.
- The hydrostatic loads due to the postulated single interior compartment flooding condition, with adjacent compartments empty.

The shear stress is the governing stress condition for the wall thickness determination.
The design of concrete walls and slabs is in accordance with ACI 318-05 & ACI 318R-05 (Ref. 6.19).

The superstructure above the main floor is a steel-framing structure that consists of steel columns, beams, insulated metal siding, and concrete on metal deck roof. The design of steel columns, beams, and welded and bolted connections is in accordance with AISC (Ref. 6.20).

4.6.3 Electrical Design Considerations

Non-safety-related AC sources are required to power the CWS pumps, valves, and other miscellaneous loads in the pumphouse.

The CWS pumps are supplied from the 13.8 KV station buses: 35BBD and 36BBD. All 480V loads (such as valves, HVAC, etc.) in the pumphouse are supplied by the 480V MCC located in the CWS pumphouse. The MCC is equipped with a stepdown transformer and a 120V distribution panel to feed the process-related 120V loads. The pumphouse indoor and outdoor lights are supplied by the local lighting cabinet.

The remote control, indication, and alarms are transmitted by the supervisory panel in the pumphouse.

The CWS pumphouse is provided with a grounding system. The electrical equipment and instrument panels are provided with grounding connections in accordance with industry practice. A cathodic protection system is provided to protect buried metal pipes and structures.

Refer to the CWS Pumphouse Electrical One-Line Diagram (Ref. 6.24, Attachment M).

The natural draft cooling towers do not have an electrical load.

4.6.4 I&C Design Considerations

Local and remote (main control room) monitoring and control of CWS related features located in the CWS pumphouse are provided. Local controls are located in the CWS pumphouse on a supervisory panel that communicates with the main control room (MCR) monitoring and control equipment. Monitoring and control in the MCR is via a process information and control system.

MCR capability is provided for operational control of each CWS pump and the associated discharge butterfly valve. Each valve is controlled in tandem with the associated pump and sequenced in accordance with pump manufacturer recommendations such that the pump is automatically tripped if the valve is not in the full-open position within a short period after starting the pump. Pump operating status and valve position are provided in the MCR.

Discharge pressure and flow for each of the CWS pumps are indicated locally and in the MCR and low pressure and low flow alarms are provided in the MCR. Motor winding temperature sensors mounted at various locations in the motors along with breaker position provide remote control, indication, and alarm of the CWS pumps.

Temperature monitoring is provided in each CWS pump bay. The temperature for each bay is provided to the MCR.

A means is provided to utilize temporary flow metering equipment on the main circulating water piping.

MCR operation of valves enables bypass of one or both return line flows from the plant to flow directly into the cooling tower basin for operation during cold weather. Position indication for bypass valves is provided in the MCR.

CWS blowdown flow to the retention basin is controlled by the blowdown control valve. The blowdown control valve is modulated using input from the cooling tower basin level instrumentation and MCR input for maintaining the desired water chemistry. CWS blowdown flow is monitored in the MCR. In addition, the CWS blowdown temperature downstream of the blowdown heat exchanger is monitored in the MCR.

Available status and alarm indications are provided to the MCR for equipment located in the CWS pumphouse, including: valve position, area temperature, power distribution equipment, HVAC, etc.

4.6.5 HVAC Design Considerations

The CWS pumphouse has two Heating and Ventilation (HV) systems that serve the pumphouse and the chemical tank room. The Heating and Ventilation (HV) system for the pumphouse consists of two 50% capacity trains. Each train consists of an outside air intake louver, supply air fan, ductwork, duct accessories, back draft damper exhaust louver, and instrumentation and controls. A temperature controller located downstream of the supply air fan will modulate the outside air intake control damper and the return air control damper to limit the supply air temperature to a minimum of 50°F. The air supply to the pump house in conjunction with the electric unit heaters will limit the pumphouse temperature to a minimum of 50 °F in the winter and a maximum of 122°F in the summer. The excess air that is not recirculated is relieved to the outside via the backdraft damper exhaust louver.

The HV system for the chemical tank room consists of an outside air combination fixed and operating louver, exhaust fan, and exhaust louver with backdraft damper. Also, a ductwork with a motor-operated isolation damper is provided in an interior wall of the tank room and the pumphouse. This arrangement allows the transfer of air from the pumphouse to the chemical tank room during winter when the outside air intake louver for the chemical tank room is closed to conserve heat energy. The exhaust air for the system is based on six air changes per hour to keep the toxic gases below the threshold limit and maintain the tank room temperature below 104°F. The exhaust fan operates continuously. At an outside temperature of 70°F the outside air intake louver opens and the transfer air isolation damper closes. When the outside air temperature drops to 50°F, the transfer air isolation damper opens and the outside air intake louver closes. The tank room unit heaters in conjunction with transfer air from the pumphouse will limit the room's minimum temperature to 50°F.

High and low temperature alarms of the pumphouse and the chemical tank room are annunciated in the main control room. Tank room fan failure is also annunciated in the main control room.

The conceptual design for the CWS pumphouse and the chemical tank room HVAC is shown on the CWS Pumphouse HVAC P&ID (Ref. 6.27, Attachment Q).

4.6.6 Fire Protection Design Considerations

Fire Area FA-UQA-01 is the upper floor level of the CWS pumphouse that contains electrical equipment and the four CWS pumps. The adequacy of the fire protection features provided is sufficient to prevent a fire originating within Fire Area FA-UQA-01 from affecting adjacent fire areas. This fire area is occasionally occupied during normal plant operations. The egress route from this area in the event of fire is via four exits to the exterior. This fire area utilizes automatic fire detection, manual fire alarms, and portable fire extinguishers. It does not utilize manual fixed fire protection.

Refer to S&L Calculation No. 2008-08861, "Fire Protection Plan for Yard and Outlying Buildings" (Ref. 6.6) for more information on fire protection.

4.7 RETENTION BASIN

The layout of the common retention basin is shown in Drawing No. 12198-004-CWS-003 (Ref. 6.17, Attachment D).

Various plant systems discharge water to the common retention basin. These sources are:

- CWS blowdown.
- ESWS blowdown.
- Wastewater treatment plant effluent.
- Demineralizer reject water.
- Miscellaneous low volume waste.

Liquid radwaste treatment effluent is also injected directly into the retention basin discharge piping.

The maximum flowrate through the basin is 9,356 gpm (Design Input 3.4). To allow sediments to settle, the basin has a surface area of approximately 101,500 ft^2 with a length of 451 ft and a width of 225 feet. At 9 ft deep, the volume of the basin is approximately 910,000 ft^3 (6,800,000 gal). The weir in the basin has a maximum height of 7.5 ft (Ref. 6.1).

The retention basin discharge drains by gravity at the corner of the retention basin, behind the weir. A prefabricated insulated-siding building will house the retention basin chemical treatment skid.

4.7.1 Civil Design Considerations

The top of the retention basin walls are at the 681 ft elevation. Finish grade outside the basin is at the 680 ft elevation. At high water level in the basin, 2.5 ft of interior freeboard is provided. The basin is accessible on all four sides.

The retention basin is located northeast of the nuclear island. The subsurface conditions at this location consist primarily of medium-dense to dense sand and gravel overlying the shale and sandstone bedrock encountered at approximately elevation 636 ft to 641 ft (Ref. 6.8). Considering a final grade elevation at approximately 674', the bottom of this basin will be founded in the granular soils.

4.7.2 Structural Design Considerations

The foundation for the retention basin is a two-foot-thick reinforced concrete slab that is 451 ft long and 225 ft wide. It is designed for 9 ft of hydrostatic water pressure with high water level at elevation 678'-6". The foundation mat is conceptually evaluated as a beam on the elastic foundation to calculate stresses due to hydrostatic pressure and differential displacements.

The retention basin slab is classified as a non-safety-related structure; therefore the following evaluations are not required:

- Seismic evaluation based on site-specific seismic-response spectra.
- Hydrodynamic loads.
- Impact of externally-generated missiles.

The design of the reinforced concrete slab is in accordance with ACI 318-05 & ACI 318R-05 (Ref. 6.19).

4.7.3 I&C Design Considerations

Local and remote (main control room) monitoring and control of features associated with the retention basin are provided. Local controls are located on a supervisory panel that communicates with the main control room (MCR) monitoring and control equipment. The supervisory panel is located in the chemical treatment prefabricated building. Monitoring and control in the MCR are via a process information and control system.

Retention basin level is displayed locally and in the MCR. Alarms are provided in the MCR for low and high level in the basin.

The retention basin discharge is monitored for temperature and flow. A high flow alarm is provided in the MCR to indicate flow exceeding the maximum allowed flow. Similarly, a high temperature alarm is provided in the MCR to indicate exceeding the allowable maximum discharge temperature.

MCR control and position indication of the discharge bypass valve are provided to allow remote alignment of the retention basin discharge to the intake structure for the prevention of ice-formation in the intake structure bays. The bypass flow is indicated in the MCR using a flow meter located downstream of the bypass valve.

4.8 DISCHARGE DIFFUSER

The retention basin discharge line is routed to the diffuser structure at the Susquehanna River. The discharge diffuser is shown in Drawing No. 12198-004-CWS-015 Sheet 3 (Ref. 6.18, Attachment N).

The discharge diffuser is essentially the discharge pipe routed along the bottom of the Susquehanna River at approximately 476 ft elevation with 72 four-inch-diameter port holes in it (Ref. 6.29). The port holes are angled 45° from the horizontal in the direction of the river flow and are spaced 1.5 ft apart. A flap gate is installed at the end of the discharge diffuser.

4.8.1 Structural Design Considerations

A reinforced concrete pad structure with a saddle-shaped top portion accommodates the discharge pipe and provides adequate bearing surface. The concrete pad is 7 ft wide and 111.5 ft long based on the preliminary layout drawing in Attachment N.

The following design parameters have been utilized for the conceptual design:

- Pipe load at the discharge equal to 10 kips in vertical and lateral direction (preliminary estimate).
- Concrete moist unit weight of 150 pcf (Ref. 6.21).
- Minimum soil surcharge pressure of 1,000 psf.
- Angle of internal friction of 35° (Ref. 6.21).
- Minimum concrete compressive strength of 5,000 psi (Ref. 6.21).

The design of the substructure concrete walls is governed by:

- The soil lateral pressure and surcharge loading pressure.
- The piping loads at the discharge.

The design of concrete pad is in accordance with ACI 318-05 & ACI 318R-05 (Ref. 6.19).

The design of the lateral-angle-type pipe supports and the anchorage will be performed in the detailed design stage based on the stress analysis results.

4.9 CHEMICAL TREATMENT

4.9.1 Intake Structure

The Susquehanna River is the source of water supplied to the CWS cooling tower and RWSS. This water is characterized as a moderately-hard, alkaline water with a low dissolved solids content averaging 143 mg/l. The composition is shown in Table 4.9.1-1 (Ref. 6.5).

There have been no sightings of zebra mussels along the Susquehanna River as shown in the most recent USGS distribution map updated 1/18/2008 (Ref. 6.26), so no treatment is provided at the intake structure for control of zebra mussels.

Treatment will be required to control microbial growth in the RWSS piping to control biofouling, microbiological deposits, and microbially-induced corrosion, especially in the smaller pipes. An oxidizing biocide was selected. Sodium hypochlorite solution (also referred to as bleach) will be injected intermittently. Facilities for sodium hypochlorite storage and injection will be located near the intake structure and chemical will be injected near the RWSS pumps.

Table 4.9.1-1 Susquehanna River Composition.

		Susquehanna River	
Constituent	Composition	Max	Mean
pH		8.1	7.8
Total dissolved solids	(mg/l)	201	143
Total suspended solids	(mg/l)	82	18
Calcium Hardness	(mg/l as CaCO3)	97	66
Total Hardness	(mg/l as CaCO3)	132	92
M.O. Alkalinity	(mg/l as CaCO3)	94	61
Calcium	(mg/l as Ca)	38.8	26.6
Magnesium	(mg/l as Mg)	10.6	6.3
Sodium	(mg/l as Na)	24.1	15.2
Chloride	(mg/l as Cl)	39.6	25.7
Sulfate	(mg/l as SO4)	51.2	26.6
Ortho-Phosphate	(mg/l as PO4)	0.7	0.2
Silica	(mg/l as SiO2)	4.8	2.8
Iron	(mg/l as Fe)	0.3	0.1

4.9.2 Cooling Tower

Based on the BBNPP Water Balance Calculation (Ref. 6.5), the CWS cooling tower will normally be operated at 3 cycles of concentration. Localized treatment will be required at the CWS cooling tower to control biofouling, sedimentation, calcium carbonate scaling, and corrosion. The condenser tubes are stainless steel metallurgy (Assumption 2.1) and there are no copper-bearing wetted components, so yellow-metal corrosion control is not required for this system.

Specific treatment chemicals are as follows:

- Acid – Sulfuric acid will be used for pH reduction to aid in calcium carbonate scale control. The pH will be maintained in the alkaline region. Acid feed will be continuous as required to maintain the target pH level.
- Oxidizing biocide – Sodium hypochlorite solution (bleach) will be used to control biofouling. Treatment will be periodic for no more than two hours per day as required by typical NPDES permit requirements.
- Deposit Control Agents – An organic phosphonate such as HEDP plus an acrylate copolymer will be used to control calcium carbonate scaling, to protect against calcium phosphate scaling that might result from reversion of HEDP, and to control silt and iron deposition. These chemicals are available in proprietary formulations and will be fed continuously to maintain target levels.
- Corrosion Inhibitor – A separate corrosion inhibitor is not required. Phosphonates used for deposit control will also provide inhibition of mild steel corrosion in alkaline systems.

The treatment chemicals will be stored onsite in tanks(s) or tote(s) near the CWS cooling tower and will be injected into the circulating water at controlled rates with metering pumps.

Chemical treatment system pumps, valves, tanks, instrumentation, and controls provide the means of monitoring water chemistry. Monitoring will be consistent with chemical vendor recommendations required for chemical dosage and performance. The NPDES permit may require additional environmental compliance monitoring at point sources, such as pump discharges to oil/water separator. Residual chlorine is measured to monitor the effectiveness of biocide treatment. Conductivity and pH are also monitored.

Sample ports are installed at the circulating water supply headers and CWS makeup header. Grab samples are analyzed at the chemistry lab.

4.9.3 Retention Basin

Use of sodium hypochlorite as an oxidizing biocide at the CWS and ESWS cooling towers will require dechlorination at the retention basin outlet prior to discharge to the Susquehanna River. Sodium bisulfite solution will be used to react with residual oxidant. Chemical storage and metering facilities located near the retention basin will inject sodium bisulfite into the basin outlet. Because biocide treatment at the cooling towers is periodic, dechlorination will be paced to match the treatment schedules. Downstream monitoring will verify conformance with typical NPDES limitations on residual oxidant.
The discharge from the retention basin will consist primarily of blowdown from the CWS and from the ESWS cooling towers. The combined water composition will depend on the cycles of concentration and on the specific cooling water chemistry control strategy used for deposit control. Using three cycles of concentration per the BBNPP Water Balance (Ref 6.5) and assuming a conservatively high sulfuric acid dosage of 33 ppm, the results in the average composition are shown in Table 4.9.2-1, below. Alternative deposit control strategies using higher pH levels with lower acid dosages and more aggressive deposit control chemical programs would have similar compositions but with higher pH levels, higher alkalinities, and lower sulfate levels.

Table 4.9.2-1 Retention Basin Discharge Composition.

		Retention Basin Discharge
Constituent	Composition	Mean
pH		8.0 to 8.5
Total dissolved solids	(mg/l)	471
Total suspended solids	(mg/l)	
Calcium Hardness	(mg/l as CaCO3)	198
Total Hardness	(mg/l as CaCO3)	276
M.O. Alkalinity	(mg/l as CaCO3)	83
Calcium	(mg/l as Ca)	80
Magnesium	(mg/l as Mg)	19
Sodium	(mg/l as Na)	46
Chloride	(mg/l as Cl)	77
Sulfate	(mg/l as SO4)	180
Ortho-Phosphate	(mg/l as PO4)	0.6
Silica	(mg/l as SiO2)	8.4
Iron	(mg/l as Fe)	0.3

5.0 LIMITATIONS

This Conceptual Design Report is prepared to support COL application and shall provide the basis for a detailed design prior to construction. Verification of inputs, assumptions, and limitations shall be performed during the detailed design stage.

Additional limitations are as follows:

5.1 This conceptual design report is based on the Bell Bend Nuclear Power Plant Conceptual Design Calculation of the Circulating Water System, Calculation No. 2008-09135, Rev. 2. Verification of inputs, assumptions, and limitations shall be performed during the detailed design stage.

5.2 Information from vendors is considered preliminary. During the detailed design, equipment specifications will be developed as required.

6.0 REFERENCES

6.1 S&L Calculation 2008-09135, Rev. 2, "Conceptual Design Calculation for the Circulating Water System" (Unverified).
6.2 S&L Report No. 2008-06824, Rev. 1, "Engineering and Economic Evaluation of the Integrated Heat Rejection Cycle."
6.3 Susquehanna Steam Electric Station (SSES) FSAR.
6.4 U.S. EPR Final Safety Analysis Report Section 10.4.5, Rev. 0, "Circulating Water System."
6.5 Calculation 2008-08550, Rev. 1, "BBNPP Unit 3 Water Balance" (Unverified).
6.6 S&L Calculation No. 2008-08861, Rev. 2, "Fire Protection Plan for Yard and Outlying Buildings" (Unverified).
6.7 U.S. EPR Final Safety Analysis Report Section 9.2.5, Rev. 0, "Ultimate Heat Sink."
6.8 Boring logs from Paul C. Rizzo Associates, Inc. performed in conjunction with the COLA for the Bell Bend site.
6.9 Ingersoll-Dresser Pumps. Type APKD, APKC, QLQC Vertical, Multistage Can Pump Brochure. (Attachment G).
6.10 S&L Drawing 12198-004-TREN-001, Rev. 0, "Single Line Pipe Trench Detail" (Unverified) (Attachment E)
6.11 S&L Drawing 12198-004-TREN-002, Rev. 0, "Multiple Line Pipe Trench Detail" (Unverified) (Attachment F)
6.12 S&L Standard SDS-E24, Rev. 1, "Buried Pipes."
6.13 S&L Drawing 12198-004-CWS-001, Rev. 5, "Piping and Instrumentation Diagram Circulating Water System" (Unverified) (Attachment A).
6.14 S&L Drawing 12198-004-RWSS-004, Rev. 2, "Conceptual Intake Structure General Arrangement" (Unverified) (Attachment B).
6.15 Environmental Protection Agency (EPA) Rule 316(b). Dated June 16, 2006.
6.16 S&L Drawing 12198-004-CWS-002, Rev. 2, "Conceptual Circulating Water Pumphouse General Arrangement" (Unverified) (Attachment C).
6.17 S&L Drawing 12198-004-CWS-003, Rev. 3, "Conceptual Retention Basin General Arrangement" (Unverified) (Attachment D).
6.18 S&L Drawing 12198-004-CWS-015, Rev. 1, "Conceptual Discharge Detail" (Unverified) (Attachment N).
6.19 ACI 318-05 & ACI 318R-05,"Building Code Requirements for Structural Concrete and Commentary," ACI Committee.
6.20 AISC, 13th Edition, "Steel Construction Manual," American Institute of Steel Construction, Inc.
6.21 Response to RFI No. EPR 08-170 from Paul C Rizzo Associates, Inc, dated 05-08-08 (Attachment S).
6.22 S&L Internal Design Information Transmittal DIT-BBNPP-003, dated 4/28/08, "Water and Soil Chemistry Parameters for Buried Commodities" (Attachment R).
6.23 Hydraulic Institute Standards for Centrifugal, Rotary & Reciprocating Pumps. Twelfth Edition. (Attachment H).
6.24 S&L Drawing 12198-004-CWS-014, Rev. 1, "Conceptual Electrical One-Line Diagram Circ Water Pump House" (Unverified) (Attachment M).
6.25 S&L Drawing 12198-004-RWSS-005, Rev. 2, "Conceptual Electrical One-Line Diagram Intake Structure for CWS and RWSS" (Unverified) (Attachment L).
6.26 Benson, A. J. and D. Raikow. 2008. Dreissena polymorpha. USGS Nonindigenous Aquatic Species Database, Gainesville, FL.
6.27 S&L Drawing 12198-004-HV-002, Rev. 0, "Conceptual Piping & Instrumentation Diagram Circulating Water Pump House Heating and Ventilation" (Unverified) (Attachment Q).
6.28 S&L Drawing 12198-004-HV-001, Rev. 0, "Conceptual Piping & Instrumentation Diagram CWS Makeup & RWS Pump House Heating & Ventilation" (Unverified) (Attachment P).
6.29 Thermal Plume Studies in the Susquehanna River at the Discharge Diffuser of the Susquehanna Steam Electric Station 1986-87. Ecology III, Inc.
6.30 Not used.
6.31 Email from SPX date 5-16-08 regarding cooling tower air flow rates (Unverified) (Attachment T).
6.32 Email from John Dalton (SPX Marley) to Richard Pospiech (S&L), 6/25/2008 (Attachment U).

7.0 CONCLUSIONS AND RECOMMENDATIONS

The specifications for pumps and piping in the Circulating Water System are summarized in the table below:

Table 7.0-1 Summary of CWS Pumps and Piping.

	Flowrate (each)	Pipe	TDH	HP (each)
CWS Pumps (4-25%)	220,180 gpm	132-inch Concrete*	126 ft (55 psi)	9,000 HP
• CWS Blowdown	8,700 gpm	18-inch Carbon Steel	-	-
CWS Makeup Pumps (3-50%)	13,100 gpm	30-inch Carbon Steel	421 ft (182 psi)	1,800 HP
Retention Basin Discharge	9,370 gpm	24-inch Carbon Steel	-	-
		24-inch Concrete	-	-
		26-inch HDPE	-	-

*Note: Two pipelines, concrete below ground, carbon steel above ground.

The intake structure utilizes a bar grating, a trash rake, dual-flow traveling screens, and screenwash pumps. CWS makeup pump operation is automatically controlled with input from the cooling tower basin level.

The CWS pumphouse utilizes a bar grating and a trash rake. The CWS pumps provide both the circulating water and the CWS blowdown. CWS blowdown flow to the retention basin is controlled by the blowdown control valve which is modulated using input from the cooling tower basin level instrumentation and MCR input for maintaining the desired water chemistry.

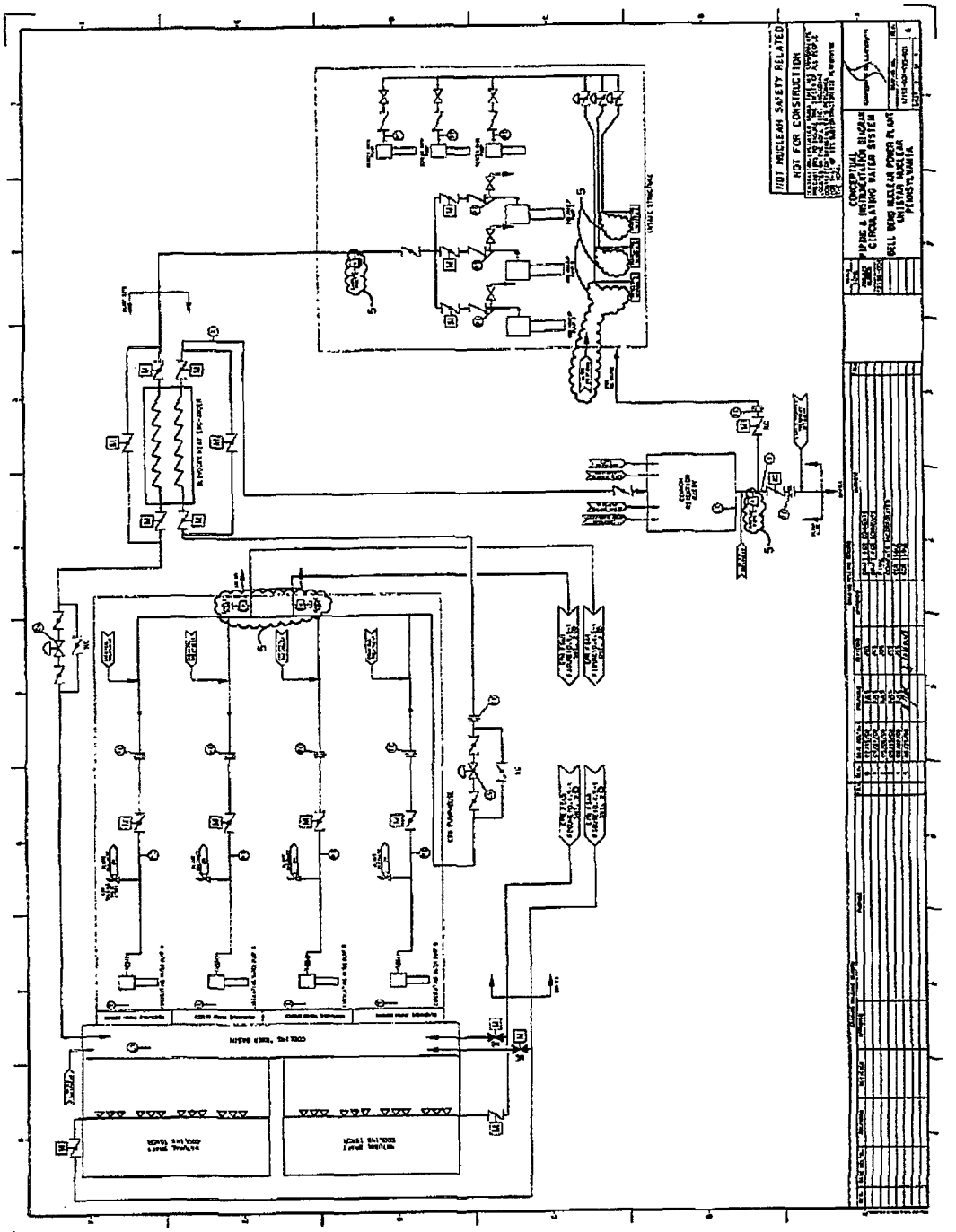
The retention basin is 451' x 225' x 9' and has a volume of approximately 910,000 ft^3 (6,800,000 gal).

Three potential retention basin discharge pipe options are described above. The final selection shall be made during the detailed design.

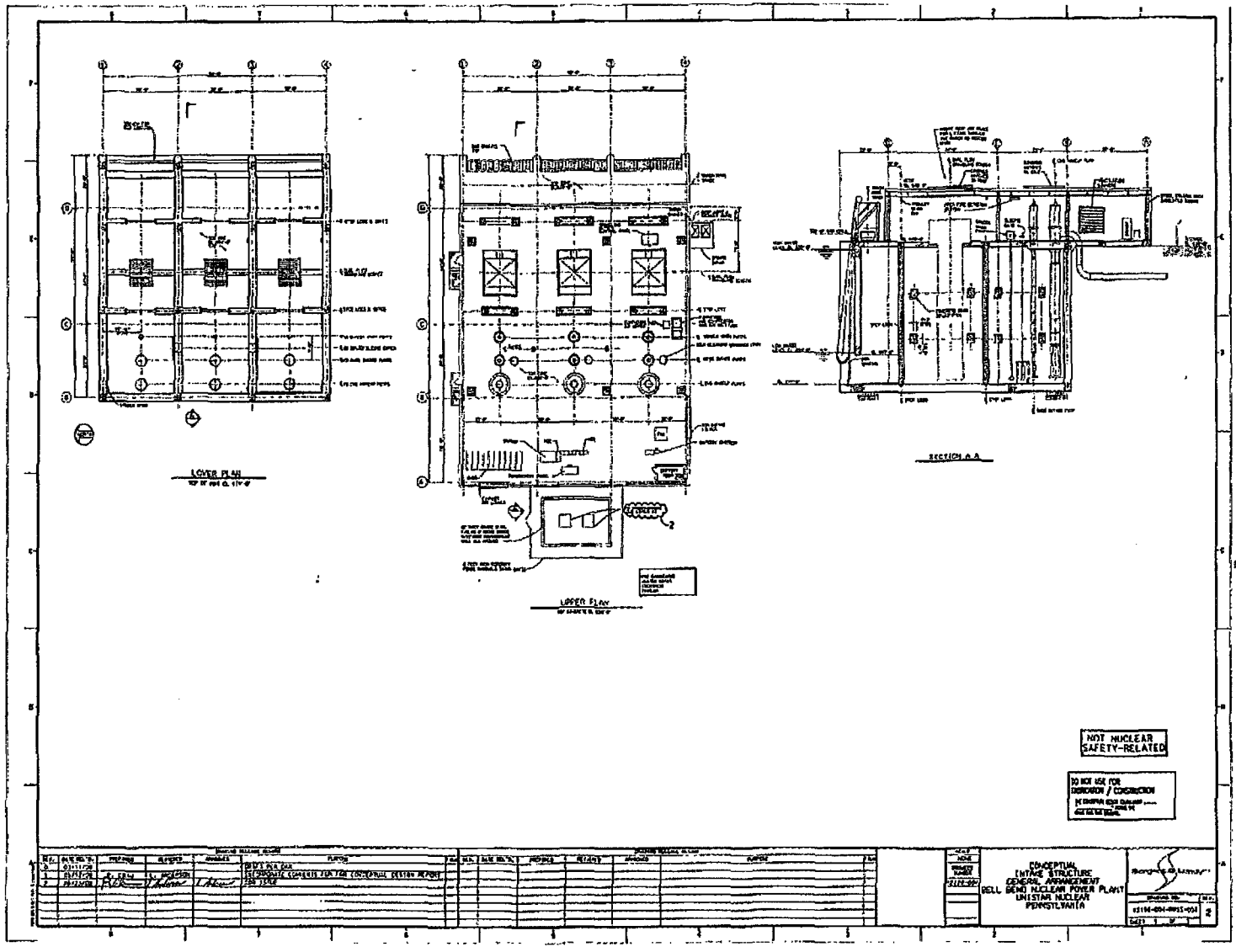
The discharge diffuser creates a large mixing zone in order to meet maximum surface temperature-rise limitations.

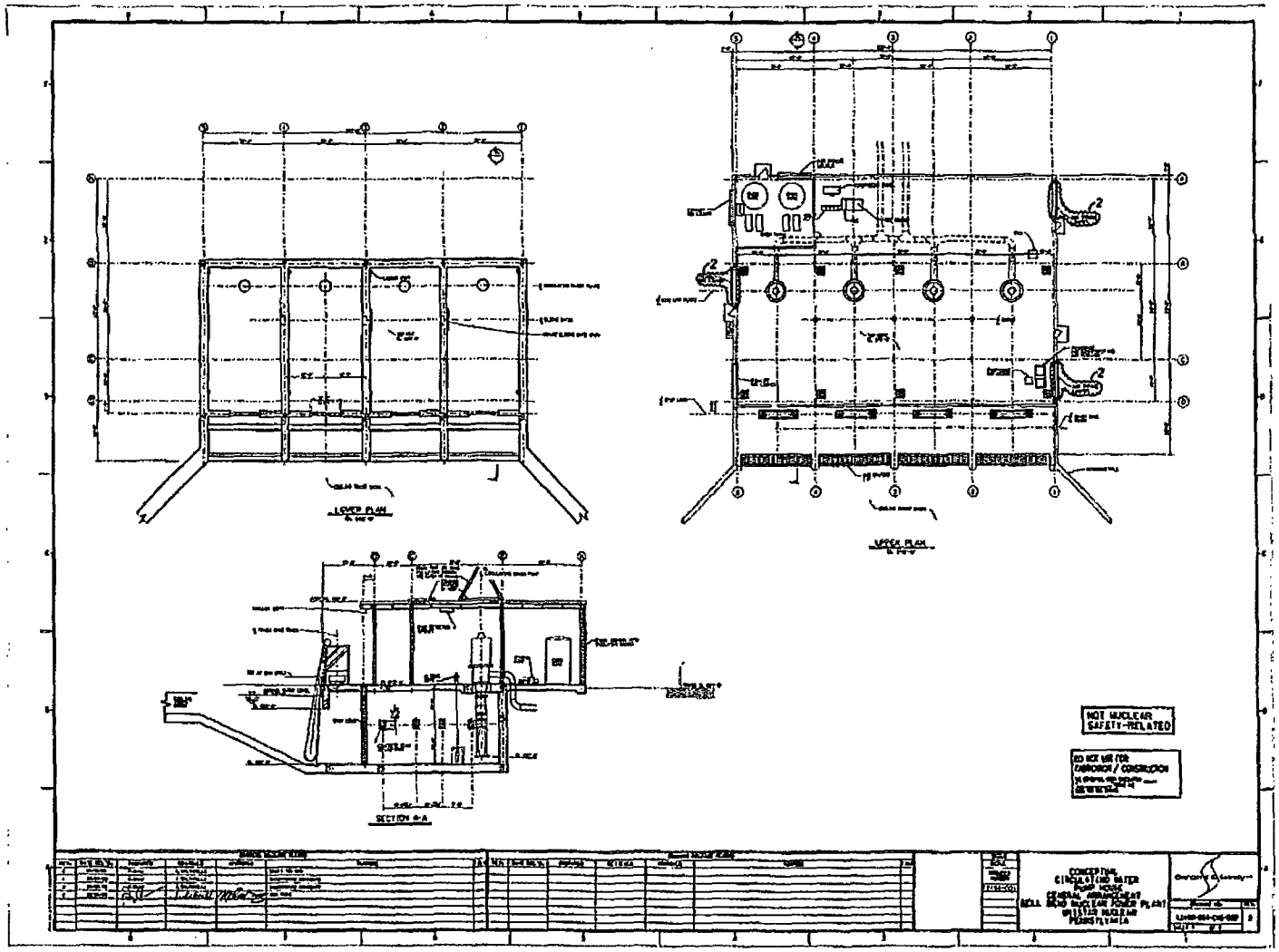
8.0 ATTACHMENTS

A	CWS Piping and Instrumentation Diagram
B	Intake Structure Layout
C	CWS Pumphouse Layout
D	Retention Basin Layout
E	Single Pipeline Trench Detail
F	Multiple Pipeline Trench Detail
G	Ingersoll-Dresser Pump Brochure
H	Hydraulic Institute Standards Excerpt
J	Flowserve Pump Brochure
K	Siemens Traveling Screen Brochure
L	Intake Structure Electrical One-Line
M	CWS Pumphouse Electrical One-Line
N	Discharge Diffuser Layout
P	Intake Structure HVAC P&ID
Q	CWS Pumphouse HVAC P&ID
R	S&L Internal DIT-BBNPP-003
S	Response to RFI EPR-08-170
T	Air Flow Rate
U	Email on Cooling Tower


NOT FOR CONSTRUCTION
CONCEPTUAL
PIPING & INSTRUMENTATION DIAGRAM
CIRCULATING WATER SYSTEM
BELL BEND NUCLEAR POWER PLANT
UNISTAR NUCLEAR
PENNSYLVANIA

Attachment B: Intake Structure Layout




LOWER PLAN
UPPER PLAN
SECTION A-A
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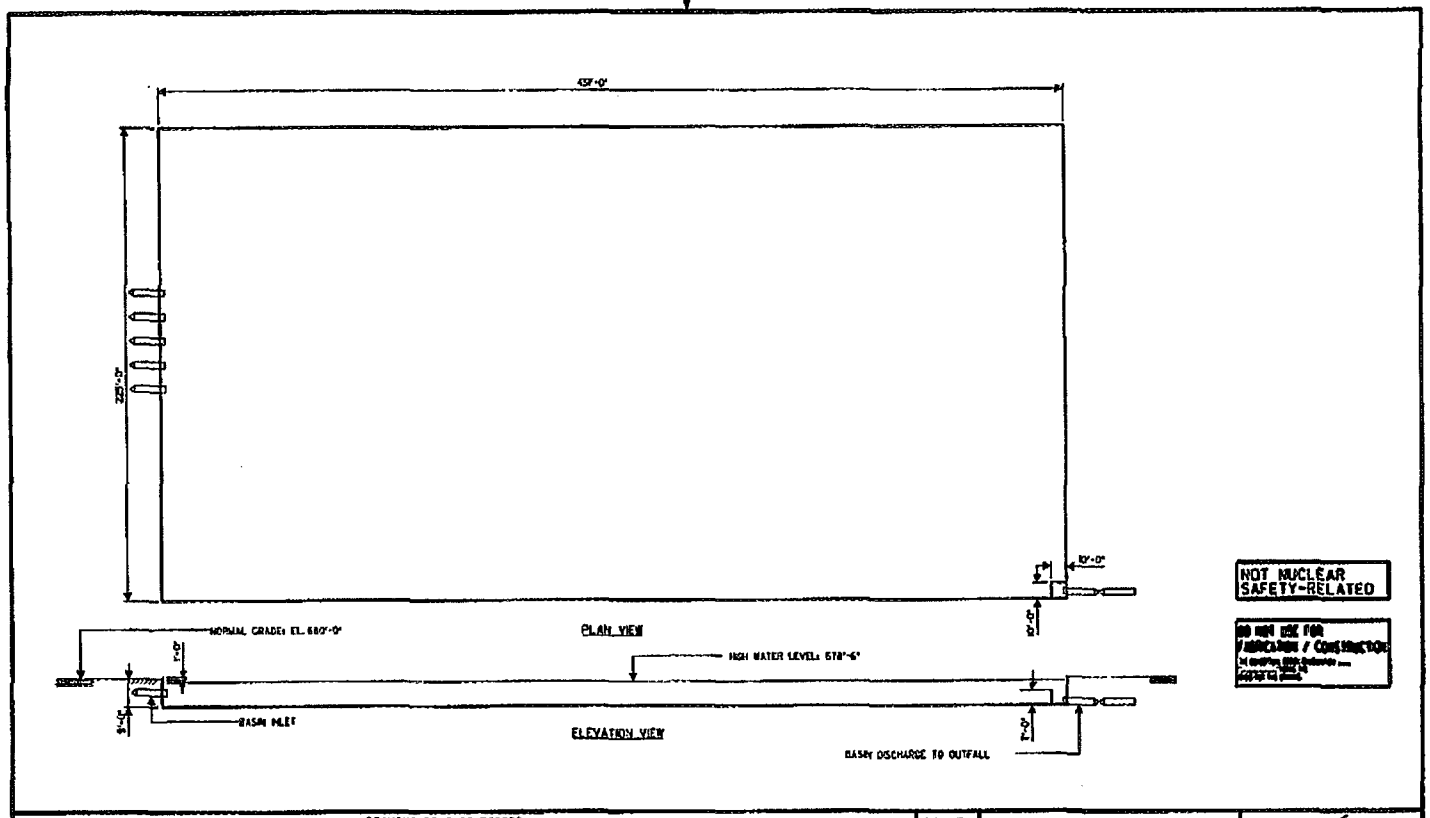
BELL BEND NUCLEAR POWER PLANT
UNISTAR NUCLEAR
PENNSYLVANIA



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1	05/07/08	P. CHAU	J. SALTARELLI		INCORPORATE COMMENTS	
1	06/04/08	P. CHAU	J. SALTARELLI		CDR ISSUE	
2	08/15/08	P. CHAU	J. SALTARELLI		CDR REV 2 ISSUE	
3	11/20/08	P. Chau	J. Saltarelli		ISSUED FOR RECORD. NO COMMENTS RECEIVED FROM DAR. REVISION LEVEL CHANGE ONLY	

SCALE: NONE
PROJECT NUMBER: 12198-004

CONCEPTUAL RETENTION BASIN GENERAL ARRANGMENT

BELL BEND NUCLEAR POWER PLANT
UNISTAR NUCLEAR
PENNSYLVANIA

Sargent & Lundy

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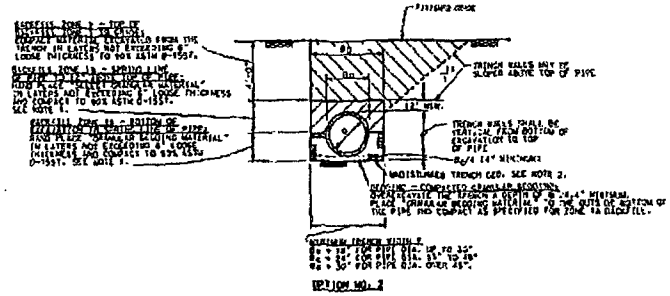

FOR PIPE INSTALLED IN COHESIVE, SILTY OR ROCKY FOUNDATION SOILS
MAY BE USED FOR GRANULAR FOUNDATION SOILS

NOTES PERTAINING TO PIPE AND CULVERT BEDDING AND BACKFILL DETAIL Y04060-01 AND 05

1. BEDDING AND BACKFILL MATERIAL SPECIFICATIONS

A. SELECT GRANULAR MATERIAL
"SELECT GRANULAR MATERIAL" SHALL CONSIST OF WELL GRADED SAND, STONE, CRUSHED STONE, PEA ROCK GRAVEL, OR CRUSHED GRAVEL WITH A MAXIMUM STONE OF 1.5". FREE FROM EXCESS OF SOFT AND UNSOUND PARTICLES AND OTHER OBJECTIONABLE MATTER.

ACCEPTABLE GRADATIONS ARE:
- ASTM C-33 - FINE CONCRETE AGGREGATE SHALL SATISFY SIEVE
- ASTM C-33 - GRADATION NO. 67 OR GRADATION NO. 7
- GRADATION SIMILAR TO WELL GRADED FINE AGRO BASE MATERIALS (i.e. ASTM D-1241, GRADATION C AND GRADATION D).

B. GRANULAR BEDDING MATERIAL
MATERIAL FOR "GRANULAR BEDDING MATERIAL" SHALL CONSIST OF WELL GRADED STONE, GRAVEL, CRUSHED STONE, PEA ROCK, GRAVEL OR SAND GRAVEL WITH A MAXIMUM STONE SIZE OF 1.5" FOR BEDDING FOR PLASTIC PIPE, OR 3/4" FOR BEDDING OTHER TYPES OF PIPE. FREE FROM EXCESS OF SOFT AND UNSOUND PARTICLES AND OTHER OBJECTIONABLE MATTER. THE FOLLOWING GRADATIONS ARE ACCEPTABLE:

US STANDARD SIEVE SIZE	PERCENT PASSING ASTM C-33 GRADATION NO.67	ASTM C-33 GRADATION 7
1"	100	
3/4"	90-100	100
1/2"		90-100
3/8"	20-55	40-70
NO. 4	0-10	0-15
NO. 8	0-5	0-5

2. SHAPE TRENCH BOTTOM
IF THE BOTTOM OF THE "TRENCH IS SOFT" OVER EXCAVATE UP TO 6"-12" AS SPECIFIED BY THE ENGINEER, AND REPLACE WITH "GRANULAR BEDDING MATERIAL" COMPACTED TO 92% ASTM D-1557.

NOT NUCLEAR SAFETY-RELATED

DO NOT USE FOR FABRICATION / CONSTRUCTION

THIS DRAWING SUPERSEDES DRAWING 12198-004-Y045-005.

FILENAME:

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0	06/04/08				CDR ISSUE

SCALE

PROJECT NUMBER 12198-004

CONCEPTUAL
SINGLE LINE PIPE
TRENCH DETAIL
BELL BEND NUCLEAR POWER PLANT
UNISTAR NUCLEAR
PENNSYLVANIA

DRAWING NO. 12198-004-TREN-001

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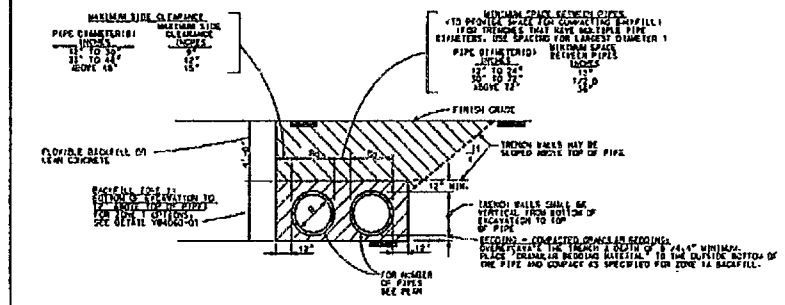

BEDDING AND BACKFILL REQUIREMENTS
MULTIPLE CONCRETE CULVERT PIPE INSTALLATION IN A TRENCH IN SOIL - CLASS "B" BEDDING

DETAIL Y04060-02

N.T.S.

NOTES PERTAINING TO PIPE AND CULVERT BEDDING AND BACKFILL DETAIL Y04060-01 AND 05

1. BEDDING AND BACKFILL MATERIAL SPECIFICATIONS

A. SELECT GRANULAR MATERIAL
"SELECT GRANULAR MATERIAL" SHALL CONSIST OF WELL GRADED SAND, FINELY CRUSHED STONE, PIT RUN GRAVEL, OR CRUSHED GRAVEL WITH A MAXIMUM STONE OF 1-1/2" - FREE FROM EXCESS OF SOFT AND UNSOUND PARTICLES AND OTHER OBJECTIONABLE MATTER.

ACCEPTABLE GRADATIONS ARE:
- ASTM C-33 - FINE CONCRETE AGGREGATE (WELL GRADED SAND)
- ASTM C-33 - GRADATION NO. 67 OR GRADATION NO. 7
- GRADATION SIMILAR TO WELL GRADED FINE ROAD BASE MATERIALS I.E. ASTM D-1241, GRADATION C AND GRADATION D.

B. GRANULAR BEDDING MATERIAL
MATERIAL FOR "GRANULAR BEDDING MATERIAL" SHALL CONSIST OF WELL GRADED STONE (LIMESTONE) CRUSHED STONE, PIT RUN GRAVEL OR CRUSHED GRAVEL WITH A MAXIMUM STONE SIZE OF 3/4" FOR BEDDING FOR PLASTIC PIPE, OR 1-1/2" FOR BEDDING OTHER TYPES OF PIPE. FREE FROM EXCESS OF SOFT AND UNSOUND PARTICLES AND OTHER OBJECTIONABLE MATTER. THE FOLLOWING GRADATIONS ARE ACCEPTABLE:

US STANDARD SIEVE SIZE	PERCENT PASSING ASTM C-33 GRADATION NO. 67	ASTM C-33 GRADATION 7
1"	100	-
3/4"	90-100	100
1/2"	-	90-100
3/8"	20-55	40-70
NO. 4	0-10	0-15
NO. 8	0-5	0-5

2. SOFT TRENCH BOTTOM
IF THE BOTTOM OF THE TRENCH IS SOFT, OVER EXCAVATE UP TO 2'-0". AS SPECIFIED BY THE CONSULTANT, AND REPLACE WITH "GRANULAR BEDDING MATERIAL" COMPACTED TO 90% ASTM D-1557.

NOT NUCLEAR SAFETY-RELATED

DO NOT USE FOR FABRICATION / CONSTRUCTION

THIS DRAWING SUPERSEDES DRAWING 12198-004-PSWS-003.

FILENAME:

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0	06/04/08				COR ISSUE

SCALE

PROJECT NUMBER 12198-004

CONCEPTUAL
MULTIPLE LINE PIPE
TRENCH DETAIL
BELL BEND NUCLEAR POWER PLANT
UNISTAR NUCLEAR
PENNSYLVANIA

DRAWING NO. 12198-004-TREN-002 REV. 0

SHEET 1 OF 1

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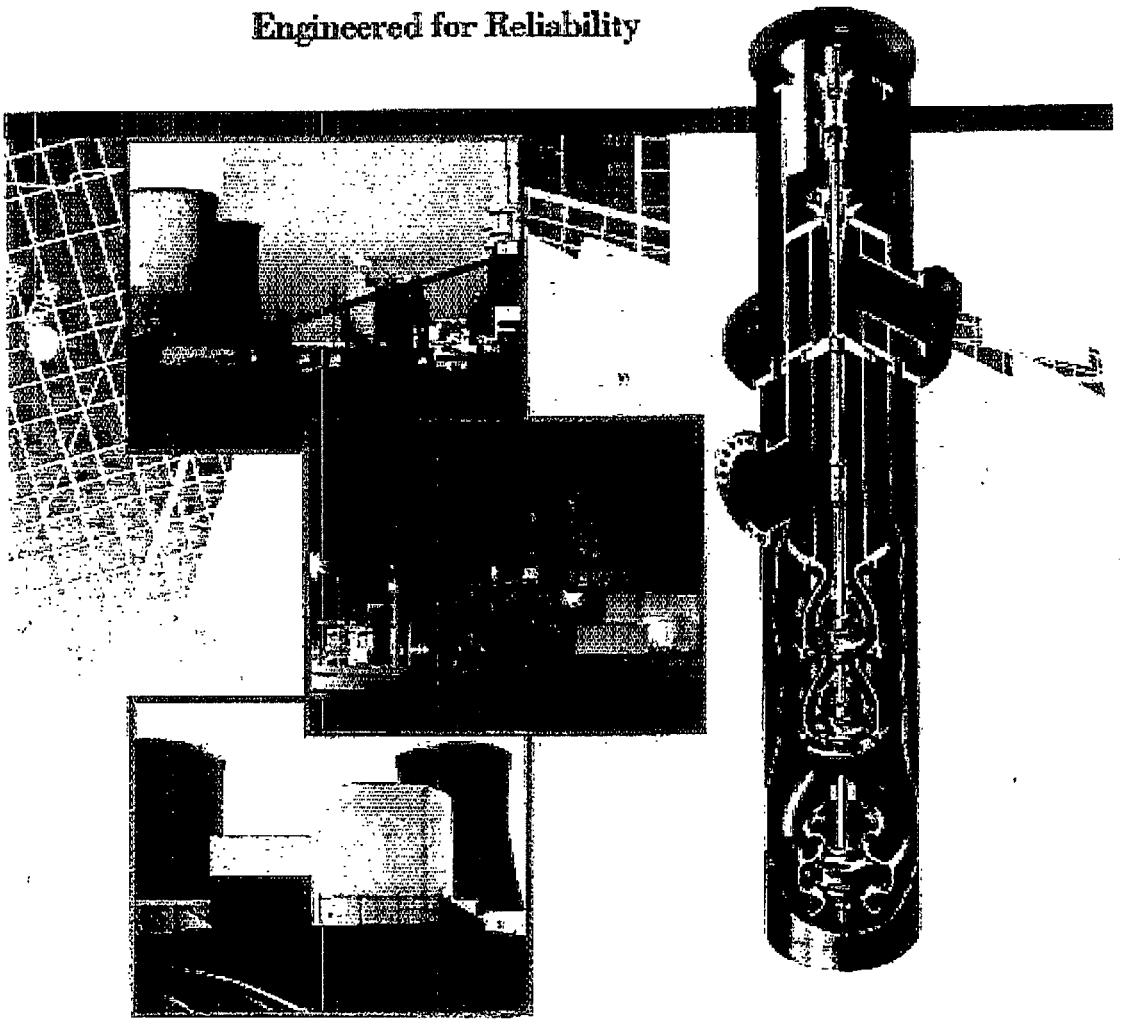
Ingersoll-Dresser Pumps

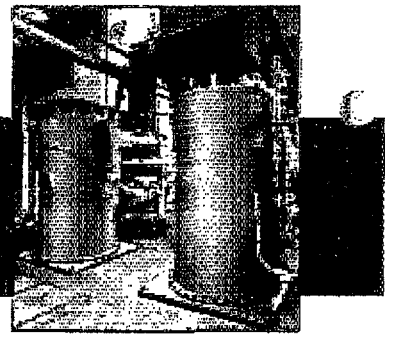
Type APKD, APKC, QLQC Vertical, Multistage Can Pump

Engineered for Reliability



Type APKD, APKC, QLQC —

Engineered for Reliability... Performance-proven in Demanding Applications

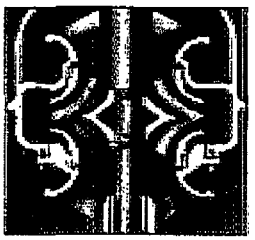


The APKD, APKC, QLQC line is a vertically mounted multistage pump. This line is specifically designed for operation on condenser condensate, heater drain service, or for applications where NPSHA is limited or the installation requirements are best suited to a vertical pump. Both single and double suction first stage designs are available, depending on the specific application.

Following are some of the features and benefits of this proven performer.

Double Suction Impeller

The APKD's and QLQC's first stage is a dual volute, double suction design. This design reduces the NPSH required by the first stage impeller. The double suction design minimizes the length of the pump, providing lower installation costs, and more importantly, an extremely rigid pump design that provides stable, reliable operation over a wide range of flows.



Impeller Attachment

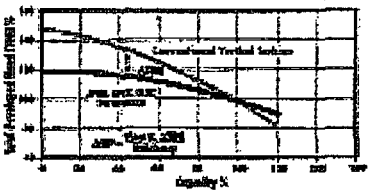
The intermediate stage impellers are positively locked to the shaft. This design eliminates any undesired movement and insures that torque will be smoothly transmitted from the shaft to the impeller even during thermal cycling and transient suction conditions.

Lineshaft Coupling Design

The shaft coupling is a solid sleeve type that features a keyed and clamped design. The torque is transmitted through full keyways and thrust is transmitted through split rings. To facilitate assembly and disassembly, no threaded parts are used in the critical coupling areas.

Curve Shape/Hydraulic Performance

Excessive high head rise to shutoff can cause a waste of power at part load or off peak operating conditions, resulting in higher operating cost of the



equipment. The APKD, APKC, QLQC line of pumps can be offered with a head rise to shutoff as low as 120% of the rated head. This compares to 140 – 150% for most vertical turbine designs. The flatter the pump head-capacity curve, the lower the part load horsepower and operating cost of the pump.

Experience in a Wide Range of Demanding Applications

Ingersoll-Dresser Pumps' APKD, APKC, QLQC is a proven performer, providing reliable service for over 45 years in the most demanding applications-condensate, high/low pressure heater drain, containment spray, residual heat removal, geothermal hot water, brine injection, pipeline booster, and hydrocarbon transfer.

Intake Design

The function of the intake, whether it be an open channel or a tunnel having 100 per cent wetted perimeter, is to supply an evenly distributed flow of water to the suction bell. An uneven distribution of flow, characterized by strong local currents, favors formation of vortices and with certain low values of submergence, will introduce air into the pump with reduction of capacity, accompanied by noise. *Uneven distribution can also increase or decrease* the power consumption with a change in total developed head. There can be vortices which do *not appear on the surface, and these also may have* adverse effects.

Uneven velocity distribution leads to rotation of portions of the mass of water about a centerline called vortex motion. This centerline may also be moving. Uneven distribution of flow is caused by the geometry of the intake and the manner in which water is introduced into the intake from the primary source.

Calculated low *average* velocity is not always a proper basis for judging the excellence of an intake. High *local* velocities in currents and in swirls may be present in intakes which have very *low average velocity. Indeed, the uneven distri*bution which they represent occurs less in a higher velocity flow with sufficient turbulence to discourage the gradual build-up of a larger and larger vortex in any region. Numbers of small surface eddies may be present without causing any trouble.

The ideal approach is a straight channel coming directly to the pump. Turns and obstructions are detrimental since they may cause eddy currents and tend to initiate deep-cored vortices.

Water should not flow past one pump to reach the next if this can be avoided. If the pumps must be in line of flow, it may prove necessary to con*struct an open front cell around each pump or to* put turning vanes under the pump to deflect the water upward.

All possible streamlining should be used to reduce the trail of alternating vortices in the wake of the pump or of other obstructions in the stream flow.

Successful proportions of the amount of submergence per se (See Suction Limitations, page 67), will depend greatly on the approaches to the intake and the size of the pump. The pump manufacturer will generally render advice on specific problems while the intake design is still preliminary *if he is provided with the necessary intake layout* drawings reflecting the physical limitations of the site.

Complete analysis of intake structures is best accomplished by scale model tests (See Model Tests of Intakes page 90).

Subject to the qualifications of the foregoing statements, Figs. 64, 65 & 66 have been constructed for single and simple multiple pump arrangements to show suggestions for basic sump dimensions. They are for pumps normally operating in the capacity range of approximately 3,000 to 300,000 *gpm. Since these values are composite* averages from a great many pump types and cover the entire range of specific speeds, they must not be thought of as absolute values but rather as basic guides subject to some possible variations. For pumps normally operating at capacities below approximately 3,000 gpm, refer to Sump or Pit Designs (small pumps) page 9[illegible].

All of the dimensions in Figs. 64, 65 & 66 are based on the rated capacity of the pump at the design head. Any increase in capacity above these values should be momentary or very limited in time. If operation at an increased capacity is to be *undertaken for considerable periods of time, the* maximum capacity should be used for the design value in obtaining sump dimensions.

The Dimension C is an average, based on an analysis of many pumps. Its final value should be specified by the pump manufacturer.

Dimension B is a suggested maximum dimension which may be less depending on actual suction bell or bowl diameters in use by the pump manufacturer. The edge of the bell should be close to the back wall of the sump. When the position of the back wall is determined by the driving equipment or the discharge piping, Dimension B may become excessive and a "false" back wall should be installed.

Dimension S is a minimum for the sump width *for a single pump installation.* This dimension can be increased, but if it is to be made smaller, the manufacturer should be consulted or a sump model *test should be run to determine its adequacy.*

Dimension H is a minimum value based on the "normal low water level" at the pump suction bell, taking into consideration friction losses through the inlet screen and approach channel. This dimension can be considerably less momentarily or infrequently without excessive damage to the pump. It should be remembered, however, that this does not represent "submergence." Submergence is normally quoted as dimension "H" minus "C." This represents the physical height of water level above the bottom of the suction inlet. The actual submergence of the pump is something less than this, since the impeller eye is some distance above the bottom of the suction bell, possibly as much as 3 to 4 feet. For the purposes of *sump design in connection with this chart, it is* understood that the pump has been selected in accordance with specific speed charts, Figs. 54,

centrifugal pumps applications

55, 56 and 57, the submergence referred to herein having to do only with vortexing and eddy formations.

Dimensions Y and A are recommended minimum values. These dimensions can be as large as desired but should be limited to the restrictions indicated on the curve. If the design does not include a screen, Dimension A should be considerably longer. The screen or gate widths should not be substantially less than S, and heights should not be less than H. If the main stream velocity is more than 2 feet per second, it may be necessary to construct straightening vanes in the approach channel, increase Dimension A, conduct a sump model test of the installation, or work out some combination of these factors.

Dimension S becomes the width of an individual pump cell or the center-to-center distance of two pumps if no division walls are used.

On multiple pump installations, the recommended dimensions in Figs. 64, 65 and 66 also apply as noted above, and the following additional determinants should be considered:

Fig. 67a. Low velocity and straight-line flow to all units simultaneously is the first recommended style of pit. Velocities in pump area should be approximately one foot per second. Some sumps with velocities of 2 feet per second and higher have given good results. This is particularly true where the design resulted from a model study. Not recommended would be an abrupt change in size of inlet pipe to sump or inlet from one side introducing eddying.

Fig. 67b. A number of pumps in the same sump will operate best without separating walls unless all pumps are always in operation at the same time, in which case the use of separating walls may be beneficial. If walls must be used for structural purposes, and pumps will operate intermittently, leave flow space behind each wall from the pit floor up to at least the minimum water level and the wall should not extend upstream beyond the rim of the suction bell. If walls are used, increase dimension "S" by the thickness of the wall for correct centerline spacing. Round or "ogive" ends of walls. NOT recommended is the placement of a number of pumps around the edge of a sump with or without dividing walls.

Fig. 67c. Abrupt changes in size from inlet pipe or channel to pump bay are not desirable. A relatively small pipe emptying into a large pump pit should connect to the pit with a gradually increasing taper section. The angle should be as large as possible, preferably not less than 45 degrees. With this arrangement, pit velocities much less than one foot per second are desirable. Especially not recommended is a small pipe directly connected to a large pit with pumps close to the inlet. Flow will have excessive change of direction to get the most of the pumps. Centering pumps in the pit leaves large "vortex areas" behind the pumps which will cause operational trouble.

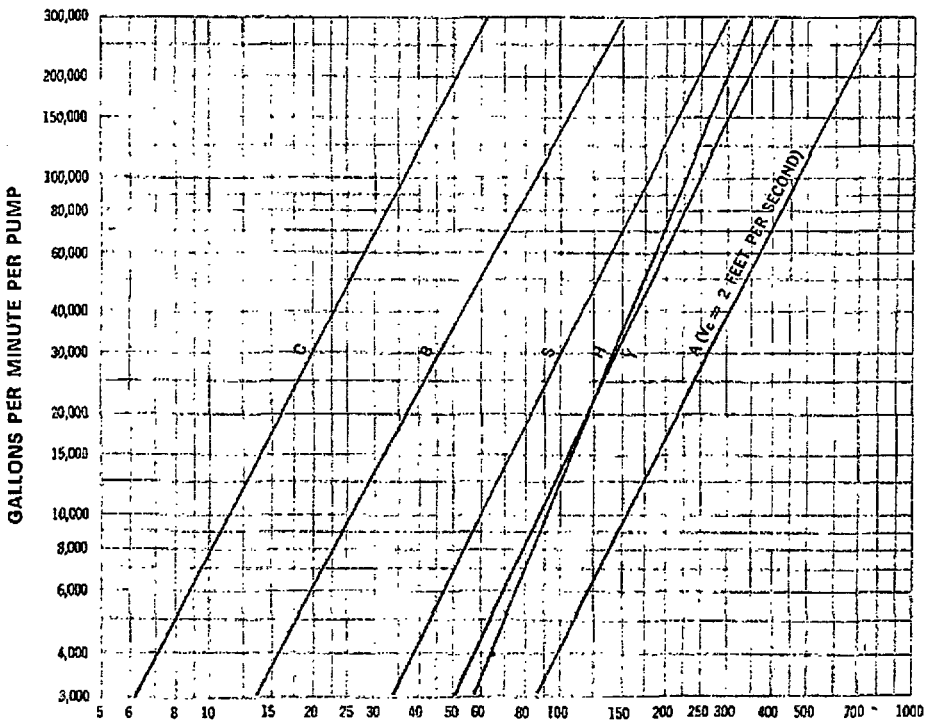
Fig. 67d. If the pit velocity can be kept low enough (below one foot per second), an abrupt change from inlet pipe to pit can be accommodated if the length equals or exceeds the values shown. It is assumed that as ratio W/P increases, the inlet velocity at "P" will increase up to an allowed maximum of eight feet per second at W/P=10. Pumps "in line" are not recommended unless the ratio of pit to pump size is quite large, and pumps are separated by a generous margin longitudinally. A pit can generally be constructed at much less cost by using a recommended design.

Fig. 67e. It is sometimes desirable to install pumps in tunnels or pipe lines. A drop pipe or false well to house the pump with vaned inlet ell facing upstream will be satisfactory in flows up to eight feet per second. Without the inlet ell, the pump section bell should be positioned at least two pipe (vertical) diameters above the top of the tunnel, not hung into the tunnel flow, especially with tunnel velocities two feet per second or more. There should be no signs of air along the top of tunnel. It may be necessary to lower the scoop or insist on minimum water level in vertical well.

Note: The foregoing statements apply to sumps for clear liquid. For fluid-solids mixtures refer to the pump manufacturer.

centrifugal pumps applications

SUMP DIMENSIONS VERSUS FLOW



RECOMMENDED SUMP DIMENSIONS IN INCHES

See explanatory notes in Text, Pages 85 and 86. Figures apply to sumps for clear liquid. For fluid-solids mixtures refer to the pump manufacturer.

Fig. 64

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SUMP DIMENSIONS VERSUS FLOW

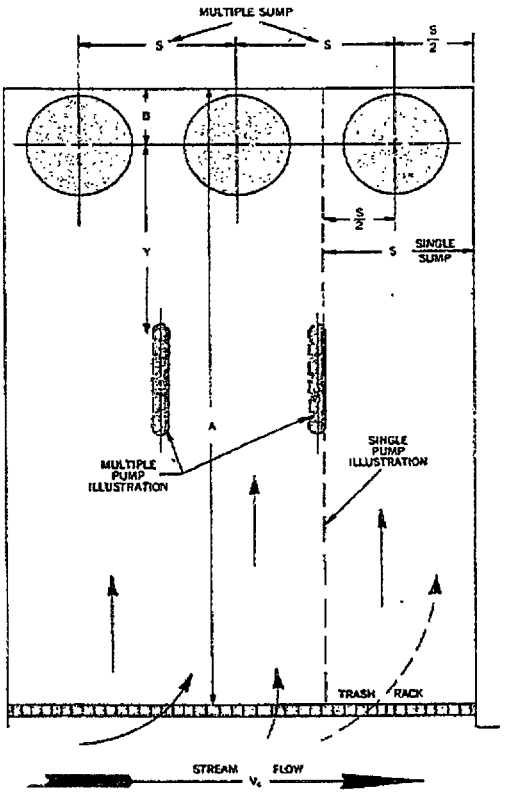

Fig. 65

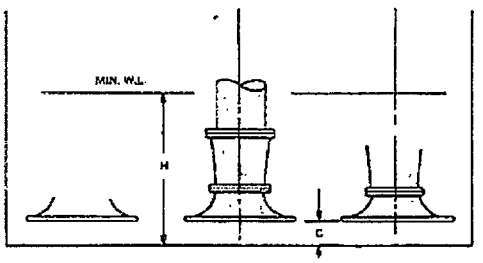

Fig. 66

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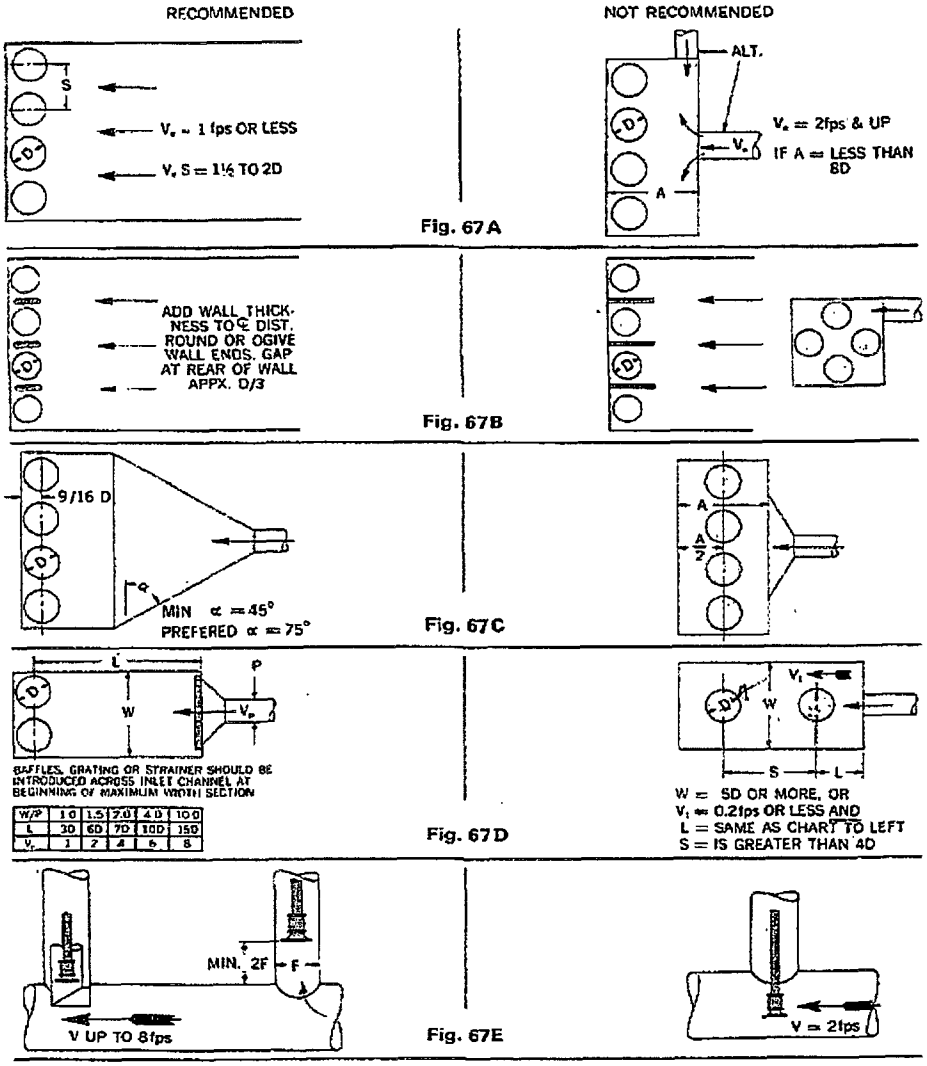
MULTIPLE PUMP PITS



W/P	1.0	1.5	2.0	4.0	10.0
L	30	60	70	100	150
V_p	1	2	4	6	8

The Dimension "D" is generally the diameter of the suction bell measured at the inlet. This dimension may vary depending upon pump design. Refer to the pump manufacturer for specific dimensions.

NOTE: Figures apply to sumps for clear liquid. For fluid-solids mixtures refer to the pump manufacturer.

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VTP Vertical Turbine, Wet Pit Pump

Flowserve's VTP vertical turbine pump is a diffuser type, single or multiple stage design for continuous service in wet pit and deep well applications. With more than 300 bowl and impeller designs, the VTP provides unsurpassed hydraulic coverage to ensure the best pump selection for a wide variety of services.

Click to enlarge
1 image available

Brands: Byron Jackson, IDP, Western Land Roller, Worthington
Applications: Agriculture, Cooling Water, Circulation, Circulating Water, Cargo Loading and Unloading, Condenser Cooling, Deep Well, Essential Service Water, Flood Protection, General Purpose, Water Cooling, Water Supply, Water Treatment, Irrigation, Marine, Mining, Municipal, Pulp and Paper, Power Generation, Screen Wash, Sewage, Sump Service, Snowmaking, Storm Water, Utility, Wet Pit
Industries: Boiling Water Reactors Non-safety, Boiling Water Reactors Safety, Construction, Cooling Systems, Cooling Water - Metals, Desalination, Dewatering & Water Supply, Flood Control, Ground Water Development and Irrigation, Miscellaneous Services, OEM, Products Pipeline, Pressurized Water Reactors - Non-safety, Pressurized Water Reactors - Safety, Snowmaking, Utilities, Water Handling and Treatment, Water Supply and Distribution, Water Treatment
Standards:
Misc:

Enclosed and Semi-Open Impellers are designed for maximum coverage of all applications.

Suction Bell is designed to provide efficient liquid flow into the eye of the first stage impeller.

Bowl Bearings, with high length to diameter ratio, on either side of the impeller provide rigid support for the bowl shaft.

Optional Bowl and Enclosed Impeller Wear Rings provide means to renew

clearances and pump efficiency.

Open Lineshaft Construction, or Enclosed Oil Lubrication for better lubrication of lineshaft bearings in abrasive services.

Features:

Engineeered models to 160 000 m3/h (750 000 gpm)
Lineshaft bearing lubrication options

- Product lubrication
- Oil lubrication (alternative lubricants available)

Drive options

- Dry or submersible electric motors
- Variable speed drive
- Engines with right angle gears
- Steam turbines

Choice of bearing materials

- Metal
- Rubber
- Carbon
- Composite

Other configurations

- VTP double casing with optional API 610 design
- VTP-WUC double casing to API 610, ASME Code Section VIII and IX, German Pressure Vessel Association (AD) and other international standards

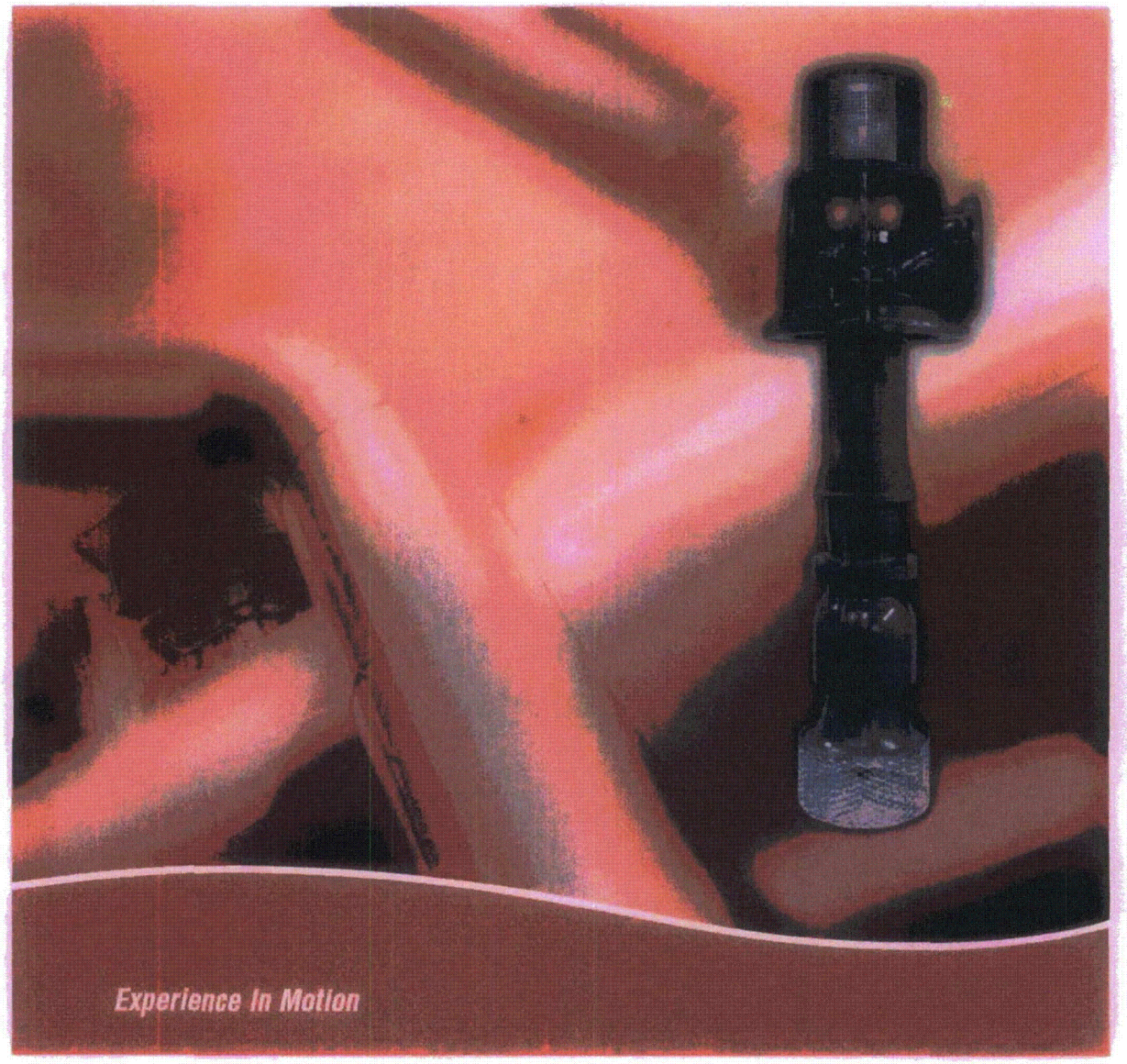
Operating parameters

- Pressures to 150 bar (2175 psi)
- Temperatures from -200°C (-325°F) to 300°C (570°F)
- Sizes to 1375 mm (55 in)
- Settings to 365 m (1200 ft)

VTP Vertical Turbine, Wet Pit Pump Chart

FLOWSERVE

VTP
Vertical Turbine, Wet-Pit Pump



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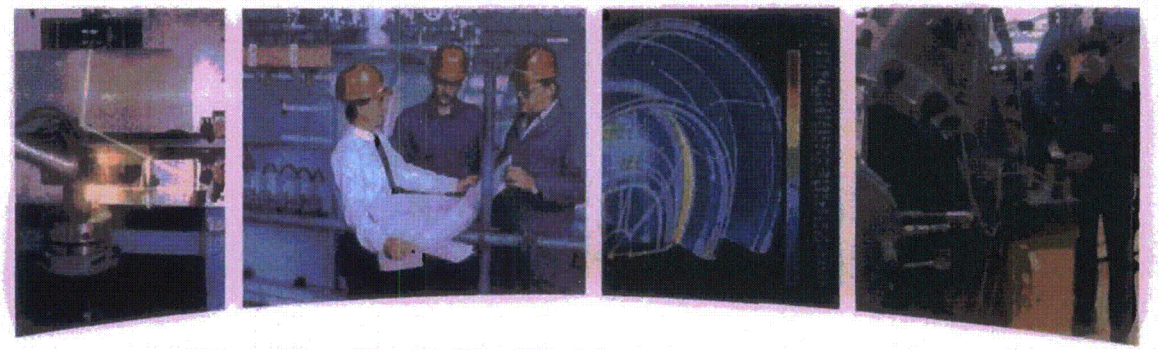

Pump Supplier To The World

Flowserve is the driving force in the global industrial pump marketplace. No other pump company in the world has the depth or breadth of expertise in the successful application of pre-engineered, engineered and special purpose pumps and systems.

Life Cycle Cost Solutions

Flowserve is providing pumping solutions which permit customers to reduce total life cycle costs and improve productivity, profitability and pumping system reliability.

Market Focused Customer Support

Product and industry specialists develop effective proposals and solutions directed toward market and customer preferences. They offer technical advice and assistance throughout each stage of the product life cycle, beginning with the inquiry.

Broad Product Lines

Flowserve offers a wide range of complementary pump types, from pre-engineered process pumps, to highly engineered and special purpose pumps and systems. Pumps are built to recognized global standards and customer specifications.

Pump designs include:
- Single stage process
- Between bearing single stage
- Between bearing multistage
- Vertical
- Submersible motor
- Rotary
- Reciprocating
- Nuclear
- Specialty

Product Brands of Distinction

ACEC™ Centrifugal Pumps

Aldrich® Pumps

Byron Jackson® Pumps

Cameron® Pumps

Durco® Pumps

Flowserve® Pumps

IDP® Pumps

Jeumont-Schneider™ Pumps

Pacific® Pumps

Pleuger® Pumps

Scienco® Pumps

Sier-Bath® Rotary Pumps

TKL™ Pumps

United® Centrifugal Pumps

Western Land Roller® Irrigation Pumps

Wilson-Snyder® Pumps

Worthington® Pumps

Worthington Simpson® Pumps

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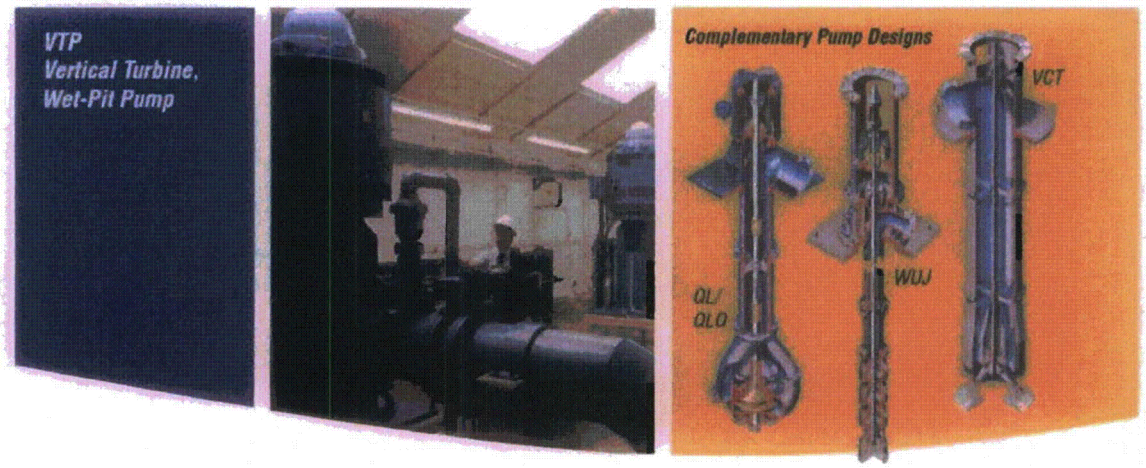


Unequaled Hydraulic Coverage and Design Flexibility

The Flowserve VTP is a single casing, diffuser type vertical turbine pump. Flowserve VTP pumps are installed in wet-pit or deep well applications where NPSH available is ample. Flowserve manufactures one of the world's most comprehensive lines of mixed flow vertical turbine pumps to ensure the best pump selection for a wide variety of services.

Engineered Flexibility

VTP pumps are available in a wide variety of configurations, constructions and materials to suit application requirements. Among the options are:

- Open or enclosed lineshaft construction
- Enclosed or semi-open impellers, keyed or collet mounted
- Bowl and enclosed impeller wear rings
- Cast iron or fabricated steel discharge heads
- Sealing configurations for open lineshaft construction
  - Packed box with flexible graphite packing
  - Single or dual mechanical seal
- Sealing configurations for enclosed lineshaft construction
  - Enclosing tube tension assembly for oil lubrication
  - Water injection packing assembly
- Above ground or below ground discharge flanges
- Multiple drivers
  - Electric motors, solid or hollow shaft
  - Engines with right angle gear drives
  - Steam turbines
- Separate axial thrust bearing assembly
- Standard and ISO 13709/API 610 (VS1), latest edition configurations

Applications

- Municipal water
- Irrigation
- General industrial
- Snow making
- Power generation
- Oil and gas production
- Hydrocarbon processing
- Mining
- Storm water
- Sump service

Rebowl Services

Flowserve can revitalize the performance of aged VTPs and reduce total operating costs. Whether for competitor or Flowserve pumps, upgrades will reduce power consumption, downtime and maintenance costs while extending the pump life.

Complementary Pumps

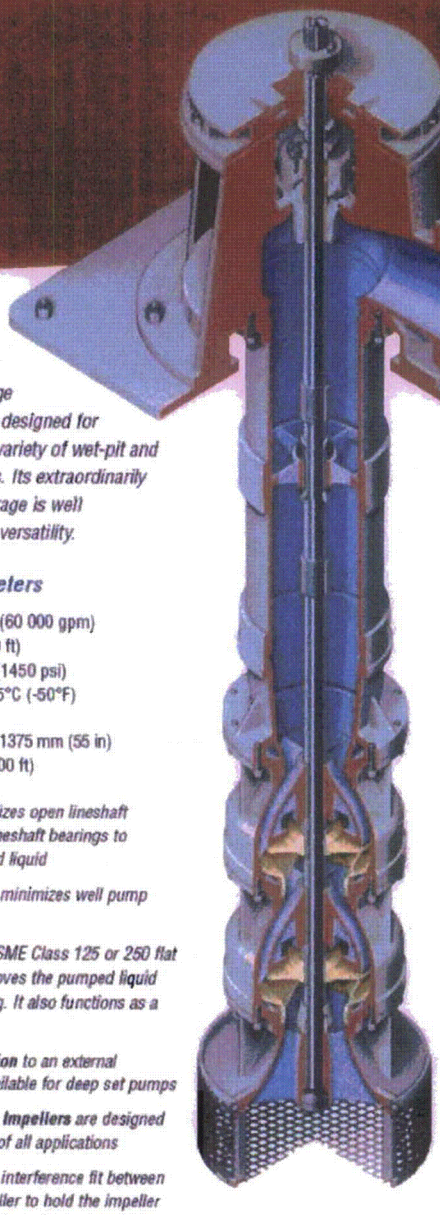
Flowserve also offers these complementary pumps:

- VCT vertical mixed flow pumps
- QL and QLQ single casing, double suction, twin volute pumps
- WUJ ISO 13709/API 610 (VS1) vertical, multistage single casing process pump
- AFV vertical axial flow pump
- VPC vertical turbine, double casing pump
- LNN between bearing, axially split, single stage, double suction pump

FLOWSERVE

VTP
Vertical Turbine, Wet-Pit Pump

Product Lubrication



The VTP is a single casing, diffuser type, single or multiple stage vertical turbine pump designed for continuous duty in a variety of wet-pit and deep well applications. Its extraordinarily broad hydraulic coverage is well complemented by its versatility.

Operating Parameters

- Flows to 13 600 m^3/h (60 000 gpm)
- Heads to 700 m (2300 ft)
- Pressures to 100 bar (1450 psi)
- Temperatures from -45°C (-50°F) to 200°C (400°F)
- Sizes 150 mm (6 in) to 1375 mm (55 in)
- Settings to 365 m (1200 ft)

Product Lubrication *utilizes open lineshaft construction allowing lineshaft bearings to be lubricated by pumped liquid*

Threaded Column Pipe *minimizes well pump casing diameter*

Discharge Head *with ASME Class 125 or 250 flat face flange smoothly moves the pumped liquid into the discharge piping. It also functions as a driver mounting base*

Prelubrication Connection *to an external lubrication source is available for deep set pumps*

Enclosed or Semi-open Impellers *are designed for maximum coverage of all applications*

Lock Collets *provide an interference fit between the bowl shaft and impeller to hold the impeller securely in place. Keyed impellers are standard for 500 mm (20 in) and larger models and optional on other sizes*

Vertical Hollow Shaft Motor *allows the pump headshaft to extend through the motor and provides impeller clearance adjustment with an adjusting nut located at the top of the motor. A two-piece headshaft with a motor stand is available for low overhead sites*

High-Pressure Stuffing Box *for working pressures up to 20 bar (300 psi). Low and extra high pressure stuffing boxes are also available*

Bearing Brackets with Rubber Lineshaft Bearings *fit between the column sections to maintain alignment and are spaced to provide adequate shaft support. Alternative bearing materials available. Bearing brackets are integral to column pipes 40 mm (16 in) and larger*

Discharge Case *with hydraulic adapter ensures efficient transfer of flow to various column sizes*

Bowl and Bell Bearings *with high length-to-diameter ratio on either side of the impeller provide rigid support for the bowl shaft*

Suction Bell *provides efficient flow of liquid into the eye of the first stage impeller. A suction case is provided for well pump applications*

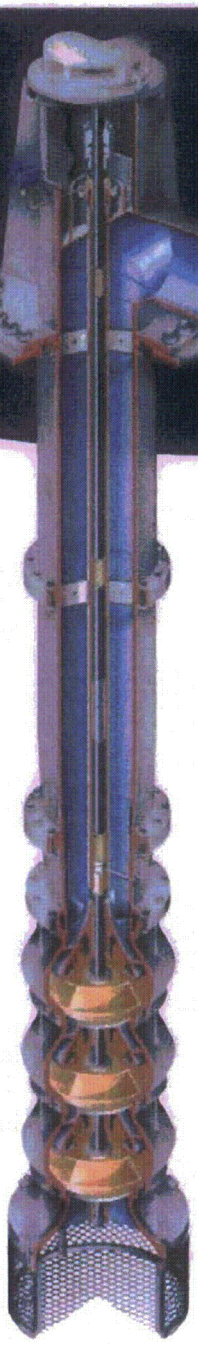
Sand Collar *prevents grit from entering the suction bell bearing*

Basket Strainer *exceeds Hydraulics Institute parameters. Cone strainers are provided for deep well installations*

flowserve.com

VTP
Vertical Turbine, Wet-Pit Pump

Enclosed Oil Lubrication



Enclosed Oil Lubrication *isolates the lineshaft and bearings from the pumped liquid minimizing maintenance in abrasive services. Alternative lubricants such as clean water or grease can also be used with enclosed lineshaft construction*

Heavy-Duty Discharge Head *with ASME Class 150, 300 or 600 raised face flanges provides a rigid and stable support for high horsepower drivers. The mitered elbow reduces the internal friction loss and turbulence. Cast iron discharge heads are available to 500 mm (20 in) discharge*

Alignment Screws *allow positioning of larger frame size motors on the discharge head for final alignment of the pump and motor shafts*

Rigid, Adjustable Flanged Coupling *provides accurate impeller clearance adjustment and shaft stability. A spacer coupling allows access to the mechanical seal without removing the motor*

Enclosed Impeller *provides close running clearance with the bowl to maintain efficiency over a broad operating range. Full range of semi-open impellers is available for particular applications*

Keyed Impellers *positively locked to the shaft eliminate shaft to impeller movement. Stainless steel slotted keys prevent radial movement while the stainless steel split-ring keys prevent axial movement. Collet mounting is standard for impellers up to 460 mm (18 in)*

Separate Steel Soleplate *allows grouting and leveling of the pump discharge head without permanently anchoring it. The pump can be removed without disturbing the foundation*

Flanged Column Pipe *contains the pressure being generated by the pump and has a rabbet fit between the flanges to maintain alignment*

Enclosing Tube *provides lineshaft protection from the pumped liquid. Lineshaft bearings are spaced at 1.5 m (5 ft) intervals to provide adequate lineshaft support*

Enclosing Tube Stabilizer *is integrally welded to the column pipe to maintain the rigidity and the alignment of the enclosing tube. Rubber stabilizers are used on column sizes to 355 mm (14 in); steel stabilizers for 400 mm (16 in) and larger*

Tension Bearing *holds the enclosing tube and lineshaft bearings in alignment. It also provides a chamber for the lubricant as it enters the enclosing tube*

Discharge Case With Bypass Port *allows positive flow of lineshaft bearing lubricant into the enclosing tube*

FLOWSERVE

Integral Axial Thrust Bearing Assembly

The axial thrust bearing assembly withstands the total hydraulic thrust as well as the rotor weight. Self-lubricating anti-friction bearings are utilized for standard applications. The integral axial thrust bearing assembly is available on VPC pumps with IEC motors.

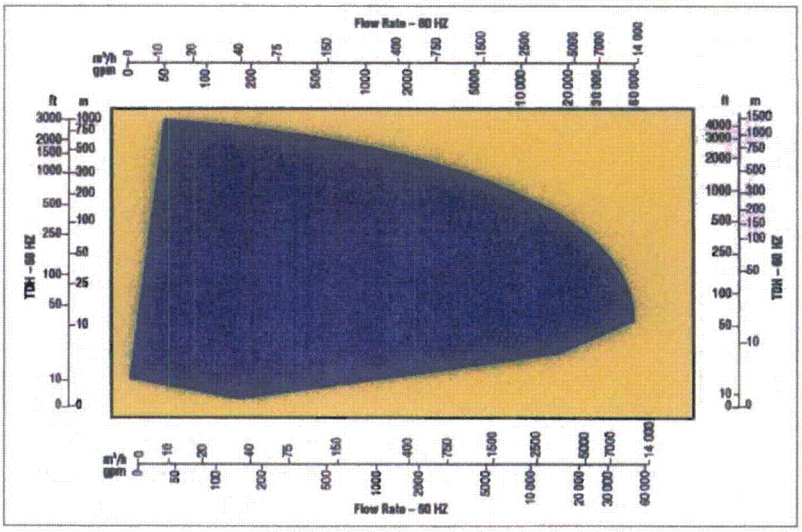
API 610 Compliant Features

- Weld neck flanges
- Precision, rigid adjustable flanged spacer coupling
- Seal chamber with jackscrews
- Studs and nuts
- O-ring construction
- One-piece pump shaft up to 6 m (20 ft)
- Dynamically balanced, keyed enclosed impellers
- Pinned wear rings
- API 610 forces and moments

Discharge Configurations

When using a fabricated discharge design, VTP pumps are available with above or below ground discharge flanges to suit site conditions.

VTP Range Chart



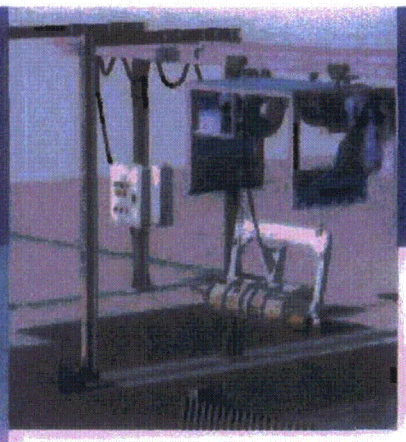
6

Water Technologies

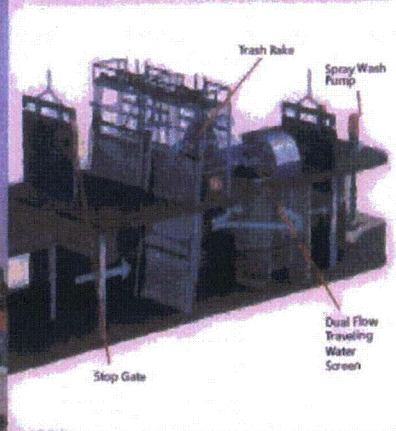
Rex® and Link-Belt® Intake Systems: proven, efficient and reliable

SIEMENS

Unrivaled experience in providing dependable, efficient screening



Trash rake removes heavy debris.



We have decades of experience solving high volume water intake problems under varying site conditions.

Rex® and Link-Belt® intake systems lead the industry

With thousands of our traveling water screens supplied to power generators, municipalities and other industries over the past century, we are the recognized leader in the water intake industry. Our intake screening systems provide clean, debris-free raw water while minimizing ecological impacts, reducing maintenance problems, and extending service life.

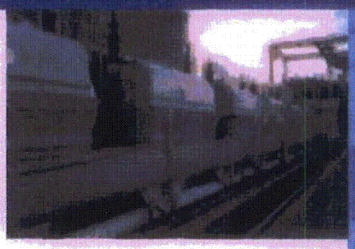
A complete system from stop gates through controls

Stop logs/gates prevent water from entering the channel during down-stream maintenance. Bar racks capture rough and larger debris to prevent it from reaching the finer mesh of the traveling water screen. These racks are cleaned by trash rakes, either stationary or traversing.

Choose from several types of traveling water screens to capture fine debris. In addition, we offer a dependable, user-friendly control system for complete and closely-calibrated control of the entire screening system.

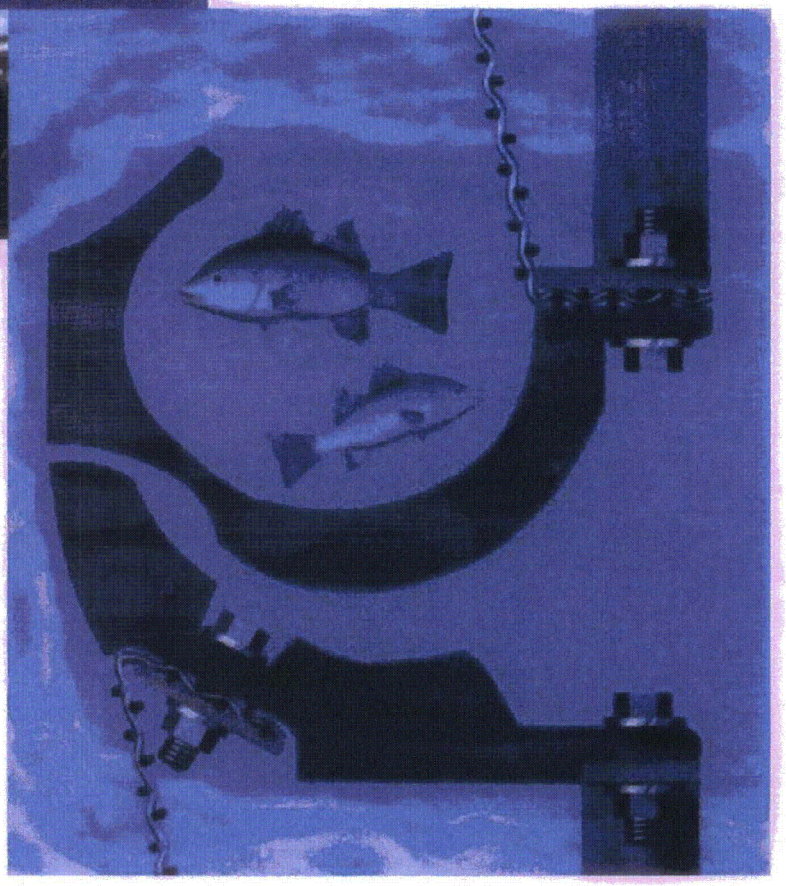
We also provide all the ancillary equipment, from pumps to auxiliary strainers, trash baskets and stationary screens. And - before we leave your site - we can arrange for training for your operating personnel.

The leader in solutions for fish-friendly screening



A Rex® fish screen installation designed with the benefit of our full-scale fish laboratory.

New technologies for fish protection such as our unique integral fish buckets are a proven way to minimize the adverse impact on marine life.



Our Modified Ristroph system meets environmental standards

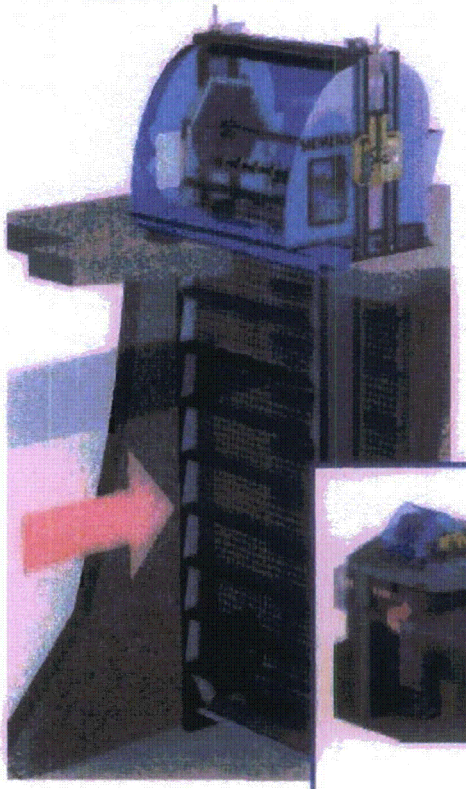
Cooling water intake systems are the highly visible object of Section 316(b) of the Clean Water Act. These standards mandate very specific requirements for all areas of intake structure operation.

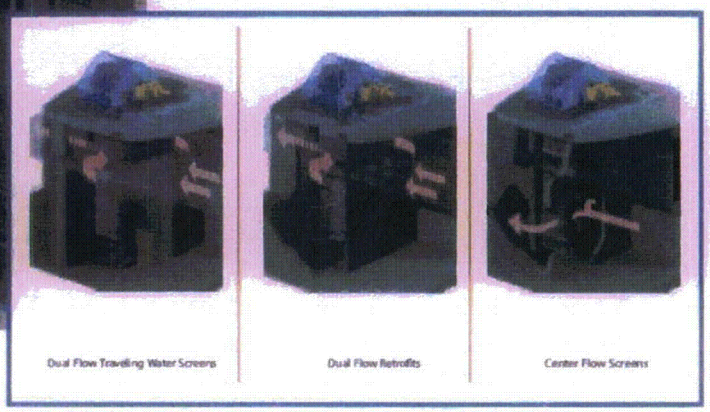
We've been designing, testing and improving fish protection systems since the late 1960's; long before the current regulations were conceived.

As a result, our Modified Ristroph fish handling intake screen systems are all able to meet the new rules.

Whether you need to plan a new intake system or a retrofit, you'll benefit from our experience and our support.

A variety of screen designs for any site condition





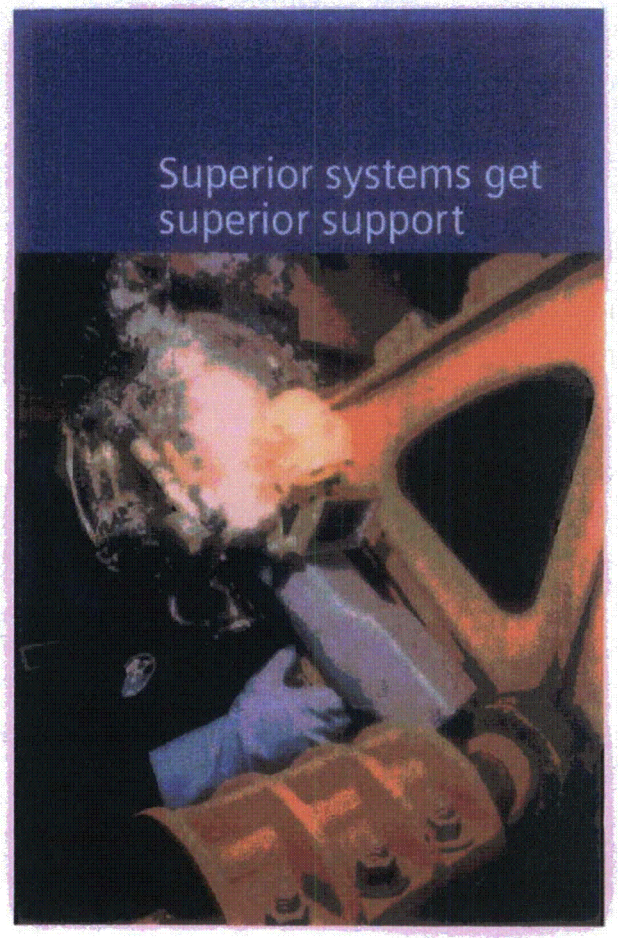
No matter what the site condition or specification, we have the right water screen to meet your needs.

Through Flow Traveling Water Screens
have submerged screen surfaces perpendicular to the intake flow. They collect and carry debris upward where it is flushed into a debris trough. Screen widths range from 2 to 14 feet (610 to 4267 mm) with vertical centers from 8 to 100+ feet (2440 mm to 30 m). Screen mesh openings are sized according to customer requirements and site conditions.

Dual Flow Traveling Water Screens
are essentially Through Flow systems turned 90 degrees, putting the screen surfaces parallel to the intake flow. This doubles the effective screening area and reduces possible downstream debris carryover. It also allows the use of finer screen meshes without increasing flow velocity.

Dual Flow Retrofits
allow an existing Through Flow screen well to be easily converted to Dual Flow operation. Curved flow diverter plates on both sides of the new Dual Flow screen engage the existing embedded guideways and create the "double entry/single exit" flow pattern.

Center Flow Screens
are similar to Dual Flow traveling screens, but direct the flow from inside to the outside of the screen. Side plates block the flow along the outer edges of the channel and direct it inward to the screen. Debris is lifted to the top and flushed away by water and gravity.



Our divers find and fix potential trouble spots.

Service – the details that make the difference

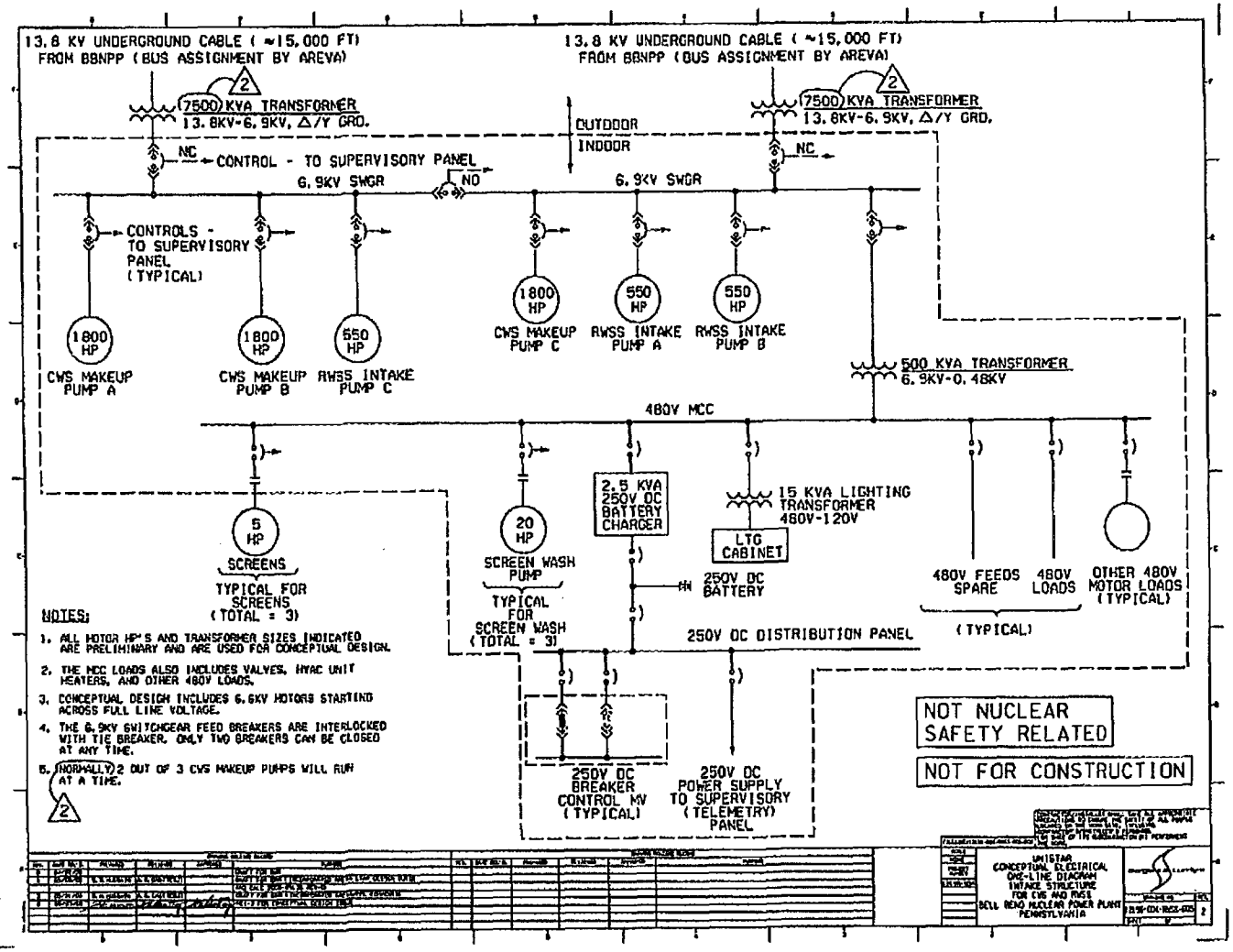
As good as our products are, they work in a tough environment and sooner or later, they need some attention. That's when our advantages become even more obvious. Our service team divers get to the bottom of the problem - literally. Once there, they replace or repair whatever's needed. While on site, our service teams can also inspect the entire installation to detect and prevent problems.

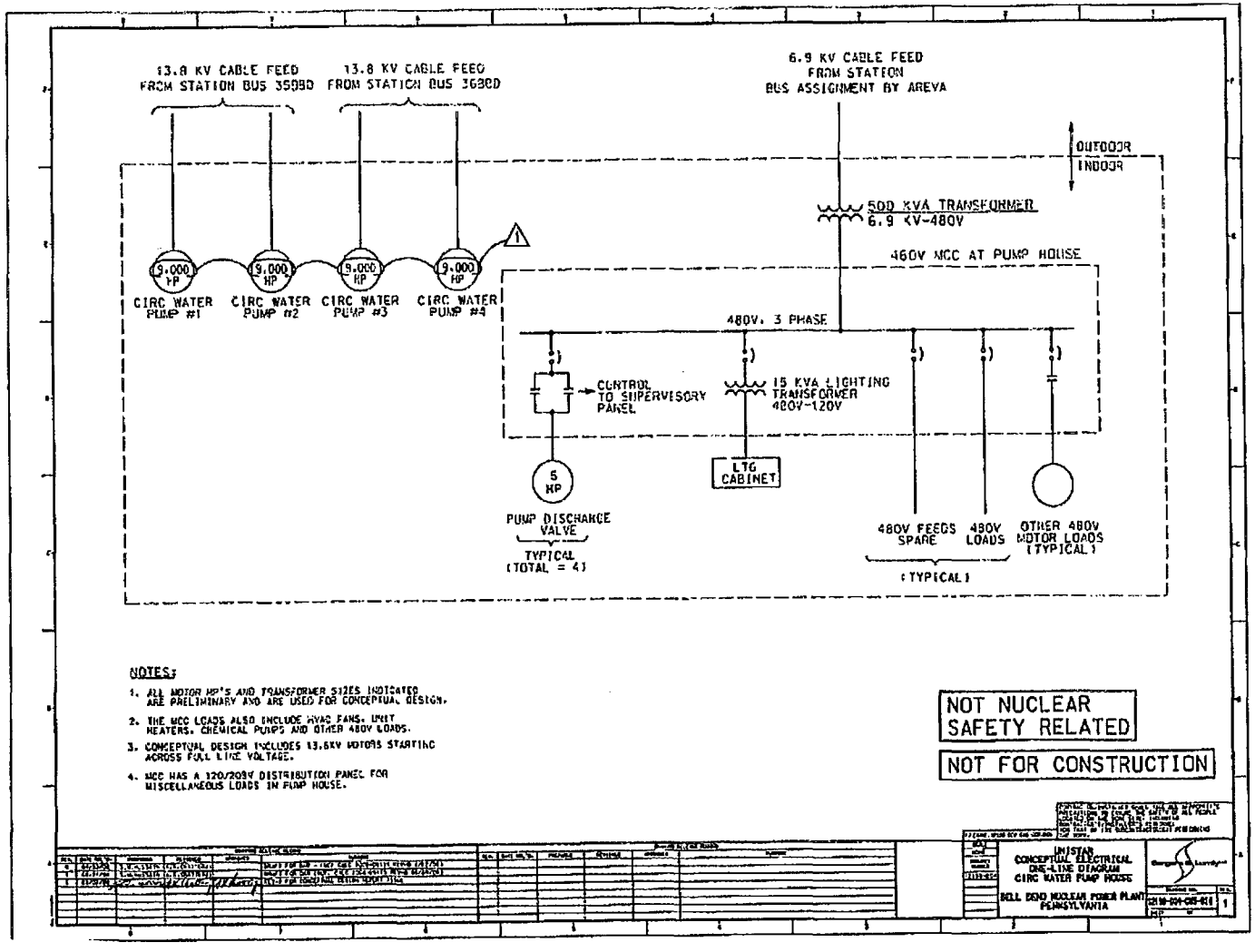
Our aftermarket service team is known for being prepared and responsive. We maintain extensive inventories of parts for our Rex®, Link-Belt® and Royce™ screen brands. These parts – baskets, framework, drive systems, etc. – are the same components that went into your original system and their perfect fit and function will return your system to original condition. Through years of continuing research and development, has also developed and made available other upgrades and improvements to our screening technologies.

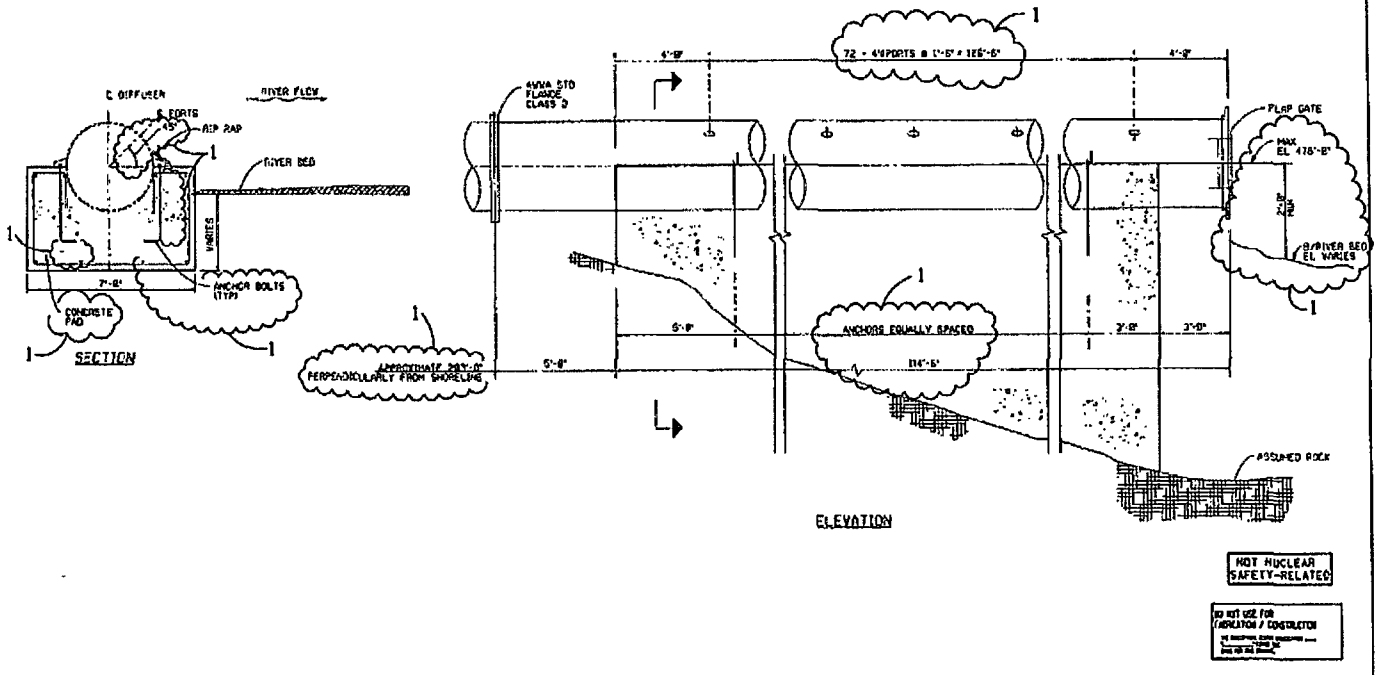
But we're more than rapid-response repair experts. We're also preventative maintenance specialists. We can develop a program tailored to your needs, conduct scheduled maintenance and provide you with the details of every inspection, repair and recommendation.

Field Services

- Diving and topside inspections
- Screen repairs and adjustments, wet or dry
- Screen installing or extracting
- Intake well cleaning
- Bar rack repair
- Implementing annual maintenance contracts


13.8 KV UNDERGROUND CABLE (~15,000 FT)
FROM BBNPP (BUS ASSIGNMENT BY AREVA)
(7500) KVA TRANSFORMER
13.8KV-6.9KV, Δ/Y GRD.
OUTDOOR
INDOOR
NC
CONTROL - TO SUPERVISORY PANEL
NO
6.9KV SWGR
CONTROLS - TO SUPERVISORY PANEL (TYPICAL)
1800 HP
CWS MAKEUP PUMP A
1800 HP
CWS MAKEUP PUMP B
550 HP
RWSS INTAKE PUMP C
1800 HP
CWS MAKEUP PUMP C
550 HP
RWSS INTAKE PUMP A
550 HP
RWSS INTAKE PUMP B
500 KVA TRANSFORMER
6.9KV-0.48KV
480V MCC
5 HP
SCREENS
TYPICAL FOR SCREENS (TOTAL = 3)
20 HP
SCREEN WASH PUMP
TYPICAL FOR SCREEN WASH (TOTAL = 3)
2.5 KVA 250V DC BATTERY CHARGER
15 KVA LIGHTING TRANSFORMER 480V-120V
LTG CABINET
250V DC BATTERY
480V FEEDS SPARE
480V LOADS
(TYPICAL)
OTHER 480V MOTOR LOADS (TYPICAL)
250V DC DISTRIBUTION PANEL
250V DC BREAKER CONTROL MV (TYPICAL)
250V DC POWER SUPPLY TO SUPERVISORY (TELEMETRY) PANEL
NOTES:
1. ALL MOTOR HP'S AND TRANSFORMER SIZES INDICATED ARE PRELIMINARY AND ARE USED FOR CONCEPTUAL DESIGN.
2. THE MCC LOADS ALSO INCLUDES VALVES, HVAC UNIT HEATERS, AND OTHER 480V LOADS.
3. CONCEPTUAL DESIGN INCLUDES 6.6KV MOTORS STARTING ACROSS FULL LINE VOLTAGE.
4. THE 6.9KV SWITCHGEAR FEED BREAKERS ARE INTERLOCKED WITH TIE BREAKER. ONLY TWO BREAKERS CAN BE CLOSED AT ANY TIME.
5. NORMALLY 2 OUT OF 3 CWS MAKEUP PUMPS WILL RUN AT A TIME.
NOT NUCLEAR SAFETY RELATED
NOT FOR CONSTRUCTION
UNISTAR
CONCEPTUAL ELECTRICAL ONE-LINE DIAGRAM
INTAKE STRUCTURE
FOR CWS AND RWSS
BELL BEND NUCLEAR POWER PLANT
PENNSYLVANIA


13.8 KV CABLE FEED FROM STATION BUS 3598D
13.8 KV CABLE FEED FROM STATION BUS 3680D
6.9 KV CABLE FEED FROM STATION BUS ASSIGNMENT BY AREVA
OUTDOOR
INDOOR
500 KVA TRANSFORMER 6.9 KV-480V
460V MCC AT PUMP HOUSE
9,000 HP
CIRC WATER PUMP #1
CIRC WATER PUMP #2
CIRC WATER PUMP #3
CIRC WATER PUMP #4
480V, 3 PHASE
CONTROL TO SUPERVISORY PANEL
15 KVA LIGHTING TRANSFORMER 480V-120V
LTG CABINET
5 HP
PUMP DISCHARGE VALVE
TYPICAL (TOTAL = 4)
480V FEEDS SPARE
480V LOADS
OTHER 480V MOTOR LOADS (TYPICAL)
(TYPICAL)
NOTES:
1. ALL MOTOR HP'S AND TRANSFORMER SIZES INDICATED ARE PRELIMINARY AND ARE USED FOR CONCEPTUAL DESIGN.
2. THE MCC LOADS ALSO INCLUDE HVAC FANS, UNIT HEATERS, CHEMICAL PUMPS AND OTHER 480V LOADS.
3. CONCEPTUAL DESIGN INCLUDES 13.8KV MOTORS STARTING ACROSS FULL LINE VOLTAGE.
4. MCC HAS A 120/208V DISTRIBUTION PANEL FOR MISCELLANEOUS LOADS IN PUMP HOUSE.
NOT NUCLEAR SAFETY RELATED
NOT FOR CONSTRUCTION
UNISTAR
CONCEPTUAL ELECTRICAL ONE-LINE DIAGRAM
CIRC WATER PUMP HOUSE
BELL BEND NUCLEAR POWER PLANT
PENNSYLVANIA



NOT NUCLEAR SAFETY-RELATED

DO NOT USE FOR FABRICATION / CONSTRUCTION

DRAWING RELEASE RECORD						
REV.	DATE REL'D	PREPARED	REVIEWED	APPROVED	PURPOSE	FILE
0	04/18/08	P. CHAU	J. SALTARELLI		DRAFT FOR COMMENT	
0	06/04/08	P. CHAU	J. SALTARELLI	N. PRESSBURGER	COR ISSUE	
1	08/21/09				COR REV 2 ISSUE	

SCALE NONE
PROJECT NUMBER 12198-004

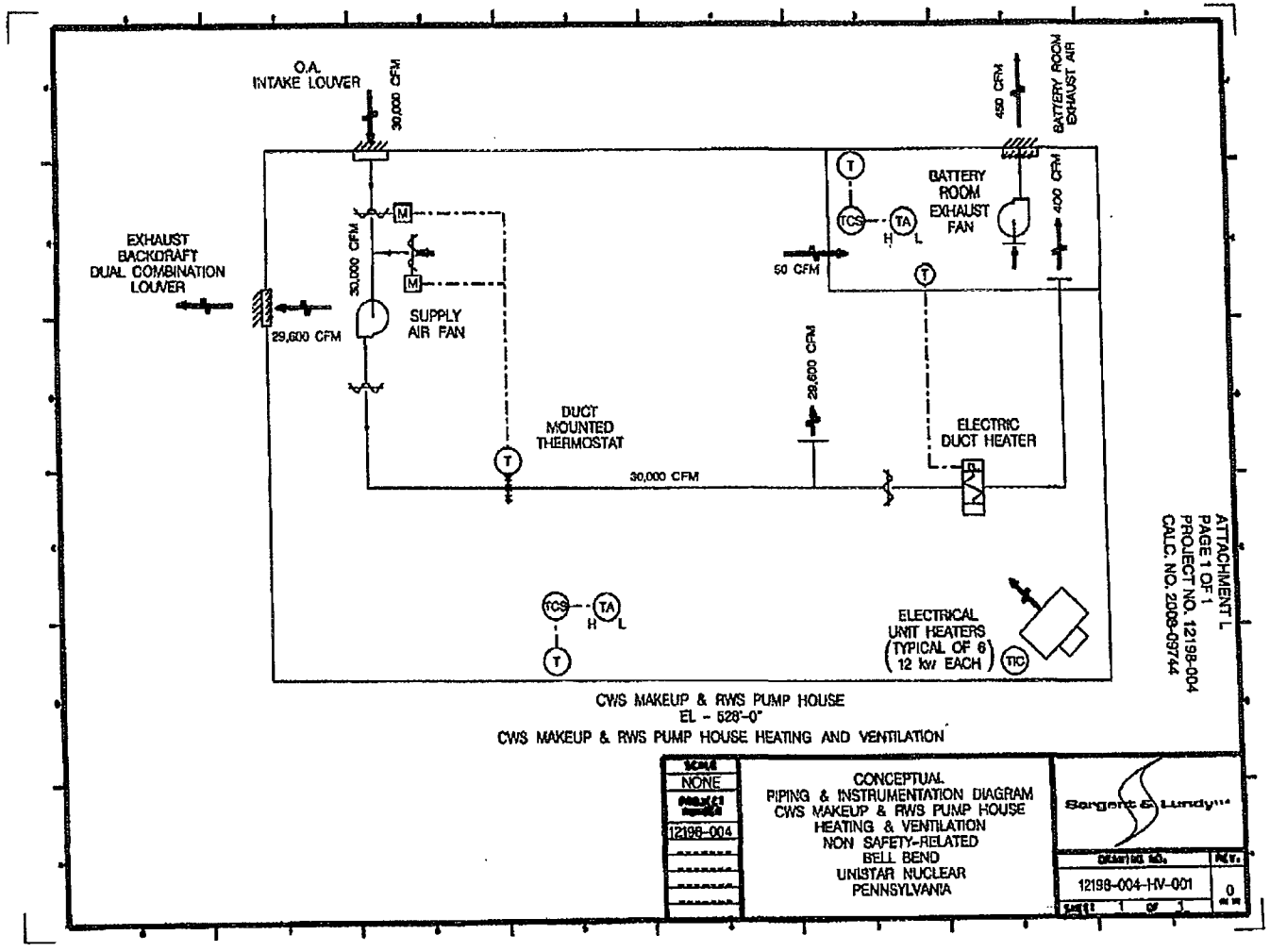
CONCEPTUAL DISCHARGE DETAIL

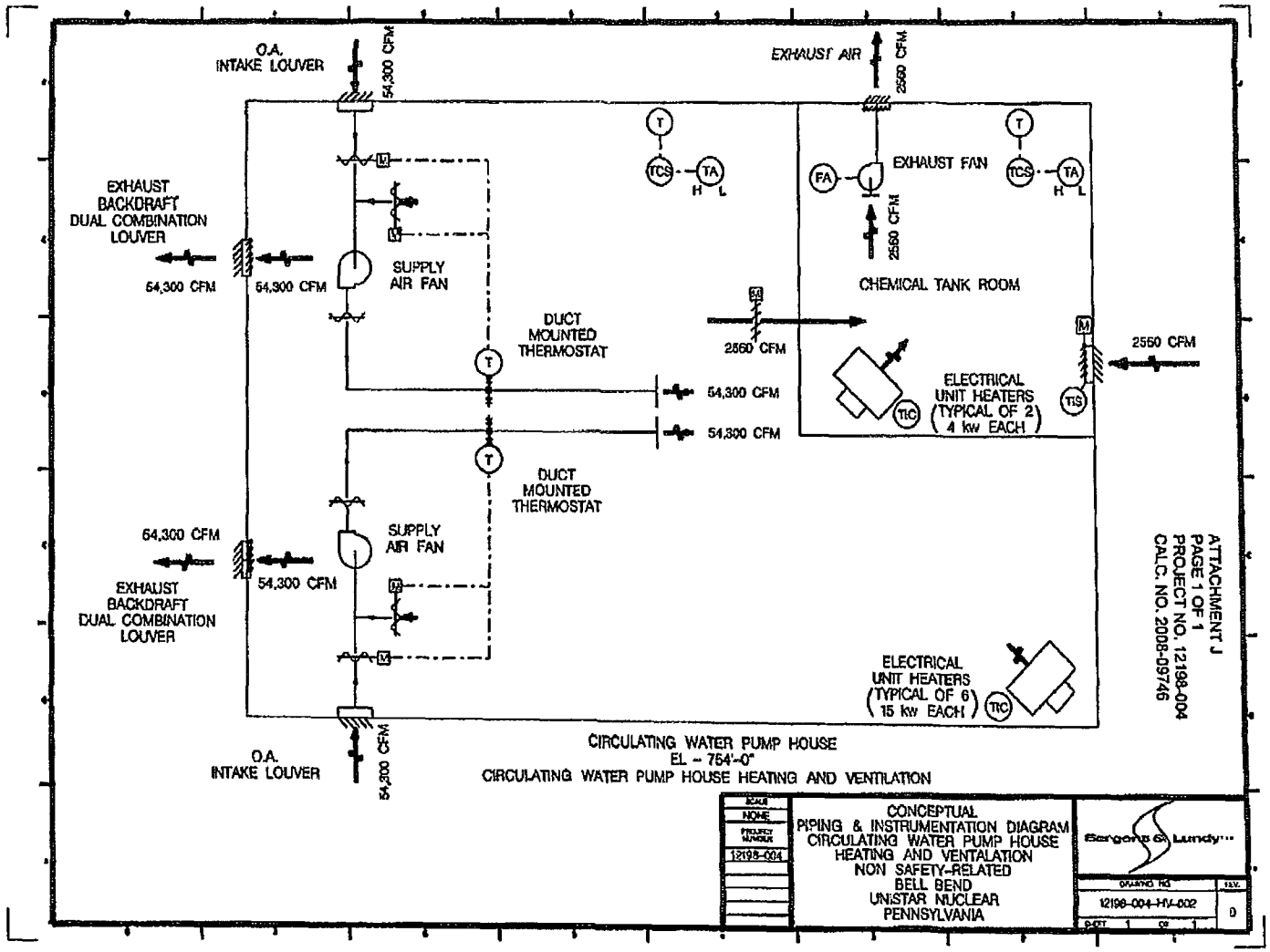
BELL BEND NUCLEAR POWER PLANT
UNISTAR NUCLEAR
PENNSYLVANIA

Sargent & Lundy LLC

DRAWING NO. 12198-004-CWS-015 REV. 1
SHEET 1 OF 1

FORM GDS 2.6.4


O.A.
INTAKE LOUVER
30,000 CFM
EXHAUST
BACKDRAFT
DUAL COMBINATION
LOUVER
29,600 CFM
30,000 CFM
SUPPLY
AIR FAN
M
M
DUCT
MOUNTED
THERMOSTAT
T
30,000 CFM
29,600 CFM
50 CFM
BATTERY
ROOM
EXHAUST
FAN
TCS
TA
H
L
T
T
450 CFM
BATTERY ROOM
EXHAUST AIR
400 CFM
ELECTRIC
DUCT HEATER
ELECTRICAL
UNIT HEATERS
(TYPICAL OF 6
12 kw EACH)
TIC
TCS
TA
H
L
T
ATTACHMENT L
PAGE 1 OF 1
PROJECT NO. 12198-004
CALC. NO. 2008-09744
CWS MAKEUP & RWS PUMP HOUSE
EL - 528'-0"
CWS MAKEUP & RWS PUMP HOUSE HEATING AND VENTILATION
SCALE
NONE
12198-004
CONCEPTUAL
PIPING & INSTRUMENTATION DIAGRAM
CWS MAKEUP & RWS PUMP HOUSE
HEATING & VENTILATION
NON SAFETY-RELATED
BELL BEND
UNISTAR NUCLEAR
PENNSYLVANIA
Sargent & Lundy
DRAWING NO.
REV.
12198-004-HV-001
0
SHEET 1 OF 1


O.A.
INTAKE LOUVER
54,300 CFM
EXHAUST AIR
2560 CFM
EXHAUST FAN
FA
TCS
TA
H L
T
EXHAUST
BACKDRAFT
DUAL COMBINATION
LOUVER
54,300 CFM
54,300 CFM
SUPPLY
AIR FAN
CHEMICAL TANK ROOM
DUCT
MOUNTED
THERMOSTAT
2560 CFM
2560 CFM
54,300 CFM
54,300 CFM
ELECTRICAL
UNIT HEATERS
(TYPICAL OF 2)
(4 kw EACH)
TIC
TIS
M
54,300 CFM
54,300 CFM
SUPPLY
AIR FAN
54,300 CFM
EXHAUST
BACKDRAFT
DUAL COMBINATION
LOUVER
ELECTRICAL
UNIT HEATERS
(TYPICAL OF 6)
(15 kw EACH)
O.A.
INTAKE LOUVER
54,300 CFM
CIRCULATING WATER PUMP HOUSE
EL. - 754'-0"
CIRCULATING WATER PUMP HOUSE HEATING AND VENTILATION
ATTACHMENT J
PAGE 1 OF 1
PROJECT NO. 12198-004
CALC. NO. 2008-09746
SCALE
NONE
PROJECT NUMBER
12198-004
CONCEPTUAL
PIPING & INSTRUMENTATION DIAGRAM
CIRCULATING WATER PUMP HOUSE
HEATING AND VENTALATION
NON SAFETY-RELATED
BELL BEND
UNISTAR NUCLEAR
PENNSYLVANIA
Sargent & Lundy
DRAWING NO.
12198-004-HV-002
REV.
D
SHEET 1 OF 1

UniStar NUCLEAR

DESIGN INFORMATION TRANSMITTAL (DIT)

DIT Form, Part 1

☒ SAFETY-RELATED ☐ NON-SAFETY-RELATED	**Originating Organization** ☐ S&L ☒ S&L Internal ☐ Unistar ☐ Other (specify)	DIT No DIT-BBNPP-003
Plant: ☐ NMP ☒ BBNPP Unit: 3		Page 1 of 2
System Designation	CIRCULATING WATER, RAW WATER, AND POTABLE WATER LINES AND BURIED EELCTRICAL CONDUITS AND DUCT BANKS	To

Subject: WATER AND SOIL CHEMISTRY PARAMETERS FOR BURIED COMMODITIES

D. C. KOCUNIK	GEOTECH. MANAGER	Daniel C. Kocunik	4/28/2008
Preparer	Position	Preparer's Signature	Date
E.S. MOTAN	SENIOR ASSOCIATE	E. Sabri Motan	4/28/2008
Reviewer	Position	Reviewer's Signature	Date
D. C. KOCUNIK	GEOTECH. MANAGER	Daniel C. Kocunik	4/28/2008
Approver	Position	Approver's Signature	Date

Status of Information: ☒ Approved for Use ☐ Unverified

Method and Schedule of Verification for Unverified DITs NA

Holds Associated with Unverified DITs: NA

Description of Information: Information is provided to document various chemical parameters present in the groundwater at the Bell Bend site.

Purpose of Issuance (Including any Precautions or Limitations): Information for evaluation of need for protective coatings and type of cement for buried pipes and concrete duct banks.

Source of Information: Data from Paul C. Rizzo Associates (attached) and the "Natural Resources Conservation Service – National Cooperative Soil Survey, Luzerne County, Pennsylvania" (Web Survey Information obtained on 3/7/2008.

Engineering Judgement Used? ☒ Yes ☐ No

Controlled Reference / Document No.: NA

Uncontrolled Reference / Document No.: NA

Distribution: Copy to Requestor R. Hameetman, M. Pressburger, H. Taylor, J. Saltarelli, R. Pospiech, J. Devgun, L. Anderson, N. Klaic, A.K. Chatterji, D. Kocunik

Copy to Project File

UniStar

DESIGN INFORMATION TRANSMITTAL (DIT)

DIT Form, Part 2

Design Information Transmittal	DIT No.	DIT	BBNPP	003
	Page	2	of	2

The following is a summary of properties for the water chemistry for the surface water and groundwater obtained from Paul C. Rizzo Associates (PCR). It is a copy of the field data obtained by PCR as part of the COLA. The data is attached for a more detailed review.

SUMMARY:

Groundwater in soil:

- pH ranges from 5.55 to 7.34 with a general range from 5.6 to 6.5.
- chlorides range from 0.75 to 13 mg/l.
- Sulfates range from 11 to 57 mg/l.
- Specific Conductance ranges from 0.048 to .469 mS/cm with a general range from 0.15 to 0.2.

Water in Bedrock:

- pH ranges from 7.28 to 11.18 with a general range from 7.5 to 9.
- Specific Conductance ranges from 0.133 to 0.544 mS/cm with a general range from 0.2 to 0.4.

Surface water:

- chlorides range from 3.9 to 27 mg/l.
- Sulfates range from 9.4 to 58 mg/l.

These chemical properties are based on water samples and not soil/rock samples. Since this water will be in contact with the buried commodities, the values presented will be representative of the materials around the buried commodities.

Data from the Natural Resources Conservation Service indicates similar trends for the upper soils present at the site.

This information was provided by PCR as draft information. It can be used for evaluating the need for cathodic protection and corrosion protection for buried commodities. No major change in these values are anticipated when test results on soil and rock samples are provided.

See attached page 1 of 1 for Sulfates and chlorides and pages 1 through 7 for the pH and other values.

1 OF 1

FEBRUARY 2008 GROUNDWATER QUALITY DATA (PRELIMINARY, DO NOT CITE)

Client Sample ID	Collection Date	Analyte	Result	Unit	Flag	
BB-MW304A-1	2/28/2008 9:00	Chloride	0.75	mg/L	J	WELL WATER DATA
BB-MW304A-1	2/28/2008 9:00	Sulfate	11	mg/L		
BB-MW304A-1	2/28/2008 9:00	Chloride	10.4	mg/L		
BB-MW304A-1	2/28/2008 9:00	Sulfate	20.7	mg/L		
BB-MW304A-1	2/28/2008 9:00	Chloride	10.1	mg/L		
BB-MW304A-1	2/28/2008 9:00	Sulfate	20.3	mg/L		
BB-G3-1	2/28/2008 12:15	Chloride	13	mg/L		SURFACE WATER DATA
BB-G3-1	2/28/2008 12:15	Sulfate	12	mg/L		
BB-G5-1	2/28/2008 14:30	Chloride	7.3	mg/L		
BB-G5-1	2/28/2008 14:30	Sulfate	15	mg/L		
BB-MW305B-1	2/28/2008 14:00	Chloride	3.9	mg/L	J	WELL WATER DATA
BB-MW305B-1	2/28/2008 14:00	Sulfate	26	mg/L		
BB-MW301A-1	2/28/2008 12:00	Chloride	2	mg/L	J	
BB-MW301A-1	2/28/2008 12:00	Sulfate	29	mg/L		
BB-MW304B-1	2/28/2008 10:50	Chloride	6.3	mg/L		
BB-MW304B-1	2/28/2008 10:50	Sulfate	57	mg/L		
BB-MW305A1-1	2/28/2008 13:30	Chloride	13	mg/L		
BB-MW305A1-1	2/28/2008 13:30	Sulfate	22	mg/L		
BB-DUP-1	2/28/2008 9:00	Chloride	3.9	mg/L		SURFACE WATER DATA
BB-DUP-1	2/28/2008 9:00	Sulfate	58	mg/L		
BB-G1-1	2/28/2008 13:15	Chloride	8.3	mg/L		
BB-G1-1	2/28/2008 13:15	Sulfate	9.4	mg/L		
BB-SR01-1	2/28/2008 7:17	Chloride	27	mg/L		
BB-SR01-1	2/28/2008 7:17	Sulfate	17	mg/L		
BB-G2-1	2/28/2008 13:45	Chloride	10	mg/L		
BB-G2-1	2/28/2008 13:45	Sulfate	13	mg/L		
BB-SR02-1	2/28/2008 8:03	Chloride	27	mg/L		
BB-SR02-1	2/28/2008 8:03	Sulfate	17	mg/L		

Table 2.4.12-14 Bell Bend NPP Unit 1 Groundwater Quality Data
(Page 1 of 7)

Location	Date	pH	Specific Conductance (mS/cm)	Turbidity (NTU)	Dissolved Oxygen (mg/L)[1]	Temperature (° Celsius)	ORP (mV)	Salinity (ppt)	TDS (mg/L)
Glacial Overburden Wells									
MW301A	10/30/2007	5.76	0.173	0.4	1.34	12.92	189.3	0.08	0.113
	1/26/2008	5.81	0.149	0.0	5.98	10.66	221.6	0.07	0.097
	2/27/2008	5.68	0.129	2.4	7.52	9.16	206.6	0.06	0.084
	4/14/2008	5.70	0.136	0.0	7.30	8.43	201.1	0.06	0.088
MW302A1	10/30/2007	5.66	0.177	2.0	-0.14	13.01	127.3	0.08	0.115
	1/26/2008	5.81	0.188	0.8	0.69	10.46	70.4	0.09	0.122
	2/29/2008	5.58	0.171	0.0	1.30	9.36	113.0	0.08	0.111
	4/16/2008	5.74	0.153	0.0	0.79	8.83	84.6	0.07	0.099
MW302A2	10/30/2007	5.68	0.165	2.1	1.40	12.92	160.3	0.08	0.107
	1/26/2008	5.76	0.186	1.0	0.68	10.52	79.3	0.09	0.121
	3/2/2008	5.74	0.189	0.0	0.00	16.86	67.0	0.09	0.123
	4/18/08	5.84	0.172	0.0	1.04	13.00	67.4	0.08	0.113
MW302A3	10/30/2007	5.55	0.159	6.7	3.31	12.73	177.8	0.08	0.104
	1/26/2008	5.67	0.179	11.3	0.85	10.62	114.4	0.08	0.116
	3/2/2008	5.70	0.187	0.0	0.45	14.08	107.3	0.09	0.122
	4/18/2008	5.76	0.182	0.0	1.89	11.27	100.6	0.08	0.109

Table 2.4.12-14 Bell Bend NPP Unit 1 Groundwater Quality Data
(Page 2 of 7)

Location	Date	pH	Specific Conductance (mS/cm)	Turbidity (NTU)	Dissolved Oxygen (mg/L)	Temperature (° Celsius)	ORP (mV)	Salinity (ppt)	TDS (mg/L)
MW302A4	10/30/2007	5.65	0.165	1.7	4.75	12.66	196.3	0.08	0.107
	1/27/2008	5.75	0.174	0.0	4.33	10.37	114.1	0.08	0.113
	3/2/2008	5.62	0.161	0.3	4.32	14.98	164.5	0.08	0.105
	4/18/2008	5.65	0.048	0.0	6.25	12.76	156.9	0.02	0.031
MW303A	10/31/2007	6.40	0.179	17.1	2.99	13.14	124.9	0.08	0.116
	1/29/2008	7.04	0.200	45.1	0.22	9.42	-21.7	0.10	0.130
	3/2/2008	6.94	0.203	62.8	4.01	4.71	-2.0	0.10	0.132
	4/19/2008	7.23	0.202	68.1	7.30	13.40	10.1	0.10	0.131
MW304A	10/31/2007	6.18	0.254	11.3	4.60	11.89	109.3	0.12	0.165
	1/28/2008	6.12	0.265	0.1	2.36	11.11	140.9	0.13	0.172
	2/27/2008	6.10	0.220	5.8	1.74	10.16	124.9	0.11	0.143
	4/15/2008	6.14	0.213	0.0	0.81	10.55	110.8	0.10	0.139
MW305A1	10/31/2007	6.35	0.204	30.2	1.51	13.61	146.7	0.10	0.133
	1/30/2008	6.14	0.186	9.3	1.22	10.84	162.3	0.09	0.121
	2/27/2008	5.97	0.159	3.0	2.65	10.43	172.4	0.08	0.103
	4/15/2008	6.21	0.169	0.0	1.78	10.65	153.0	0.08	0.110
MW305A2	10/31/2007	6.89	0.267	34.2	-0.17	12.78	8.3	0.13	0.174

2 of 7

Table 2.4.12-14 Bell Bend NPP Unit 1 Groundwater Quality Data
(Page 3 of 7)

Location	Date	pH	Specific Conductance (mS/cm)	Turbidity (NTU)	Dissolved Oxygen (mg/L)1	Temperature (° Celsius)	ORP (mV)	Salinity (ppt)	TDS (mg/L)
	1/30/2008	6.82	0.241	0.0	0.00	11.19	-47.0	0.12	0.157
	3/2/2008	6.77	0.236	0.0	0.00	14.97	-41.7	0.11	0.153
	4/18/2008	6.69	0.235	0.0	0.00	12.67	-23.1	0.11	0.149
MW306A	10/31/2007	6.28	0.189	6.5	5.24	13.02	168.0	0.09	0.123
	1/27/2008	6.23	0.178	0.8	5.72	12.10	130.7	0.08	0.116
	2/29/2008	6.07	0.167	0.0	6.52	11.50	204.8	0.08	0.108
	4/16/2008	6.18	0.172	0.0	6.67	11.35	153.5	0.08	0.112
MW307A	10/30/2007	7.27	0.294	139.6	3.96	13.36	41.8	0.14	0.191
	1/27/2008	7.34	0.300	10.8	2.54	9.56	7.9	0.14	0.194
	2/26/2008	7.20	0.294	49.9	4.11	11.28	31.2	0.14	0.191
	4/17/2008	7.14	0.279	36.3	4.89	12.32	122.0	0.13	0.180
MW308A	10/30/2007	5.95	0.138	15.5	3.90	11.96	134.6	0.07	0.090
	1/27/2008	5.91	0.147	0.0	0.89	10.98	214.0	0.07	0.096
	2/26/2008	5.78	0.142	0.4	0.59	9.63	239.6	0.07	0.092
	4/17/2008	5.72	0.143	0.0	0.35	12.21	157.5	0.07	0.093
MW309A	10/31/2007	6.49	0.348	3.8	4.59	14.22	155.8	0.17	0.227
	1/28/2008	6.29	0.469	0.0	5.71	9.30	151.1	0.23	0.304

Table 2.4.12-14 Bell Bend NPP Unit 1 Groundwater Quality Data
(Page 4 of 7)

Location	Date	pH	Specific Conductance (mS/cm)	Turbidity (NTU)	Dissolved Oxygen (mg/L)	Temperature (° Celsius)	ORP (mV)	Salinity (ppt)	TDS (mg/L)
	3/1/2008	6.13	0.414	0.0	4.77	15.20	150.9	0.20	0.269
	4/19/2008	6.15	0.429	0.0	5.23	9.48	245.4	0.21	0.279
MW310A	10/30/2007	7.18	0.079	1093.3	8.30	13.29	76.5	0.04	0.051
	1/26/2008	6.58	0.122	132.7	3.83	9.47	153.5	0.06	0.079
	2/26/2008	6.41	0.130	12.4	3.91	7.28	141.6	0.06	0.084
	4/17/2008	6.12	0.123	0.0	5.27	10.05	139.6	0.06	0.080
Shallow Bedrock Wells									
MW301B1	10/30/2007	9.42	0.210	8.8	1.75	12.74	-137.5	0.10	0.136
	1/26/2008	10.11	0.154	0.0	0.00	11.15	-191.5	0.07	0.100
	2/29/2008	10.13	0.156	0.0	0.00	10.21	-166.4	0.07	0.101
	4/14/2008	9.63	0.133	0.0	0.00	10.80	-186.5	0.06	0.086
MW302B	10/30/2007	9.19	0.256	15.7	0.22	12.28	-190.7	0.12	0.167
	1/26/2008	9.18	0.298	26.0	0.01	10.17	-317.5	0.14	0.194
	3/2/2008	9.19	0.283	11.9	0.54	13.41	-232.0	0.14	0.184
	4/18/2008	9.17	0.294	0.0	0.09	12.19	-204.4	0.14	0.191
MW303B	10/31/2007	7.88	0.162	2.0	0.35	12.25	-7.5	0.08	0.105
	1/29/2008	7.54	0.176	0.0	0.00	11.12	-127.8	0.08	0.114

Table 2.4.12-14 Bell Bend NPP Unit 1 Groundwater Quality Data
(Page 5 of 7)

Location	Date	pH	Specific Conductance (mS/cm)	Turbidity (NTU)	Dissolved Oxygen (mg/L)	Temperature (° Celsius)	ORP (mV)	Salinity (ppt)	TDS (mg/L)
	3/2/2008	7.47	0.191	0.0	0.06	10.34	-56.4	0.09	124
	4/19/2008	7.62	0.191	0.0	0.00	13.19	-86.4	0.09	0.124
MW304B	10/31/2007	9.86	0.332	10.0	5.27	12.17	-69.7	0.16	0.216
	1/29/2008	11.18	0.518	0.0	0.00	11.62	-178.5	0.26	0.336
	2/27/2008	10.71	0.418	1.5	0.00	10.82	-138.6	0.20	0.272
	4/15/2008	11.10	0.544	0.0	0.00	11.39	-151.3	0.26	0.347
MW305B	10/31/2007	7.32	0.264	2.5	2.60	12.97	57.3	0.13	0.172
	1/30/2008	7.43	0.272	0.0	0.00	11.49	-151.5	0.13	0.177
	2/27/2008	7.37	0.251	2.4	0.00	10.78	-109.3	0.12	0.163
	4/15/2008	7.32	0.266	0.0	0.00	11.39	-118.6	0.13	0.173
MW307B	10/30/2007	8.78	0.250	3.9	5.95	12.80	-24.6	0.11	0.158
	1/27/2008	8.73	0.248	0.0	-0.12	11.75	-197.2	0.12	0.161
	2/26/2008	8.45	0.248	0.0	0.01	12.15	-158.3	0.12	0.161
	4/17/08	8.70	0.246	0.0	0.00	13.68	-89.4	0.12	0.160
MW308B	10/30/2008	7.79	0.210	934.4	10.17	13.17	48.3	0.10	0.137
	1/27/2008	7.70	0.430	969.0	0.42	11.83	-68.3	0.21	0.279
	2/26/2008	7.41	0.412	1067.0	1.85	14.28	8.5	0.19	0.261

Table 2.4.12-14 Bell Bend NPP Unit 1 Groundwater Quality Data
(Page 6 of 7)

Location	Date	pH	Specific Conductance (mS/cm)	Turbidity (NTU)	Dissolved Oxygen (mg/L)	Temperature (° Celsius)	ORP (mV)	Salinity (ppt)	TDS (mg/L)
	4/17/2008	7.45	0.454	1115.9	3.43	11.70	77.7	0.22	0.294
MW309B	10/31/2007	7.29	0.459	6.3	1.30	11.50	-1.2	0.22	0.298
	1/28/2008	7.32	0.465	0.0	-0.10	11.11	-99.1	0.23	0.302
	3/1/2008	7.28	0.456	0.0	0.00	14.95	-102.0	0.22	0.296
	4/19/2008	7.36	0.452	0.0	0.00	13.78	-68.0	0.22	0.293
MW310B	10/30/2007	7.78	0.196	3.4	-0.25	12.44	-63.4	0.09	0.127
	1/26/2008	7.64	0.194	0.0	-0.08	11.24	-143.4	0.09	0.126
	2/26/2008	7.61	0.192	0.0	0.82	9.71	-67.2	0.09	0.125
	4/17/2008	7.52	0.196	0.0	0.00	13.04	-130.4	0.09	0.137
Deep Bedrock Wells									
MW303C	10/31/2007	7.97	0.173	6.0	5.45	12.76	58.7	0.08	0.113
	1/29/2008	7.98	0.171	0.0	0.00	11.38	10.5	0.08	0.111
	3/2/2008	7.94	0.169	0.0	0.02	14.75	-121.0	0.08	0.110
	4/19/2008	8.14	0.171	0.0	0.00	13.21	-166.4	0.08	0.111
MW304C									
	1/29/2008	9.58	0.552	182.1	0.24	11.83	-34.2	0.27	0.359
	3/1/2008	9.46	0.411	296.1	0.13	14.24	-173.4	0.20	0.267

Table 2.4.12-14 Bell Bend NPP Unit 1 Groundwater Quality Data
(Page 7 of 7)

Location	Date	pH	Specific Conductance (mS/cm)	Turbidity (NTU)	Dissolved Oxygen (mg/L)[1]	Temperature (° Celsius)	ORP (mV)	Salinity (ppt)	TDS (mg/L)
	4/15/2008	9.31	0.361	84.2	0.10	12.12	-161.5	0.17	0.235
MW306C	10/31/2007	8.59	0.197	16.6	-0.10	12.48	-264.8	0.09	0.128
	1/27/2008	9.23	0.492	17.4	0.27	11.15	-27.4	0.24	0.320
	3/2/2008	8.97	0.517	3.9	0.02	16.09	-131.6	0.25	0.336
	4/18/2008	9.24	0.512	40.3	0.01	13.95	-41.3	0.25	0.335

[1]Small negative DO values indicate near zero and values are within the calibration tolerance. In subsequent rounds these values were recorded as 0.0 on the field form.

7 of 7

UniStar

May 13, 2008

Lannis Selz
AREVA NP, Inc
3315 Old Forest Road
PO Box 10935
Lynchburg, VA 24506-0935

RFI #08-141

Subject: Response to RFI EPR-08-170, from Lannis Selz to George Wrobel, dated January 31, 2008.

Attached is a copy of the subject RFIs, as well as the Paul C. Rizzo Associates response.

Sincerely,

G. van Noordennen

Gerry van Noordennen

xc: J. Price, w/o
B. Perdue
R. Hamectman, S&L
T. Barnett, S&L

ENGINEERS & CONSULTANTS
CORPORATE HEADQUARTERS - PITTSBURGH
ExpoMart, Suite 270-E • 105 Mall Boulevard • Monroeville, PA 15146-2288
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www.rizzoassoc.com

May 8, 2008
Project No. 07-3891

Mr. Michael Cain
c/o Heather Scholtes
PPL Nuclear Development
38 Bomboy Lane, Suite 2
Berwick, PA 18603

TRANSMITTAL
RESPONSE TO RFI EPR 08-170
BERWICK NUCLEAR POWER PLANT

Dear Mr. Cain:

Please find enclosed geotechnical data in response to RFI EPR 08-170.

If you have any questions or need additional copies, please do not hesitate to call me at (412) 856-9700, extension 1039, or e-mail me at Antonio.fernandez@rizzoassoc.com.

Thank you for your assistance.

Sincerely,
Paul C. Rizzo Associates, Inc.

Antonio Fernandez, Ph.D., P.E.
Project Manager

AF/dcf

Enclosures

L19 073891/08

•Monroeville PA (Corp.HQ)•Johnstown PA•San Francisco CA•St. Louis MO•Waldwick NJ•Columbia SC•
•Buenos Aires Argentina•Plzen Czech Republic•Lima Peru•St. Petersburg Russia•Cape Town South Africa•

AREVA

REQUEST FOR INFORMATION

RFI Number: RFI-EPR-08-170	Date of Request: 1/31/2008	Sheet 1 of 2
To: George Wrobel, CG/G		
Subject: *COLA Geotechnical Site Characteristic Data*		
Contract No.: A0000832	Project or Plant: Pennsylvania Power and Light (PPL) (Berwick, U.S. EPR)	
Reference Documents: See Below		

Information Requested (indicate Intended Use):

For preparation of the Berwick COLA, it is necessary to reconcile the U S EPR design with the Berwick site In support of this, certain Geotechnical information is required. It is AREVA's understanding that this information has been obtained through a geological/geotechnical survey of the Berwick site

The following list is a summary of the data required by AREVA to perform this reconciliation. If the data is provided from other source documents please provide the document title and revision number If the information is not final, please provide a date when final information will be available to tie to current schedule activity PL230285005 that will provide this information

Because this information will be used by AREVA to perform the required reconciliation of the U.S. EPR design for the Berwick site, the following requested design input must be provided from an approved QA source.
For each layer of the Berwick soil profile please provide:

1. Thickness

2. Unit weight

3 Shear wave velocity - Strain-compatible S-wave velocities for three soil conditions, i.e , best estimate, lower bound and upper bound

4. S-wave damping ratio - Strain-computable S-wave damping ratios for three soil conditions, i.e., best estimate, lower bound and upper bound

5 P-wave damping ratio - P-wave damping ratio is usually taken as 1/3 of the corresponding strain comparable S-wave damping ratio. Confirmation that this is acceptable for this soil profile

6 Poisson's ratio and/or compression wave velocity If compression wave velocity is to be provided, please provide the strain-compatible P-wave velocities for three soil conditions, i e , best estimate, lower bound and upper bound

7 Shear modulus reduction curve - This information will not be needed if the strain-compatible S-wave velocity and damping ratio are provided

8 Friction angle

9 Cohesion

10. At rest, active and passive earth pressure coefficients

11. Recommended bearing capacity/settlement estimates

12. Groundwater elevation

13 Groundwater/Soil Acid content, sulfate content & Chloride content

14. Confirmation of horizontal soil uniformity by geotechnical engineer.

15. For any borrow fill sources provide the information identified in Nos 1-14 of the RFI, as applicable

RFI Classification:	☐ Document Request ☒ Design Input Request ☐ Document Clarification ☐ Other:	Verification Required: ☒ Yes ☐ No *Date Response Required: February 22, 2008*

Prepared By:	Signature: B.D. Hoyle	Title/Organization: Principal Engineer/New Plants Engr	Date: 2/8/08
Approved By:	Signature: J.B. Wheeler	Title/Organization: Engr. Manager/New Plant Deployment	Date: 2/8/08

RFI Response (Include Any conditions or Restrictions for Use):

See PC Rizzo response dated May 8, 2008 (attached)

G. [illegible] — Unistar — 5-13-08

Response By:	Signature: [illegible]	Title/Organization: Project Manager RWBH	Date: 5/12/08
Verified By:	Signature: [illegible]	Title/Organization: Senior Hydrogeologist Project Associate	Date: 5/12/08
Approved By:	Signature: [illegible]	Title/Organization: [illegible]	Date: 5/13/08

DCR ENGINEERS & CONSULTANTS

EPR 08-170

By:	AF	Date:	6/8/2008	Subject:	Response to RFI EPR-08-170	Sheet No.	1	of	8
						Project No.	07-3891.03		

The following list provides the response to each of the 15 items listed by the RFI:

1. Thickness

The thickness of the existing soils is provided by *Table 2.5.4-29*.

TABLE 2.5.4-29
RECOMMENDED VALUES FOR DYNAMIC ELASTIC PROPERTIES
(Page 1 of 1, English units)

	Unit	Depth (ft)		γ (kg/m³)	ρ (kg/m³)	V_p (m/s)	ν	G_{max} (psf)	E_{max} (psf)	D_{min} (%)	Comments
SOILS	Glacial Overburden 1	0.0	20.0	1160	2550	126	0.37	5180	14220	1.00	$G_{max} = \rho V_s^2$ $E_{max} = 2(1+\nu)G_s$
	Glacial Overburden 2	20.0	40.0	2000	7000	128	0.44	20700	59580	1.00	
ROCK FORMATIONS	Mahantango Formation Layer 1	40.0	60.0	6500	12000	170	0.31	244120	636430	0.80	- Velocities determined from best estimate soil profile
	Mahantango Formation Layer 2	60.0	100.0	7150	15000	170	0.39	289600	734250	0.80	- Poisson's Ratios determined from velocity ratio squared
	Mahantango Formation Layer 3	100.0	155.0	7600	16100	170	0.36	304940	827380	0.70	- Initial Shear Damping (DSo): determined from "Free-Free" Testing for Rocks, and RCTS Testing for Overburden and Grayson Chert Conglomerate
	Mahantango Formation Layer 4	155.0	220.0	6900	16100	170	0.31	391440	936010	0.70	- (*) Depth of in-situ layers provided at Nuclear Island Location
	Mahantango Formation Layer 5	220.0	270.0	6950	16750	170	0.30	422900	1099710	0.70	
	Mahantango Formation Layer 6	270.0	-	5600	16250	170	0.29	480380	1225040	0.70	
FILLS	Category 1 Granular Fill/Backfill	0.0	10.0	600	1250	140	0.35	1570	4240	1.00	NA: Not Applicable
		10.0	20.0	600	1570	140	0.35	2760	7510	1.00	
		> 20.0		1000	2100	140	0.35	4350	11770	1.00	
	Concrete	NA	NA	7240	12900	150	0.20	244180	586030	0.80	

Table 2.5.4-29 provides the in-situ soil profile below the center line of the reactor. Please refer to the Response to RFI EPR-08-436 for strain compatible soil profiles

2. Unit Weight

The unit weight is provided by *Table 2.5.4-29* below. The fill material will replace the overburden soils around the facilities.

DCR ENGINEERS & CONSULTANTS

EPR 08-170

By: AF Date: 5/8/2008 Subject: Response to RFI EPR-08-170 Sheet No. 2 of 8
Project No. 07-3891.03

TABLE 2.5.4-23
RECOMMENDED VALUES OF INDEX PROPERTIES
(Page 1 of 1, English units)

Unit	USCS or URCS	Water Content (%)	Liquid Limit (%)	Plastic Index (%)	Unit Weight (pcf) Dry	Moist	Sat	Observations
Glacial Overburden	SW	20	NP	NP	105	126	131	URCS Classification: (Weathering, Strength, Discontinuity, Weight) NA: Not Applicable NP: Non Plastic (*) See grain size curves
Mahantango Formation	AAAA	0.5	NP	NP	169	170	170	
Category 1 Granular Fill	SW	6	NP	NP	133	141	144	
Category 1 Granular Backfill	SW	6	NP	NP	126	134	140	
Concrete Fill	NA	NA	NA	NA	NA	150	NA	

3. **Shear Wave Velocity – Strain Compatible S-Wave Velocity for three soil conditions, i.e., best estimate, lower bound, and upper bound.**

   Please refer to the Response to RFI EPR-08-436.

4. **S-wave damping ratio – Strain compatible S-wave damping ratios for three soil conditions, i.e., best estimate, lower bound, and upper bound.**

   Please refer to the Response to RFI EPR-08-436.

5. **P-Wave damping ratio is usually taken as 1/3 of the corresponding strain compatible S-wave damping ratio.**

   Soil amplification analysis is performed for vertically propagated shear wave. Vertical ground motion is obtained by following Reg Guide 1.208. Compressional damping does not affect the site amplification results. The 1/3 ratio proposal is acceptable

6. **Poisson's ratio and/or compression wave velocity. If compression wave velocity is to be provided, please provide the strain-compatible P-wave velocities for three soil conditions, i.e., best estimate, lower bound, and upper bound.**

   The Poisson ratio is provided in *Table 2.5.4-29*. This value should be used to estimate the strain compatible P-Wave velocities for the three soil conditions

7. **Shear modulus reduction curve – This information will not be needed if the strain-compatible S-wave velocity and damping ratio are provided**

   Strain-compatible S-wave velocity and damping ratio are provided (Items 3 and 4)

8. **Friction Angle**

DCR ENGINEERS & CONSULTANTS

EPR 08-170

By: AF Date: 5/8/2008 Subject: Response to RFI EPR-08-170 Sheet No. 3 of 8
Project No. 07-3891.03

Table 2.5.4-25 provides the recommended strength parameter values.

TABLE 2.5.4-25
RECOMMENDED VALUES FOR STRENGTH PROPERTIES
(Page 1 of 1, English units)

Formation	SPT	c (psf)	φ (°)	q_u (psf)	q_a (psf)	Observations
Glacial Overburden	35	0	35.0	NA	NA	- Friction obtained from SPT Correlation for Dense Sands and Gravels (Peck, 1974) - Unconfined Compressive Test for qu - Equivalent cohesion and friction (RMR) - Concrete strength consistent with Vs = 6800 fps - NM: Not Measured - NA: Not Applicable
Mahantango Formation	NA	7.3	40.0	NA	1050	
Category 1 Granular Fill	NM	0.0	35.0	NA	NA	
Category 1 Granular Backfill	NM	0.0	35.0	NA	NA	
Concrete Fill	fc = 5000 [psi]					

9. Cohesion

Recommended cohesion is provided by *Table 2.5.4-25*.

10. At Rest, Active, and Passive Earth Pressure Coefficients

The coefficients are provided by *Table 2.5.4-33*. Note that the overburden soils will be replaced by engineered backfill around the facilities. The earth pressure coefficients of the backfill are the applicable ones. The overburden values are provided for reference purposes.

TABLE 2.5.4-33
EARTH PRESSURE COEFFICIENTS
(Page 1 of 1)

Formation	φ (°)	k_a	k_p	k_o	k_{aE}	k_{pE}	Observations
Glacial Overburden	35	0.27	3.69	0.43	0.58	8.12	NA - Not Applicable k_a - Active Earth Pressure Coefficient k_p - Passive Earth Pressure Coefficient k_o - At Rest Earth Pressure Coefficient
Mahantango Formation	NA	NA	NA	NA	NA	NA	
Granular Fill/Backfill	35	0.27	3.69	0.43	0.58	8.12	
Concrete Fill	NA	NA	NA	NA	NA	NA	

ENGINEERS & CONSULTANTS

EPR 08-170

By:	AF	Date:	5/8/2008	Subject:	Response to RFI EPR-08-170	Sheet No.	4	of	8
						Project No.	07-3891.03		

11. Recommended bearing capacity/settlement estimates

Allowable bearing Capacities are in the excess of 40 ksf for buildings placed over engineered fills. For the case of the Nuclear Island placed on top of concrete and the Mahantango formation, the allowable bearing capacity is higher than 100 ksf. Settlements are below the 2 inch threshold for facilities placed on top of engineered fill and negligible for the Nuclear Island.

12. Groundwater Elevation

Normal groundwater:

The seasonal variation of Normal Groundwater Elevation below the center line of the containment:

Oct	Nov	Dec	Jan	Feb	Mar	Apr
655.7	657.7	657.5	657.7	658.8	659.3	658.1

Maximum groundwater: El. 671 msl

13. Chemical Properties of soil and water

Available Chemical Testing of Water:

CHEMICAL TEST RESULTS OF GROUNDWATER WATER SAMPLES AT MW-301 (NUCLEAR ISLAND)
(Page 1 of 1, English and SI Units)

Location	Date	pH	Sulfates [mg/l]*	Chlorides [mg/l]*
MW-301 (Nuclear Island)	10/30/2007	5.78		
	1/26/2008	5.81		
	2/27/2008	5.68	29	2
	4/14/2008	5.7	OI-TBC	OI-TBC
	7/7/08	OI-TBC	OI-TBC	OI-TBC
	9/29/08	OI-TBC	OI-TBC	OI-TBC

(*) Winter monitoring program
OI-TBC: Open Item, To be Completed

Available Chemical Testing of Soil (Plan view given for boring location):

Fw: Nine Mile Point
PAWEL KUT to: RICHARD P POSPIECH 06/23/2008 10:12 AM

History: This message has been replied to.

Air Flowrates

Pawel

---- Forwarded by PAWEL KUT/Sargentlundy on 06/23/2008 10:11 AM ----

From: Bill.Schott@ct.spx.com
To: PAWEL.KUT@sargentlundy.com
Cc: Paul.Secen@ct.spx.com, Kent.Martens@ct.spx.com, rblomquist@rmbsales.com
Date: 05/16/2008 04:15 PM
Subject: Nine Mile Point

Pawel,

Here is the data I think you are asking for..

	Exit Air Flow, cfm
Natural Draft Towers	54,848,028
Round Towers	58,860,000
Rectangular Towers	55,566,000

The conditions were 800,000 gpm at 114.76/90/74.
Regards,

Bill Schott, PE
Proposal Engineer
SPX Cooling Technologies
7401 W 129 Street
Overland Park, KS 66213 USA
913-664-7809 office phone
913-693-9406 office fax

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<JOHN.DALTON@ct.spx.com
>
06/25/2008 08:57 PM

To RICHARD.P.POSPIECH@Sargentlundy.com
cc Paul.Secen@ct.spx.com, Kent.Martens@ct.spx.com
bcc
Subject BELL BEND - Data and Information

History: This message has been replied to and forwarded.

Richard,

As requested, your undimensioned drawing and answers follow below. Thank you & all the best,

1a) Drawing: (See attached file: Bell Bend - undimensioned.pdf)
1b) Dimensions: 475' high x 350' base diameter per Richard Pospiech 6/24/08 e-mail.

2) No. Fan assisted natural drafts and fan assisted plume abated natural drafts (hybrid) are available, but are quite different towers.

3) Yes. The basin can be sized, within reason, to handle any water volume required by the customer by changing the diameter and/or depth.

4) Airflow - we did not do the design. 35,000,000-60,000,000 cfm??

5a) Reinforced concrete shell, plinth, and basin.
5b) Distribution system: Concrete flume or RTR headers, PVC laterals, polypropylene spray arms and nozzles.
5c) Bottom supported PVC film fill and PVC eliminators
5d) Fiberglass fill and eliminator support
5e) Stainless hardware

6) Sound:

(Embedded image moved to file: pic25724.jpg)

Information needed on cooling tower:
1. Dimensions (height, diameter), and drawing.
2. Does tower have structural features that will permit the installation of dry cooling fans, heat exchangers, sound attenuation equipment, and hot air distribution ducting?
3. Will basin be sized to provide sufficient volume to allow draindown of the circulating water system without overflow with the basin initially at maximum operating water level?
4. Air flow rate
5. Internal construction materials, including:
a. Material for piping laterals
b. Material for spray nozzles
c. Fill material
6. Noise levels? At what distance away?

John Dalton
Proposal Engineer
Field Erected Products
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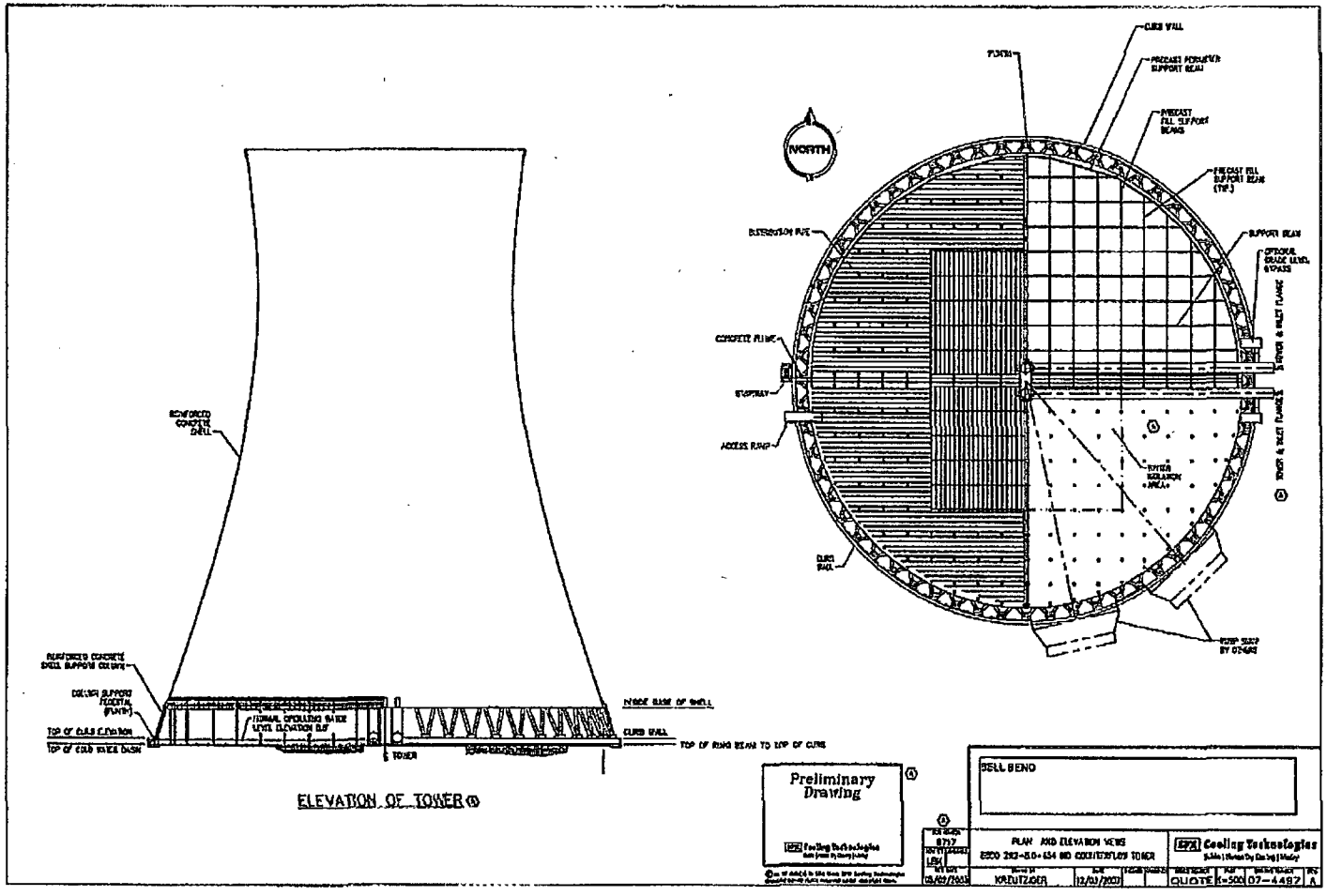
Bell Bend - undimensioned.pdf pic25724.jpg

BELL BEND

SPX COOLING TECHNOLOGIES

Sound data for a free and unobstructed environment per CTI ATC-128
Sound Pressure Level (SPL) expressed in dB (re: 20E-6 Pa).

SPL		31.5	63	125	250	500	1000	2000	4000	8000	dBA
5	From Curb		60	60	64	72	74	72	77	77	82
50	From Curb		61	59	60	68	71	70	73	72	78
100	From Curb		59	60	57	63	66	64	66	66	72
200	From Curb		58	59	56	57	61	60	61	60	67


NORTH
CURB WALL
PLINTH
PRECAST PERIMETER SUPPORT BEAM
PRECAST FILL SUPPORT BEAMS
PRECAST FILL SUPPORT BEAM (TYP.)
SUPPORT BEAM
OPTIONAL GRADE LEVEL BYPASS
DISTRIBUTION PIPE
CONCRETE PLUMC
STAIRWAY
ACCESS RAMP
CURB WALL
WATER SOLUTION AREA
REINFORCED CONCRETE SHELL
REINFORCED CONCRETE SHELL SUPPORT COLUMN
COLUMN SUPPORT FOOTING (PLINTH)
TOP OF CURB ELEVATION
TOP OF COLD WATER BASIN
NORMAL OPERATING WATER LEVEL ELEVATION 815'
INSIDE BASIN OF SHELL
CURB WALL
TOP OF RING BEAM TO TOP OF CURB
TOWER
ELEVATION OF TOWER
Preliminary Drawing
BELL BEND
PLAN AND ELEVATION VIEWS
Cooling Technologies
KREUTZIGER
12/03/2007
QUOTE
07-4497
A

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

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 — Date: 8-14-2008
N. M. Patel

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

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

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4. METHODOLOGY AND CRITERIA 4
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8. CONCLUSIONS 7
9. REFERENCES 7

Attachments		No. of Pages
1	Point Precipitation Frequency Estimates From NOAA Atlas 14	1
2	Conceptual Storm Sewer Network for The Plant Area	1
3	Conceptual Sketch of Drainage Areas for Stormwater Detention Ponds	1
4	Detention Storage Volume Computation Sheet for Ponds	1
5	Salient Features of the Stormwater Detention Ponds	1

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

Report No: SL-009446, Rev.2
Project No. 12198-004
August 14, 2008
Attachment 1: Page 1 of 1

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.

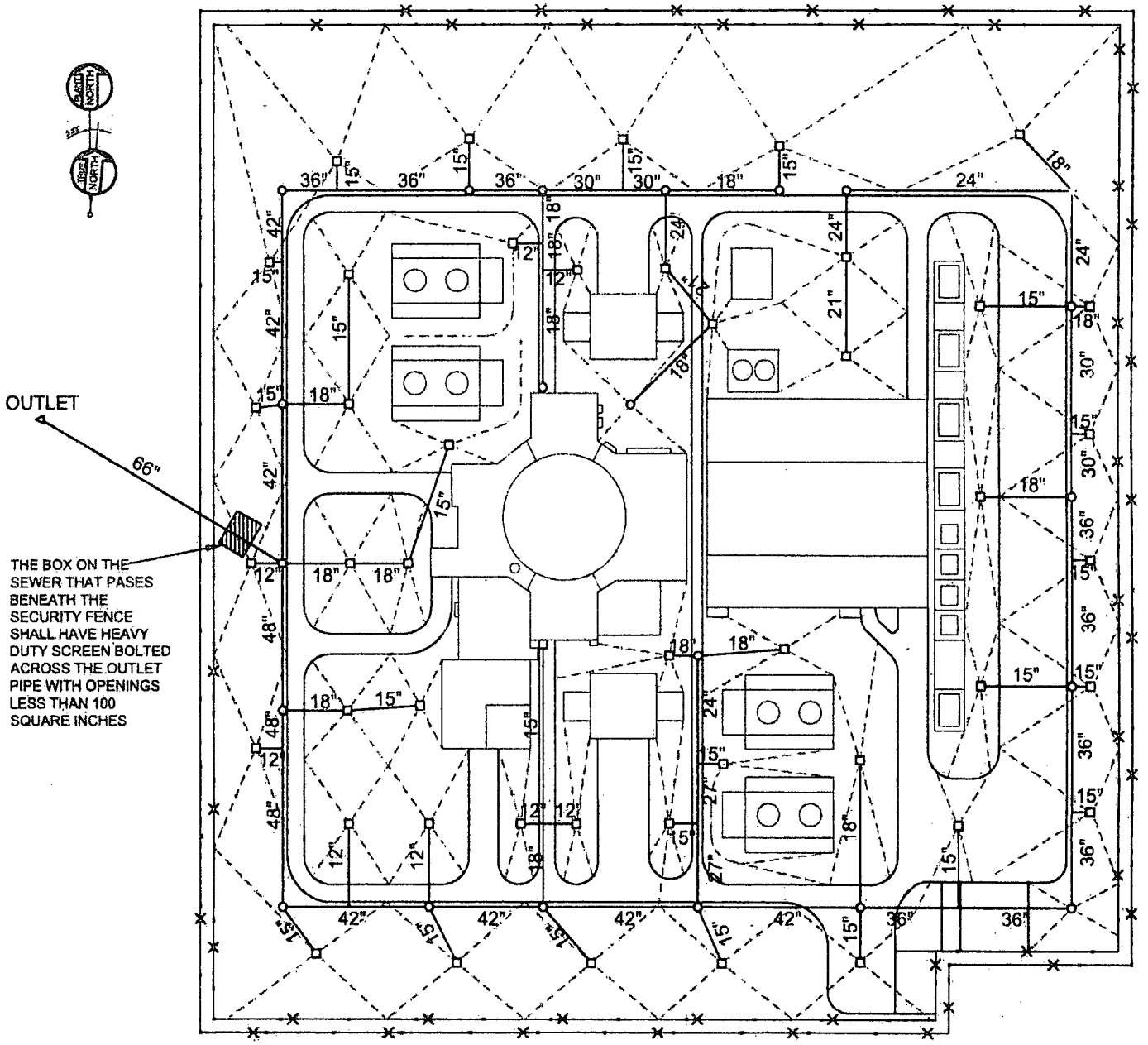
*** Upper bound of the 90% confidence interval Precipitation Frequency Estimates (inches)**

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)**

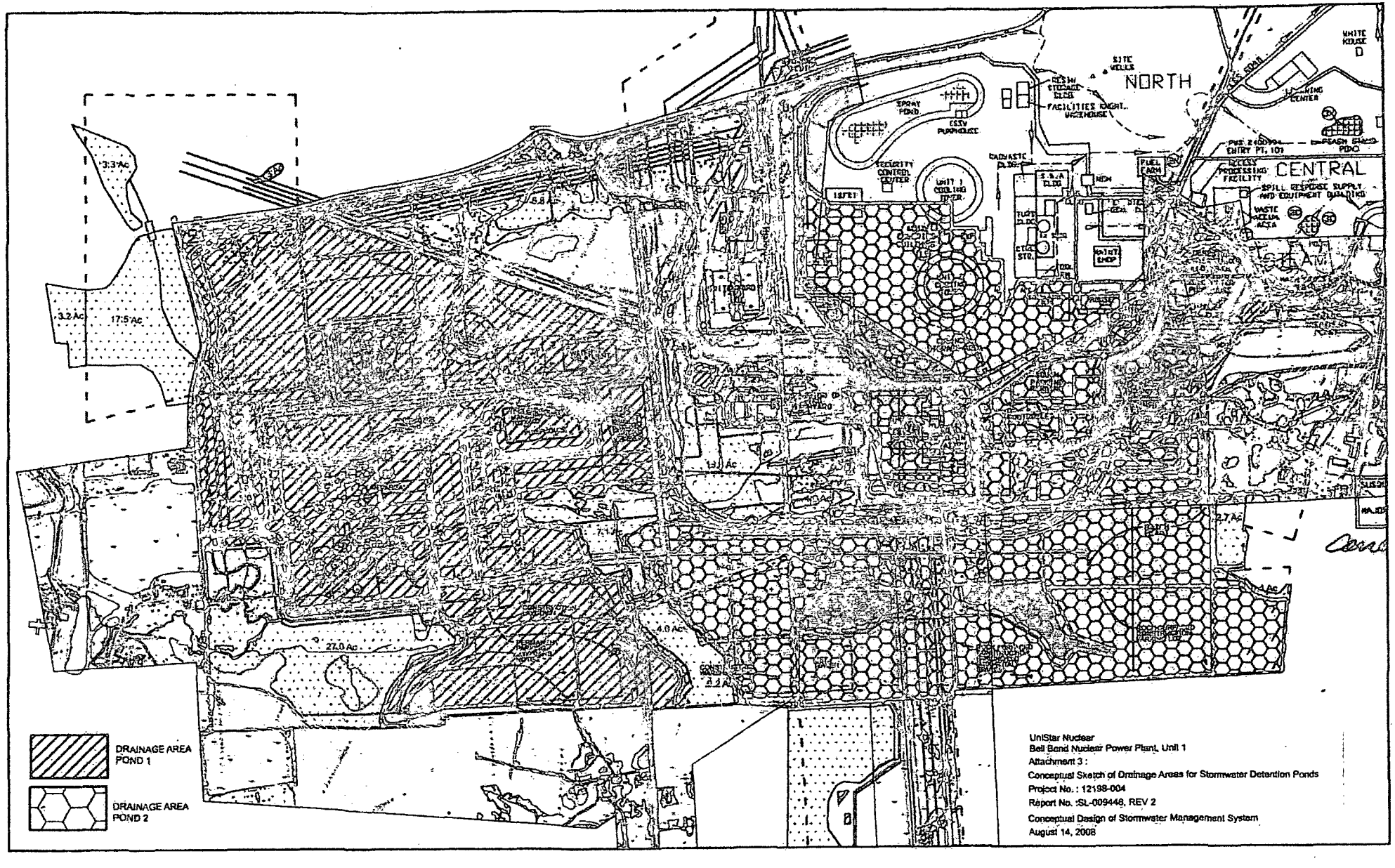
ARI** (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day	45 day	60 day
1	0.30	0.47	0.57	0.76	0.93	1.09	1.19	1.48	1.83	2.18	2.54	2.87	3.38	3.94	5.44	6.82	8.67	10.50
2	0.36	0.56	0.68	0.91	1.12	1.31	1.43	1.78	2.19	2.61	3.04	3.43	4.04	4.68	6.41	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.

- 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
Project No. : 12198-004
Report No. : BL-009446, REV 2
Conceptual Design of Stormwater Management System
August 14, 2008



UniStar Nuclear
Bell Bend Nuclear Power Plant, Unit 1
Attachment 3 :
Conceptual Sketch of Drainage Areas for Stormwater Detention Ponds
Project No. : 12198-004
Report No. :SL-009448, REV 2
Conceptual Design of Stormwater Management System
August 14, 2008

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

806.14(a)(1) Identification of project sponsor

RECEIVED
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Combined License Application
Part 1: General and Administrative Information
1.0 General Information
- 1.1 Applicant
- 1.2 Description of Business or Occupation
- 1.3 Organization and Management
  - 1.3.1 PPL Bell Bend, LLC
  - 1.3.2 PPL Bell Bend Holdings, LLC
  - 1.3.3 PPL Nuclear Development, LLC
  - 1.3.4 PPL Generation, LLC
  - 1.3.5 PPL Energy Supply, LLC
  - 1.3.6 PPL Energy Funding Corporation
  - 1.3.7 PPL Corporation
  - 1.3.8 Financial Relationship Between PPL Bell Bend, LLC and Its Owners

Figure 1.0-1

1.0 GENERAL INFORMATION

This part of the Combined License (COL) Application for the Bell Bend Nuclear Power Plant addresses the requirements of 10 CFR 50.33, "Content of applications; general information," (CFR, 2007a) and provides details of the applicant's corporate identity and location, applicant's ownership organization, the type of licenses being applied for, the applicant's financial qualifications, decommissioning funding assurance, foreign ownership, control, or domination information, and agreement limiting access to classified information.

1.1 APPLICANT

The Applicant for the Bell Bend Nuclear Power Plant (BBNPP) is PPL Bell Bend, LLC. PPL Bell Bend, LLC is not acting as the agent or representative of another person. Applicant's name, address, and principal office is as follows:

PPL Bell Bend, LLC
Two North Ninth Street
Allentown, PA 18101

1.2 DESCRIPTION OF BUSINESS OR OCCUPATION

The Applicant is a single purpose limited liability company created for the purpose of owning and operating BBNPP. PPL Bell Bend LLC, is a Delaware limited liability company. It is a subsidiary of PPL Bell Bend Holdings, LLC which was created to facilitate the proposed development and financing of the Bell Bend unit. PPL Bell Bend Holdings, LLC is a subsidiary of PPL Nuclear Development, LLC. PPL Nuclear Development, LLC is a subsidiary of PPL Generation, LLC which in turn is a subsidiary of PPL Energy Supply, LLC. PPL Generation LLC owns and controls generating capacity of 11,556 MW in the United States. PPL Energy Supply, LLC is engaged in the generation of electric power in the U.S. and the delivery of electricity in the U.K. and is a subsidiary of PPL Energy Funding Corporation. PPL Energy Funding Corporation is the parent company for various finance and service companies serving PPL Corporation and certain of its affiliates and is a subsidiary of PPL Corporation. PPL Corporation is the ultimate parent for all PPL's generation assets, generating operating companies, marketing and trading activities and distribution companies.

All subsidiaries of the PPL Corporation are wholly-owned by the PPL Corporation or subsidiaries of the PPL Corporation. There are no participants in the BBNPP project that are not part of the PPL Corporation or subsidiaries of the PPL Corporation.

The principal office of PPL Bell Bend, LLC is located in Allentown, Pennsylvania. Pennsylvania is the principal place of business.

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1.3 ORGANIZATION AND MANAGEMENT

A simplified organizational chart depicting the relationship between the Applicant and its direct and indirect parent companies is provided in Figure 1.0-1. The organization and management of each of the business entities depicted on the chart are discussed below.

1.3.1 PPL Bell Bend, LLC

The business and affairs of PPL Bell Bend, LLC are managed under the direction of a Board of Managers, currently consisting of four managers.

The Managers of the PPL Bell Bend, LLC, all of whom are U.S. citizens, are as follows:

James E. Abel

Victor N. Lopiano

Britt T. McKinney

William H. Spence

The Board of Managers is authorized to appoint officers for the conduct of the business of the Company and determine their responsibilities and duties.

The President, Victor N. Lopiano, is a U.S. citizen, is selected by the Board of Managers, and is the senior executive responsible for day to day operations of the Company. He has nuclear management experience.

The names, titles and addresses of the principal executives and officers of the Company, all of whom are U.S. citizens, are as follows:

PPL Bell Bend, LLC Principal Executives and Officers

Name	Title	Address
Victor N. Lopiano	President	Two North Ninth Street Allentown, PA 18101
Terry L. Harpster	Vice President - Bell Bend Project Development	38 Bomboy Lane, Suite 2 Berwick, PA 18603
Michael J. Caverly	Vice President - Financial	Two North Ninth Street Allentown, PA 18101
James E. Abel	Treasurer	Two North Ninth Street Allentown, PA 18101

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1.3.2 PPL BELL BEND HOLDINGS, LLC

The business and affairs of PPL Bell Bend Holdings, LLC are managed under the direction of a Board of Managers, currently consisting of four managers.

The Managers of the PPL Bell Bend Holdings, LLC, all of whom are U.S. citizens, are as follows:

James E. Abel

Victor N. Lopiano

Britt T. McKinney

William H. Spence

The Board of Managers is authorized to appoint officers for the conduct of the business of the Company and determine their responsibilities and duties.

The President, Victor N. Lopiano, is a U.S. citizen, is selected by the Board of Managers, and is the senior executive responsible for day to day operations of the Company. He has nuclear management experience.

The names, titles, addresses, of the principal executives and officers of the Company, all of whom are U.S. citizens, are as follows:

PPL Bell Bend Holdings, LLC Principal Executives and Officers

Name	Title	Address
Victor N. Lopiano	President	Two North Ninth Street Allentown, PA 18101
Terry L. Harpster	Vice President - Bell Bend Project Development	38 Bomboy Lane, Suite 2 Berwick, PA 18603
Michael J. Caverly	Vice President - Financial	Two North Ninth Street Allentown, PA 18101
James E. Abel	Treasurer	Two North Ninth Street Allentown, PA 18101

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1.3.3 PPL NUCLEAR DEVELOPMENT, LLC

The business and affairs of PPL Nuclear Development, LLC are managed under the direction of a Board of Managers, currently consisting of four managers.

The managers of PPL Nuclear Development, LLC, all of whom are U.S. citizens, are as follows:

James E. Abel

Victor N. Lopiano

Britt T. McKinney

William H. Spence

The Board of Managers is authorized to appoint officers for the conduct of the business of the Company and determine their responsibilities and duties.

The President, Victor N. Lopiano, is a U.S. citizen, is selected by the Board of Managers, and is the senior executive responsible for day-to-day operations of the Company. He has senior nuclear management experience.

The names, titles and addresses of the principal executives and officers of its Company, all of whom are U.S. citizens, are as follows:

PPL Nuclear Development, LLC Principal Executives and Officers

Name	Title	Address
Victor N. Lopiano	President	Two North Ninth Street Allentown, PA 18101
Terry L. Harpster	Vice President - Bell Bend Project Development	38 Bomboy Lane, Suite 2 Berwick, PA 18603
Britt T. McKinney	Vice President	769 Salem Boulevard Berwick, PA 18603
Michael J. Caverly	Vice President - Financial	Two North Ninth Street Allentown, PA 18101
James E. Abel	Treasurer	Two North Ninth Street Allentown, PA 18101

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1.3.4 PPL GENERATION, LLC

The business and affairs of PPL Generation, LLC are managed under the direction of a Board of Managers, currently consisting of four managers.

The managers of PPL Generation, LLC, all of whom are U.S. citizens, are as follows:

Paul A. Farr

Robert J. Grey

James H. Miller

William H. Spence

The Board of Managers is authorized to elect officers for the conduct of the business of the Company and determine their responsibilities and duties.

The President, William H. Spence, is selected by the Board of Managers, is a U.S. citizen, and is the senior executive responsible for day-to-day operations of the Company.

The names, titles and addresses of the principal executives and officers of its Company, all of whom are U.S. citizens, are as follows:

PPL Generation, LLC Principal Executives and Officers

Name	Title	Address
William H. Spence	President	Two North Ninth Street Allentown, PA 18101
Victor N. Lopiano	Senior Vice President	Two North Ninth Street Allentown, PA 18101
Britt T. McKinney	Senior Vice President and Chief Nuclear Officer	769 Salem Boulevard Berwick, PA 18603
Dennis J. Murphy	Vice President & Chief Operating Officer-Eastern Fossil and Hydro	Two North Ninth Street Allentown, PA 18101
Bradley E. Spencer	Vice President & Chief Operating Officer-Western Fossil and Hydro	303 North Broadway Suite 400 Billings, Montana 59101
Cornelius J. Gannon	Vice President	769 Salem Boulevard Berwick, PA 18603
William E. Riebling	Vice President-Engineering and Construction	Two North Ninth Street Allentown, PA 18101
James E. Abel	Treasurer	Two North Ninth Street Allentown, PA 18101

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1.3.5 PPL ENERGY SUPPLY, LLC

The business and affairs of PPL Energy Supply, LLC are managed under the direction of a Board of Managers, currently consisting of five managers.

The managers of PPL Energy Supply, LLC, all of whom are U.S. citizens, are as follows:

James E. Abel

Paul A. Farr

Robert J. Grey

James H. Miller

William H. Spence

The Board of Managers is authorized to elect officers for the conduct of the business of the Company and determine their responsibilities and duties.

The President, James H. Miller, is selected by the Board of Managers, is a U.S. citizen, and is the senior executive responsible for day to day operations of the Company.

The names, titles and addresses of the principal executives and officers of the Company, all of whom are U.S. citizens, are as follows:

PPL Energy Supply, LLC Principal Executives and Officers

Name	Title	Address
James H. Miller	President	Two North Ninth Street Allentown, PA 18101
Paul A. Farr	Executive Vice President	Two North Ninth Street Allentown, PA 18101
James E. Abel	Vice President and Treasurer	Two North Ninth Street Allentown, PA 18101
J. Matt Simmons, Jr.	Vice President and Controller	Two North Ninth Street Allentown, PA 18101

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1.3.6 PPL ENERGY FUNDING CORPORATION

The business and affairs of PPL Energy Funding Corporation are managed under the direction of a Board of Directors, currently consisting of five directors. There is no Chairman of the Board.

The directors of PPL Energy Funding Corporation, all of whom are U.S. citizens, are as follows:

James E. Abel

Paul A. Farr

Robert J. Grey

James H. Miller

William H. Spence

The Board of Directors is authorized to elect officers for the conduct of the business of the Company and determine their responsibilities and duties.

The President, James H. Miller, is selected by the Board of Directors, is a U.S. citizen, and is the senior executive responsible for day to day operations of the Company.

The names, titles and addresses of the principal executives and officers of the Company, all of whom are U.S. citizens, are as follows:

PPL Energy Funding Corporation Principal Executives and Officers

Name	Title	Address
James H. Miller	President	Two North Ninth Street Allentown, PA 18101
Paul A. Farr	Vice President	Two North Ninth Street Allentown, PA 18101
James E. Abel	Treasurer	Two North Ninth Street Allentown, PA 18101

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1.3.7 PPL CORPORATION

The business and affairs of PPL Corporation are managed under the direction of a Board of Directors, currently consisting of eleven directors. The Chairman of the Board is Mr. James H. Miller. Mr. Miller is a U.S. citizen. His address is Two North Ninth Street, Allentown, PA 18101.

The Chairman of the Board of Directors is appointed by, and may only be removed by the PPL Corporation Board Members. The Chairman chairs the meetings of the Board of Directors.

The other directors of PPL Corporation, all of whom are U.S citizens, are as follows:

Frederick M. Bernthal	Stuart Heydt
John W. Conway	Craig A. Rogerson
E. Allen Deaver	W. Keith Smith
Louise K. Goeser	Susan M. Stalnecker
Stuart E. Graham	Keith H. Williamson

The Board of Directors is authorized to elect officers for the conduct of the business of the Company and determine their responsibilities and duties.

Mr. Miller is also the President and Chief Executive Officer (CEO), who is selected by the Board of Directors and has senior nuclear management experience.

The names, titles, addresses, and citizenship of the principal executives and officers of the Company, all of whom are U.S. citizens, are as follows:

PPL Corporation Principal Executives and Officers

Name	Title	Address
James H. Miller	Chairman, President and CEO	Two North Ninth Street Allentown, PA 18101
Paul A. Farr	Executive Vice President and Chief Financial Officer	Two North Ninth Street Allentown, PA 18101
William H. Spence	Executive Vice President and Chief Operating Officer	Two North Ninth Street Allentown, PA 18101
Robert J. Grey	Senior Vice President, General Counsel and Secretary	Two North Ninth Street Allentown, PA 18101
James E. Abel	Vice President - Finance and Treasurer	Two North Ninth Street Allentown, PA 18101
J. Matt Simmons, Jr.	Vice President and Controller	Two North Ninth Street Allentown, PA 18101

1.3.8 FINANCIAL RELATIONSHIP BETWEEN PPL BELL BEND, LLC AND ITS OWNERS

PPL Energy Supply, LLC will provide (1) the initial capitalization and contribution of equity to PPL Bell Bend, LLC, required for projecting financing of construction; (2) a parent support agreement to make certain funding available during plant operations; and (3) a parent guarantee for decommissioning funding. The ability of PPL Energy Supply, LLC to meet these commitments is addressed in Sections 1.5 and 1.6.2 below.

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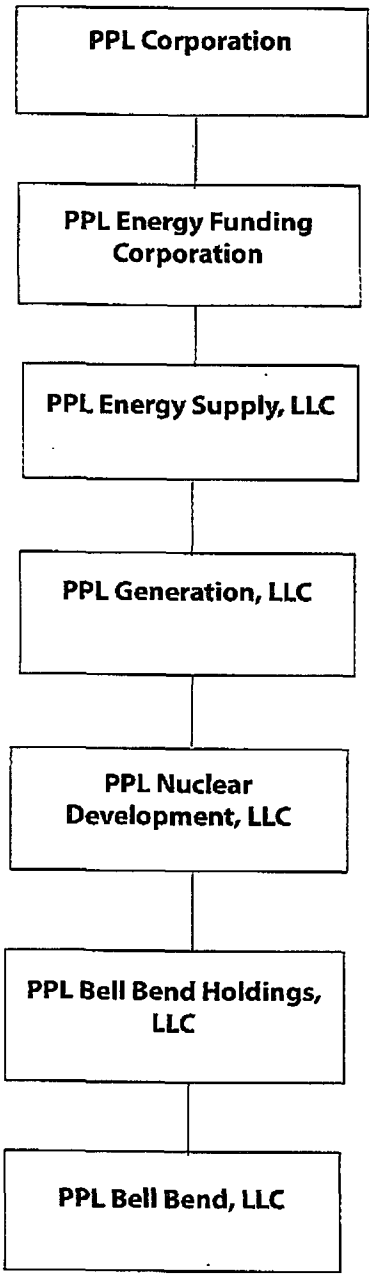
Figure 1.0-1 Organizational Structure



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T. L. Harpster
VP-Bell Bend Project-Development

PPL Bell Bend, LLC
38 Bomboy Lane, Suite 2
Berwick, PA 18603
Tel. 570.802.8111 FAX 570.802.8119
tlharpster@pplweb.com

October 9, 2009

RECEIVED
OCT 15 2009
SRBC

Project Review Coordinator
Susquehanna River Basin Commission
1721 North Front Street
Harrisburg, PA 17102-2391

ATTN: Paula B. Ballaron, Regulatory Program Director

BELL BEND NUCLEAR POWER PLANT
SUPPLEMENTAL INFORMATION FOR
APPLICATION FOR SURFACE WATER WITHDAWAL
APPLICATION FOR CONSUMPTIVE WATER USE
BNP-2009-307

Dear Ms. Ballaron:

Enclosed for the Susquehanna River Basin Commission's review please find supplemental application documents for the proposed Bell Bend Nuclear Power Plant (BBNPP), to be located in Salem Township, Luzerne County, PA. These materials are submitted in support of the application for surface water withdrawal and the application for consumptive water use for the project that were submitted to the Commission on May 13, 2009.

Representatives of PPL and the SRBC met on July 8, 2009 at the Commission's office to discuss the applications for the project. Based on our discussions, the Commission requested additional information to support the application review. This information is in response to that request.

The documents included in this supplemental application are mostly excerpts from or reports attached to the Combined Construction and Operating License Application (COLA) submitted to the Nuclear Regulatory Commission (NRC) for the project and can be found in that document. Additional information, such as letters from other agencies, are included also.

Should you are your staff have any questions, please contact Tinku Khanwalkar at 610-774-5466 or akhanwalkar@pplweb.com.

Respectfully,

Terry L. Harpster

TLH/kw

Attachment: Supplemental Application Documents

2009-078
2009-080 2009-079

ENTERED
Date: 10/16/09
Initials: [illegible]

cc: (w/o attachment)

Mr. Thomas W. Beauduy
Deputy Director
Susquehanna River Basin Commission
1721 North Front Street
Harrisburg, PA 17102-2391

Mr. Michael G. Brownell
Chief, Water Resources Management
Susquehanna River Basin Commission
1721 North Front Street
Harrisburg, PA 17102-2391

Mr. Paul O. Swartz
Executive Director
Susquehanna River Basin Commission
1721 North Front Street
Harrisburg, PA 17102-2391

bcc: V.N. Lopiano
M.J. Caverly
R.R. Sgarro
G.J. Kuczynski
J.V. Kelly
J.S. Fields
M.B. Detamore
B.A. Snapp
D.J. Paulin
A. Khanwalkar
C.S. Shamory
T.V. Jacobsen
N.A. Evans
J.C. Phillips

Attachment 1

Supplemental Application Documents

DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT, U.S. ARMY CORPS OF ENGINEERS
P.O. BOX 1715
BALTIMORE, MD 21203-1715

REPLY TO
ATTENTION OF
Operations Division

April 9, 2009

U.S. Nuclear Regulatory Commission
Ms. Stacey Imboden
11555 Rockville Pike
MS T – 7E30
Rockville, Maryland 20852

Dear Ms. Imboden:

This is written in response to your January 6, 2009 notice in the Federal Register for **PPL Bell Bend, LLC; Bell Bend Nuclear Power Plant Application; Notice of Intent To Prepare an Environmental Impact Statement and Conduct Scoping Process** for a proposed nuclear power facility, located on approximately 882 acres, five miles northeast of Berwick, in Luzerne County, Pennsylvania.

Pursuant to Section 10 of the Rivers and Harbors Act, a Department of the Army permit is required for work or structures in navigable waters of the United States and pursuant to Section 404 of the Clean Water Act, a Department of the Army permit is required for the discharge of dredged or fill material into waters of the United States, including jurisdictional wetlands. Any proposal to perform the above activities within the area of Federal jurisdiction will require the prior approval of this office. Since the proposed project involves work in the Susquehanna River, its adjacent waters and wetlands, it would appear that both a Section 10 permit and a Section 404 permit will be required.

In a letter dated December 29, 2008, the Nuclear Regulatory Commission (NRC) accepted the Corps of Engineers (Corps), an agency with jurisdiction by law, as a cooperating agency to ensure that the information presented in the National Environmental Policy Act (NEPA) document is adequate to fulfill the requirements of Corps regulations (33 CFR 320 through 332), the Clean Water Act Section 404(b)(1) Guidelines and the Corps public interest review process. To ensure that all Corps related information and/or issues are considered in the scoping process, the Corps requests to be involved with all writing sessions and to be a full participant in all phases of the draft environmental impact statement (DEIS), including the development of the purpose and need of the project. Based upon our review of the information received to date, the purpose and need of the project, as defined by the Corps, appears to be to "provide 1,600 MWe of additional base load electrical power to the northeast portion of the PJM (the Pennsylvania, Jersey, Maryland Regional Transmission Organization) grid".

As part of the evaluation of permit applications subject to Section 404 of the Clean Water Act, the Corps is required to apply the criteria set forth in the Environmental Protection Agency's (EPA) 404(b)(1) Guidelines (40 CFR Part 230, hereinafter "Guidelines"). The Guidelines establish criteria which must be met in order for the proposed activities to be permitted pursuant to Section 404. Specifically, these Guidelines state, in part, that no discharge of dredged or fill

material shall be permitted if there is a practicable alternative to the proposed discharge that would have less adverse impact on the aquatic ecosystem provided the alternative does not have other significant adverse consequences. An area not presently owned by the applicant which could reasonably be obtained, utilized, expanded or managed in order to fulfill the basic purpose of the proposed activity may be considered if it is otherwise a practicable alternative.

The Corps is required to evaluate permit applications based on an evaluation of the probable impacts, including cumulative impacts, of the proposed activity and its intended use on the public interests. The benefits which reasonably may be expected to accrue from the proposal must be balanced against its reasonably foreseeable detriments. Based upon our review of the available NRC information and the Corps defined purpose and need of the project, we have determined that the project, as proposed, will have an adverse impact to aquatic resources. Furthermore, because power generation does not need to be sited in wetlands to fulfill its basic project purpose, there is a presumption that alternatives exist that are less damaging to the aquatic environment. The information presented in the DEIS must be adequate to fulfill the requirements of the Corps 404(b)(1) alternatives analysis and the Corps public interest review (PIR) factors.

To fulfill the Corps requirements for an adequate 404(b)(1) alternatives analysis and the public interest interview, we are requesting that the following information be included in the DEIS:

1. A detailed analysis of all reasonable forms of energy that could meet the Corps' project purpose and need. The analysis should include, but not be limited to, fossil fuel, fission, hydroelectric, biomass, solar, wind, geothermal, and other potential near future options, including a complete description of the criteria used to identify, evaluate, and screen project alternatives. Project alternatives can and should include combinations of alternative forms of energy to meet the project purpose and need;

2. A detailed analysis of alternative locations for the project (or any of the alternative energy sources) that would have less impact to wetlands and waterways. The information presented at the alternative site audits during the week of March 30th included data and information relevant to constructing a nuclear power plant facility at three alternate site locations (known as candidate sites): the Sandy Bend site in Mifflin Co., PA; the Montour site in Montour Co., PA; and the Martins Creek site in Warren Co., NJ. While data collected using resource mapping is acceptable, site specific information regarding potential impacts to wetlands, endangered species, historic and archeological resources, floodplains, external substations, and external transmission corridors needs to be provided. For example, two of the candidate sites include access to existing transmission corridors. It is assumed that existing rights-of-ways (ROW's) would be used when possible to avoid unnecessary impacts to wetlands. In addition, when evaluating these candidate sites, the Corps believes that there are several ranking factors (as represented in the environmental report presented by AREVA) that should be excluded when evaluating the alternatives analysis in the DEIS. These ranking factors include, but are not limited to, additional land acquisition, expansion potential, and ownership. In relation to ownership, as stated above, the Guidelines specifically state that an area not presently

owned by the applicant which could be reasonably be obtained, utilized, expanded or managed in order to fulfill the basic purpose of the proposed activity may be considered if it is otherwise a practicable alternative;

3. A detailed analysis of the steps taken to minimize the proposed on-site impacts. This on-site analysis does not preclude the necessity to review the off-site alternatives or various forms of energy. This information must include the following:
   a.) Methods to avoid and minimize impacts to Waters of the U.S. This analysis should include:

      i.) Methods to relocate or redesign the proposed construction laydown areas to uplands; and
      ii.) Modification of the construction schedule so that the area proposed for permanent impacts could be utilized as construction laydowns areas.

   b.) For each on-site alternative, provide acreage and type of waters/wetlands that would be impacted (include both temporary and permanent). For waterways, include both the linear footage of waterway impacts (measured along the centerline of the waterway) and square feet of impact; for wetlands, include both square footage and acreage impacts; and for temporary wetland impacts, quantify any change in wetland classification (e.g., palustrine forested to palustrine emergent, etc.) and method of work to accomplish these changes;

4. Identify all preconstruction activities (associated with the construction of cooling ponds, haul roads, dredging, and other aspects of infrastructure necessary to support the construction of the Bell Bend plant) that will result in a discharge of dredged or fill material into Waters of the U.S., or work within the Susquehanna River (i.e. requiring a Department of the Army Section 404/Section 10 permit);

5. Provide quantities of water demand for Bell Bend's plant operation including water withdraw and consumptive use information. Include the low and the peak demand amounts for proposed water withdraw, water consumed, and water that will be discharged back into the Susquehanna River;

6. Since a permit will be required from the Susquehanna River Basin Commission (SRBC) for water withdraw/consumptive use, The DEIS will need to address the mitigation requirement for the water withdraw/consumptive use permit required from the Susquehanna River Basin Commission (SRBC). The DEIS will also need to address whether this mitigation will require Section 404 and/or Section 10 authorization(s);

7. A narrative to describe and quantify cumulative and *indirect* wetland and stream impacts resulting from the project;

8. The DEIS must incorporate a detailed mitigation and monitoring plan that complies with the Corps final mitigation rule, published April 10, 2008 (33 CFR Part 332). Approval of

9. A narrative addressing public benefits of the proposed project which is separate from the project's proponents' benefits;

10. A description of the relative extent of public and private need for the proposed project;

11. Copies of all previously issued Federal, State, and local permits and plans for the existing facilities at the project site as well as a description and plans for all mitigation completed for these previously authorized projects; and

12. A list of all required Federal, State, and local permits for the proposed project.

Please find enclosed a permit application checklist (Enclosure 1). These items are required for the Corps Individual Permit application package that Pennsylvania Power and Light (PPL) will submit directly to the Corps. In addition, in accordance with the final mitigation rule, PPL's application package must include a statement describing how impacts to waters of the U.S. are to be avoided and minimized.

Please be informed that additional information requests may be needed by the Corps as the EIS is developed. The information requested above, as well as any subsequent requests, is necessary information that the Corps will need to document our final permit decision.

If you have any questions concerning this matter or if you wish to meet with the Corps to discuss this correspondence, please call Mrs. Amy Elliott, at this office at (814) 235-0573.

Sincerely,

William P. Seib
Acting Chief, Regulatory Branch

Enclosure

Enclosure 1
PERMIT APPLICATION CHECKLIST
(Bell Bend Nuclear Power Plant)

General

- ✓ Describe the overall project and provide a general location map of the entire project area
- ✓ Show the relationship of the proposed work location to submerged and terrestrial historic sites; parks; named swamps and wetlands; streams; and any other natural resources of concern
- ✓ Provide a large view overall plan sheet of the project site showing the existing site conditions and the proposed work.
- ✓ Provide large plans and 8 ½" x 11" plan sheets for proposed impact areas
  - ✓ Provide top view, cross-section and/or profile drawings that include dimensions of all structures and fill proposed, including elevation and materials relative to jurisdictional waterway and wetland boundaries
- ✓ Provide a detailed written description of the project, including dimensions and structural composition of culverts, pipelines, building structures, access roads, stormwater management facilities and any other attendant features of project construction
  - ✓ Identify the disposal site(s) for excess fill material and suitable dredge material disposal, including site capacity and site plans
- ✓ Identify permanent and temporary impacts
  - ✓ Include a definition of temporary by timeframe and describe restoration of the proposed temporary impact
  - ✓ Indicate the anticipated impact area for use of temporary marsh mats, and indicate the dimensions and marsh mat
- ✓ Provide a timeline/schedule for the process of obtaining all Federal, State and local authorizations for the proposed project and provide a construction schedule
- ✓ Describe the purpose and need for the project, including public need and benefit, users, suppliers, any other supporting information
- ✓ Describe the existing land and waterway use of project site location
- ✓ Describe potential cumulative impacts relative to the purpose of the project and prospective for future additional expansion
- ✓ Describe on-site and off-site avoidance and minimization of impacts
  - ✓ Describe why impacts were not avoided
- ✓ Describe maintenance, including preservation, of existing structures and protection methods of those existing structures during the proposed project construction
  - ✓ Indicate the existing roads, buildings and/or facilities that would be removed or relocated
- ✓ Describe how the project construction and maintenance may affect the existing utility or roadways easement corridors relative to their maintenance and potential future expansion and address all potential safety issues relative to construction and operation within these types of corridors
  - ✓ Describe work in right-of-ways, including maintenance and amount of tree clearing in forested areas in these areas
- ✓ Describe the method of work including equipment access; staging areas; maintenance; restoration of pre-construction contours; stream diversion; and sequence of construction
- ✓ Overlay the proposed project plans on aerial photography (source and date indicated)
  - ✓ Overlay the proposed project area on maps showing the following (each of the maps should include the source, page/sheet number and date information):
    - ✓ Wetlands of Special State Concern (i.e. exceptional value – EV)
    - ✓ National Wetland Inventory
    - ✓ County soil surveys
    - ✓ Department of Natural Resources Wetland map
    - ✓ Topography map
- ✓ Provide any other supporting information
- ✓ Provide adjacent property owners names and addresses
  - ✓ Nearby community association names and addresses
    - ✓ The list of adjacent property owners should be provided in the application as well as electronic format (for printing mailing labels for the public notice)

Wetland/Streams

- ✓ Identify (list) all streams, named wetlands/swamps
  - ✓ The stream name must include a listing of all the downstream waterway links to the Susquehanna River - a description of the connection of the waterway/wetland to navigable waters (nontidal wetland adjacent to an unnamed tributary to X creek, which is a tributary to X river, a tributary to X River, which is a navigable waterway)
- ✓ Indicate the square foot area and acreage of each wetland proposed to be impacted and indicate whether it abuts, is adjacent to a stream or is isolated
  - ✓ Indicate the type of wetland proposed to be impacted
  - ✓ Indicate the total area of the wetland to be impacted and the proposed impact area
  - ✓ Indicate the latitude and longitude coordinates of each wetland proposed to be impacted
- ✓ Indicate the length and average width at the approximate ordinary high water mark of each stream proposed to be impacted
  - ✓ Indicate the total length and area of the stream to be impacted and the proposed impact length and area
  - ✓ Indicate the latitude and longitude coordinates of each stream proposed to be impacted at the upstream and downstream proposed impact limits
  - ✓ Describe the condition of the stream in the proposed impact area

Dredging (of the Susquehanna River)

Do you wish to have a 10-year maintenance dredging clause for the permit, if issued?

- ✓ Indicate the method of dredging
- ✓ Provide a legible plan showing the currently existing shoreline configuration as well as any other nearby pier facilities and/or remnants; pilings; shoreline erosion control structures; non- tidal wetlands; and property lines with adjacent property owners' names and addresses
- ✓ Show the project relative to any submarine cables; pipelines; outfalls; ditches; or any stormwater conveyance systems.
- ✓ For the proposed dredging, provide a cross-section drawing of the dredge area, including side slopes relative to the bottom substrate; and the ordinary high water mark.
- ✓ Indicate the disposal site, location, and capacity; and provide plans
- ✓. Describe the vessels utilizing the facility including type, length, width, and draft; the expected use of the proposed facility as it relates to navigational activity; the purpose of the proposed project; and the historic use of the property and project area waterway
- ✓ Indicate the distance from the channelward end of the proposed work to the navigational fairway.
- ✓ Identify fisheries and living resources information
- ✓ Identify future maintenance needs - siltation potential (for sloughing/settling); future continuous maintenance dredging; and the rate of sediment deposition based on increased boat wakes, shoreline development, etceteras
- ✓ Provide the bottom sediment substrate composition
- ✓ Provide a sediment analysis for the presence of hazardous dredgate and pollutants (volatiles; acid, basic, neutral compounds; pesticides; and PCBs)?

Other

- ✓ Describe invasive plant species monitoring and restoration, if necessary in proposed work areas
- ✓ Describe emergency procedures in the event of construction and operation accident
- ✓ Describe potential issues with return water into the Susquehanna River, such as thermal pollution; water quality; bottom scouring at outlet, etceteras
- ✓ Provide a copy of the Corps jurisdictional determination and plans

Note: Additional information may be necessary as determined during project evaluation.

Commonwealth of Pennsylvania

Department of Environmental Protection

Water Management: The proposed transmission line to transport sewage from the Bell Bend facility should be sized to handle flows from both the Susquehanna Steam Electric Station (SSES) and the Bell Bend facility, should SSES decide to terminate the existing Outfall 079 river discharge in the future.

Act 537 Planning approval for the facility's sewage is needed. Since Berwick is located in the Northcentral Region of DEP, that regional office will need to be contacted for that approval.

The Application did not identify the need to obtain a Water Quality Management Permit for the industrial wastewater treatment facilities that will be constructed to treat the wastewater before it is discharged to the Susquehanna River.

A detailed evaluation of the combined thermal effects of both the SSES and the proposed Bell Bend discharge will need to be included in the NPDES application.

The Application does not include all of the detailed information that is required to determine if the project will conform to all Water Management Program requirements.

The Application states that the closest impaired water body to the proposed project is the Little Nescopeck Creek. The closest 2008 Integrated Water Quality Monitoring and Assessment report listed impaired water body is the Susquehanna River.

Stream habitat assessment should be included in the measurement of success for the comparison of the natural stream design sections to the reference stream sections.

The effects of thermal discharges, chemical additives in discharges, impingement and entrainment issues of aquatic organisms from the existing SSES and the proposed Bell Bend facility intake and blowdown structures should continue being addressed together due to the close proximity of these intake structures to the Susquehanna River.

Watershed Management: There are issues related to filling the wetlands which may have a large impact on the project. Wetland replacement may be an issue.

There is an issue with Walker Run, with wild trout being found in a stream not on the Pa. Fish and Boat Commission's wild trout list. If the stream is reclassified, there is the potential that we will have to deal with EV wetlands. Current project design calls for a section of this stream to be relocated and piped.

Groundwater Monitoring: The application describes the pre-application hydrological monitoring program that will be implemented at the BBNPP site, including installations of groundwater (GW) monitoring wells. It is recommended that the applicant continue to maintain the existing wells, following the completion of the pre-construction phase, and for the purpose of future GW monitoring. The applicant should also make a commitment to develop and maintain a GW Monitoring and Protection Program, during plant operations, to comply with the industry's GW Protection Initiative.

Radioactive Waste Management/Low-Level Radioactive Waste (LLRW): The application contains a discussion of potential actions or measures to reduce the amount of Class B and C wastes. It is expected that the applicant will develop and implement an effective waste minimization plan to minimize the generation of all types of waste including

Class A and Greater-Than-Class C (GTCC) wastes. Additionally, the planned Radioactive Waste Processing Building at BBNPP may not have sufficient capacity for on-site storage of LLRW considering uncertainties associated with the future of LLRW and GTCC disposal. It is recommended that the applicant construct a separate temporary storage facility for LLRW and GTCC wastes, during the initial construction of the facility.

Radioactive Waste Management/Spent Nuclear Fuel (SNF): The Commonwealth has publicly expressed concerns regarding long-term storage of SNF at reactor sites. Considering that there is currently no permanent repository for SNF, it is possible that there will be a need for an Independent Spent Fuel Storage Installation (ISFSI) at the proposed BBNPP site in the future. Therefore, the applicant should demonstrate that the proposed site is adequate for construction of an ISFSI and dry storage of SNF during normal and extended plant operations, as applicable.

ISSUE SUMMARY
Form SOP-0402-07, Revision 7B

DESIGN CONTROL SUMMARY

CLIENT:	Unistar Nuclear Energy	UNIT NO.:	Page No.: 1
PROJECT NAME:	**Bell Bend Nuclear Power Plant**		
PROJECT NO.:	12198-004	☐ NUCLEAR SAFETY- RELATED	
CALC. NO.:	2008-07916	☒ NOT NUCLEAR SAFETY-RELATED	
TITLE:	Raw Water Supply System Pump and Pipe Sizing Calculation		
EQUIPMENT NO.:			

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Final for Approval

INPUTS/ ASSUMPTIONS
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APPROVER	R.A. Hameetman (see Rev. 0 for signature)	DATE:	4/18/2008

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Revision 1 incorporates the following changes:
1. Make up to UHS pond routed through media filters, and assumed intermittent make up rate to UHS storage pond revised from 2,000 gpm to 1,820 gpm.
2. Added manual isolation and bypass valves around UHS pond and FP water storage tank make up contol valves. Added manual isolation valve to UHS pond make up line downstream of control valve station.
3. Revised plant finish grade elevation from 675.5 ft. to 673 ft MSL.
4. Re-routed make up lines from FP building to FP water storage tanks.
5. Revised pipe lengths due to relocations of UHS storage and wastewater retention ponds, and piping re-route around wetlands.
6. Added piping and intermitttent 5 gpm flow for "floor wash" supply header to Turbine & Reactor Bldgs.
Revised pages: 2, 3, 4, 5, 6, 9, 10, 11, 12, 13, 14, 15, 16, and Attachments 1 and 2, all pages.
Added Attachment 9.

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3. Drawing 12198-004-RWSS-002, Rev. 0	1
4. ASME B16.9-2003 Mandatory Appendix I Table I11	1
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1 Purpose

The purpose of this calculation is to size the pumps and piping for the Bell Bend Raw Water Supply System.

2 Assumptions

2.1 The maximum pressure drop across the strainers is assumed to be 10 psid. This assumption is reasonable since the strainers are sized for a "clean screen" pressure drop of 2 psid at the design flow.

2.2 Pipe diameters are sized on maintaining average fluid velocities in the range of 6 to 14 feet per second.

2.3 Any combination of intermittent flows including makeup to the UHS storage pond, makeup to the Fire Protection System water storage tank, and media filter backwashing are assumed not to occur simultaneously. Only one media filter is backwashed at a time. [Unverified]

2.4 Makeup to the fire water protection storage tank is assumed to be initiated based on storage tank level, and will be supplied to the tank at the maximum rate of 625 gpm rather than a continuous flow of 5 gpm (Ref. 7.2).

2.5 The location of the raw water system tie in to the makeup demineralizers is not known at this time. For the purpose of this calculation, the raw water makeup connection is assumed to be at the demineralized water storage tanks. [Unverified]

2.6 The required supply pressure to the makeup demineralizer system is not known at this time. For the purpose of this calculation, a supply pressure of 10 psig is assumed. This assumption is reasonable, since 10 psig (23 ft head) should provide adequate NPSH to a small booster pump. [Unverified]

2.7 The total required head to pump to the UHS cooling towers is calculated based on the flow path to tower 3URB. This path bounds the pressure drop to the other towers since the path to 3URB is the longest (Ref.7.1 Fig. 1.2-3, Ref. 7.4), and the flow rates to the other towers are identical.

2.8 Square-edged flow metering orifices are typically designed with Beta ratios in the range of 0.65 to 0.70. For the purpose of calculating head loss in this calculation, the Beta ratios are conservatively assumed to be 0.65, since the smallest orifice opening produces the highest pressure drop across the orifice.

2.9 The plant high point of finish grade elevation of 673 ft. is assumed for the Bell Bend site (Ref. 7.19)

2.10 The elevation of the water level in the Fire Protection System water storage tanks is not known at this time. For the purpose of this calculation, the tank maximum water level is

assumed to be 20 feet above the plant grade elevation. This is reasonable for the height of a 300,000 gallon storage tank (Ref. 7.1, Section 9.5.1.2.1).

2.11 The RWSS tie in to the plant demineralized water system is assumed to be at an elevation of 3 feet above the plant grade elevation. This assumption is reasonable, since the raw water is assumed to be supplied to a small floor-mounted booster pump.

2.12 The elevation of the maximum water level in the UHS cooling tower basins is not known. For the purpose of this calculation, the maximum basin water level is assumed to be 10 feet above the plant grade elevation. [Unverified]

2.13 A pump efficiency of 80% is assumed for calculating the pump motor horsepower.

2.14 Raw water make up flow to the UHS cooling towers is based on 3 cycles of concentration. Per Calculation 2008-08550 (Ref. 7.18) the makeup flow rate is 1713 gpm to (2) UHS towers (1713 gpm /2 = 856.5 gpm/tower) and 3426 gpm total flow to (4) towers during shutdown/cooldown. [Unverified]

2.15 The limit on suspended solids for the UHS cooling towers is assumed to be 150 milligrams /liter. This assumption is reasonable since it is the limit recommended in Table 5-1, "Operating Guidelines for Cooling Tower Systems in Electric Power Plants" of Reference 7.11. [Unverified]

2.16 The anticipated rate of water loss from the UHS pond due to evaporation and seepage has not been determined. For the purposes of this calculation, a makeup rate of 1,820 gpm is assumed to be adequate for intermittent makeup flow. [Unverified]

2.17 The design flow for the demineralizers is increased from 80 gpm to 107 gpm for the purpose of cleaning the reverse osmosis filter for the demineralized water system (Ref. 7.18). [Unverified]

2.18 The amount of water required for backwashing the self-cleaning strainers is less than 5% of the throughput flow rate. This small intermittent flow is considered insignificant, and is not included in the pump and pipe sizing calculation.

2.19 The supply pressure to the floor wash header is assumed to be 35 psig [To be verified during detailed design].

3 Design Input

3.1 The source of water for the Raw Water Supply System (RWSS) is the Susquehanna River (Ref. 7.15).

3.2 The Raw Water Supply System (RWSS) provides the initial source of water supplied to the plant demineralized water, essential service water, and fire protection systems (Section 9.2.9, Ref. 7.1).

3.3 Potable and sanitary water will be supplied from the municipal water supply, and not from the RWSS (Ref. 7.17).

3.4 The maximum RWSS make up flow rate to the Fire Protection system is 625 gpm per Response to RFI SL-BER-053 dated 7/29/08 (Ref. 7.2).

3.5 Pipe lengths are obtained from the RWSS conceptual layout drawings (Refs. 7.4 and 7.5), and estimated from the conceptual intake structure general arrangement (Ref. 7.15).

3.6 The end-to-end dimensions for reducers are taken from Table I11 of Reference 7.10.

3.7 The media filter water velocity in the forward flow direction is 5 gpm/ ft^2 of filter surface (Ref. 7.13), and the velocity in the reverse flow for backwashing is 12 gpm/ft^2 of filter surface (Ref. 7.12).

3.8 The top of dike elevation for the UHS storage pond is 674 ft (Ref. 7.19).

3.9 5 gpm is supplied to the floor wash drains (Ref. 7.2).

3.10 The high water level in the wastewater retention basin is at elevation 678'-6" (Ref. 7.20).

4 Methodology and Acceptance Criteria

The calculation investigates pump and pipe sizes for two alternative designs based on two modes of system operation. One mode is to size the system to provide the water required for all the continuous water demands with the plant in shutdown/cooldown mode plus the single largest intermittent water demand. The pumps are sized to collectively handle the flow to (4) UHS towers, the demineralized water treatment system, and the flow required for filter backwashing.

A second mode is to size the system to provide the water required for the continuous water demands with the plant in normal operation. Each individual pump is sized to handle the water demand for (2) UHS cooling towers and the make up to the DWTS. In this mode, depending on plant status, a portion of the makeup water supplied to the UHS cooling towers is diverted to handle the intermittent water demands, including filter backwashing.

The attached flow diagrams represent the analysis for two modes of operation. Figure 1 represents the flow rates and line sizes for supplying all the continuous loads (four UHS cooling towers plus the demineralized water) simultaneously with supplying the largest intermittent load, which is the media filter backwash.

Figure 2 represents the flow rates and pipe sizes for maintaining flow to the demineralizers while partially diverting flow from the UHS cooling towers to supply water for filter backwashing.

The pipes are sized based on a fluid velocity of approximately 10 ft/sec for the anticipated flow rate per MES-2.11 (Ref. 7.7). The head loss for each section of piping is calculated for the maximum flow that is anticipated for that particular section. The pipe sections analyzed and the node points between sections are shown on Figures 1 and 2. The total friction head loss for the

piping is then found by summing the friction losses between the nodes for the limiting flowpath.

The following system flow paths are evaluated for total head loss:

1. RWS pumps to the wastewater retention pond.
2. RWS pumps to the demineralizer system.
3. RWS pumps to UHS cooling tower 3URB.
4. RWS pumps to the FP water storage tanks.
5. RWS pumps to the UHS pond.
6. RWS pumps to the farthest Turbine Building floor wash header isolation valve.

The flow rates shown on the flow diagrams are the maximum anticipated flow rates for a particular piping section. Therefore, the flow rates between nodes are not necessarily additive.

4.1 Pipe Sizes

The pipe sizes are selected based on the nearest pipe size for a velocity of approximately 10 ft/sec at the maximum flow for that section. The pipe diameters are calculated based on the continuity equation:

$$Q = V \times \frac{\pi d^2}{4}$$

Where:
Q = flow rate in ft^3/sec
V = design velocity, 10 ft./ sec
d = pipe diameter, ft.

Converting flow rate to gpm and pipe diameter to inches and rearranging terms gives the following equation:

$$d = 12 \times \sqrt{\frac{4Q}{7.48 \times 60 \times \pi V}}$$

Where:
Q = flow rate in gpm
d = pipe internal diameter, inches
V = design velocity, 10 ft. /sec

Pipe diameters are calculated in Attachment 1.

4.2 Piping Friction Loss Determination

Pipe is sized based on the assumed range of flow velocities. Pipe friction factors (f) for each pipe section are read from the Moody Chart (Ref. 7.6, Pg. A-24) based on the relative roughness of the pipe and the Reynolds Number of the flow. The relative roughness is calculated as the ratio of the absolute roughness (ε), for carbon steel pipe and the pipe internal diameter (D, in ft).

Relative roughness = ε / D (Ref. 7.6, Pg. A-24)

The Reynolds Number for the pipe section is calculated using the relation:

$$\mathrm{Re} = 123.9 \times \frac{dv\rho}{\mu}$$ (Ref. 7.6, Equation 3-3)

Where:
d = pipe internal diameter, inches
v = fluid velocity, ft/sec.
ρ = fluid density, lbm/ft^3
μ = absolute viscosity, centipoise

Friction head loss is calculated for each pipe section using the Darcy-Weisbach equation:

$$h_L = \frac{fLv^2}{D2g}$$ (Ref. 7.6, Equation 3-5)

Where:
h_L = head loss in pipe line or fitting, ft.
f = the friction factor for pipe or fitting (dimensionless) as read from Moody Chart
L = length of pipe, ft.
v = fluid velocity in pipe, ft/sec.
g = gravitational acceleration (32.2 ft./ sec^2)
D = pipe inside diameter, ft.

The head loss through valves and fittings is similarly calculated using the following equation:

$$h_L = K\frac{v^2}{2g}$$ (Ref. 7.6, Equation 3-14)

The resistance coefficients (K) used for pipe fittings and valves are generic values taken from Crane TP #410 (Ref. 7.6) and Sargent & Lundy Mechanical Engineering Guideline MES-2.16 (Ref. 7.8).

The K values used are shown for each fitting on Attachment 1.

Resistance coefficients for pipe reducers are calculated in the spreadsheet using the following equation:

$$K_2 = \frac{0.8 \times \sin\frac{\theta}{2} \times \left(1-\beta^2\right)}{\beta^4}$$ (Ref. 7.6, Eq. 2-15)

Similarly, the resistance coefficient for pipe increasers are calculated in Attachment 1 using the following equation:

$$K_2 = \frac{2.6 \times \sin\frac{\theta}{2} \times \left(1-\beta^2\right)^2}{\beta^4} \quad \text{(Ref. 7.6, Eq. 2-14)}$$

Where:
K_2 = the resistance coefficient based on the larger pipe diameter
β = the ratio of smaller to larger pipe diameters
θ = angle of convergence or divergence in enlargements or contractions in pipes

Flow orifices are assumed to be square-edged orifices. The resistance coefficients (K) for the orifices are calculated using the following relation:

$$K_{orifice} = \frac{1-\beta^2}{C^2 \times \beta^4} \quad \text{(Ref. 7.6, pg. A-20)}$$

Where:
β = ratio of orifice diameter to pipe inside diameter
C = orifice flow coefficient

The orifice flow coefficient (C) used in this calculation is 0.67 and is read from a graph of orifice flow coefficients (Ref. 7.6 pg A-20), based on fully developed turbulent flow and the assumed orifice beta ratio (Assumption 2.8).

4.3 Pump Sizing Calculation

The pumps are sized for the maximum flow rate plus a margin of 10% and the maximum calculated head loss including a 10% margin applied to the piping friction loss per Ref. 7.9. The calculation is shown in Attachment 1.

Pump brake horsepower is calculated using the equation:

$$Bhp = \frac{gpm \times H(ft) \times sp.gr.}{3960 \times efficiency} \quad \text{(Ref. 7.14)}$$

4.4 Acceptance Criteria

There are no acceptance criteria since this is a calculation for a conceptual design.

5 Calculations

5.1 Media Filters and Backwash Flow

The media filters are dual-media (sand and anthracite) pressure filters. The filters will be sized to filter the anticipated continuous flow requirements for normal power operation. This includes the design flow to two cooling towers plus the water continuously supplied to the demineralized water system. The design flow rate through an individual filter bed is thus 1820 gpm [2 x 856.5 gpm + 107 gpm].

The media filter water velocities are 5 gpm/ft^2 and 12 gpm/ft^2 for forward and reverse flows, respectively (Design Input 3.7).

$$V_1 = \frac{5gpm}{1ft^2} \qquad V_2 = \frac{12gpm}{1ft^2}$$

The filtering and back wash flow rates, Q_1 and Q_2 respectively, expressed in terms of the continuity equation:

$$Q_1 = V_1 \times A_1 = \frac{5gpm}{ft^2} \times A_1 \qquad Q_2 = V_2 \times A_2 = \frac{12gpm}{ft^2} \times A_2$$

Since the filter vessel diameters are constant, the cross sectional areas are also constant:

$$A_1 = A_2$$

Equating the terms for the areas and rearranging, the flow rate required for backwashing is thus:

$$Q_2 = \frac{V_2}{V_1} \times Q_1 = \frac{12gpm/ft^2}{5gpm/ft^2} \times 1820gpm = 4368gpm$$

A second media filter bed is used to supply flow to the two additional UHS cooling towers during shutdown/cooldown operation, and the third filter bed is used to supply intermittent flows including make up to the Fire Protection water storage tank, UHS storage pond, floor wash drains, and backwash water for one of the filter beds.

The fourth filter bed is assumed to be in backwash mode.

5.2 Pipe Section Flow Rates

The Figure 1 maximum flow rates through the individual pipe sections upstream of Node C are based supplying the single largest intermittent flow (media filter backwash), simultaneously with the design flow for the demineralized water system and (4) UHS towers. The maximum flow rate for the pipe section between Nodes C-D is based on supplying (4) UHS towers simultaneously with design flow to the demineralized water system and the UHS storage pond. The flow rate for the pipe section between Nodes D-E is based on supplying maximum flow to the FP Water

Storage tank simultaneously with the design flow for the demineralized water system and (4) UHS towers.

The flow rates shown on Figure 1 are summarized as follows:

Pipe Section	Water Demand	Max. Flow Rate
Node J to 3URB	(1) UHS tower	856.5 gpm
Node H to Node J	(2) UHS towers	1713 gpm
Node F to Node H	(2) UHS towers FP Water Storage Tank Total	1713 625 2338 gpm
Node E to Node L	Floor wash drains Demin Water Supply Total	5 107 112 gpm
Node E to Node F	(4) UHS towers FP Water Storage Tank Total	3426 625 4051 gpm
Node D to Node E	(4) UHS Towers FP Water Storage Tank Demin Water Supply Total	3426 625 107 4158 gpm
Node C to Node D	(4) UHS Towers Demin Water Supply UHS Storage Pond Total	3426 107 1820 5353 gpm
Node A to Node C	(4) UHS Towers Demin Water Supply Filter Backwash Total	3426 107 4368 7901 gpm

In Figure 2, the flow rate in the pipe sections between Nodes A and C is based on running all three raw water pumps at their design flows of 1820 gpm per pump. The maximum raw water flow available for make up to the UHS towers is thus:

3 filter beds x 1,820 gpm/filter bed	5,460 gpm
Less continuous flow to DWTS	(107 gpm)
	5,353 gpm

Maximum flow to each UHS basin = 5,353 gpm /4 UHS tower basins = 1,338.25 gpm

The flow rate through the pipe sections between Nodes C and E is based supplying the design flow to (3) media filters.

The flow rate between Nodes E and F is based on supplying (4) UHS towers at maximum flow rates of 1,338 gpm per tower simultaneously with the design flow of 107 gpm to the demineralized water system.

If the normal makeup to the UHS tower basins is partially diverted to provide filtered water for

filter backwashing, the basin level will decrease. After the backwash cycle has been completed, the makeup to the UHS tower basins is increased to the maximum capacity of the filters to recover tower basin level in the minimum time. The flow rates in the branch sections to the UHS tower basins are based on providing the maximum makeup flow through (3) media filters, without simultaneous makeup to the FP storage tank or UHS storage pond.

The flow rate between Nodes F and H is based on supplying (2) UHS towers at their maximum flow rate simultaneously with make up to the FP Water Storage Tank at the design flow of 625 gpm.

The flow rates shown on Figure 2 are summarized below:

Pipe Section	Water Demand	Max. Flow Rate
Node A to Node B	(4) UHS towers Demin Water System Filter Backwash Total	985 107 4368 5460 gpm
Node B to Node D	(3) Media Filters	5460 gpm
Node D to Node E	(4) UHS towers Demin Water System Total	5353 107 5460 gpm
Node E to Node L	Floor wash Demin Water System Total	5 107 112 gpm
Node E to Node F	(4) UHS towers	5353 gpm
Node F to Node G	(2) UHS towers	2677 gpm
Node F to Node H	(2) UHS towers FP Storage Tank Total	2677 625 3302 gpm
Node H to Node J	(2) UHS towers	2677 gpm

5.3 Pipe Sizing

The pipe sizing calculations are shown in Attachment 1.

5.4 Line Resistance Losses

The friction losses for the various sections of piping are calculated in Attachment 1, pages 1 through 4, and pages 6 through 10 for Figures 1 and 2, respectively. The total friction loss for the limiting run of piping is also shown on the spreadsheet. The equations used for calculating the pipe sizes, line losses, and pump sizes are shown in their respective cells on Attachment 1, pages 12-27.

5.5 Pump Sizing

The pump capacities are sized for the maximum anticipated flow rate plus a 10% margin. A margin of 10% is also applied to the system friction losses for determining the required total dynamic head of the pumps. These margins are applied to the pump sizing only, and are not fed

back into the pipe friction loss calculation.

The total maximum required flow rate for Figure 1 is 7,901 gpm [4 x 856.5 + 107 + 4,368], which is based on water supplied to the demineralized water system, (4) UHS cooling towers, and backwash of one media filter. Since the makeup flows to the UHS pond, Fire Protection water storage tank, floor wash, and filter backwashes are all intermittent flows, it is assumed that these flows will not occur simultaneously. Therefore, the pumps are sized on continuous flows to four UHS towers during plant shutdown/cooldown, water to the demineralizers, and the maximum intermittent flow, which is for media filter backwashing. The pump sizing calculation for Figure 1 is tabulated on Attachment 1, page 5.

The total maximum required flow rate for Figure 2 is 5,460 gpm [3 x 1713 + 107], which is based on three raw water pumps operating at the individual design flows of 1820 gpm. The pump sizing calculation for Figure 2 is tabulated on Attachment 1, page 11.

6 Results and Discussion

System Head Loss

The required pump total developed head (TDH) is largest in the flow path to UHS cooling tower basin 3URB in both Figure 1 and in Figure 2 (584 ft and 616 ft, respectively). The variation in head loss between the flow paths for Figure 1 is 30% [(584-449)/449], and for Figure 2 is 22% [(616-506)/506].

A supply pressure of 10 psig was assumed for the tie in point to the demineralized water system. The pressure to the demineralizer system can be then be increased using a small booster pump that is sized to accommodate the head loss in the water conditioning equipment. Sizing the raw water pumps based a higher terminal pressure would require a substantial increase in motor horsepower. A supply pressure of 35 psig was assumed for the floor wash header; however, this will be verified during detailed design.

Media Filters

Media filters are capable of handling suspended solids up to 1,000 mg/liter and provide about 90% removal (Ref. 7.13, pg. 9-18). The highest TSS concentration reported for samples taken from the Susquehanna River in 2007 indicate a concentration of 152 mg/l (Ref. 7.16). Conservatively assuming only an 80% removal efficiency for the media filters, the raw water supplied to the UHS cooling towers would then be at most 30.4 mg/l [0.2 x 152]. This TSS concentration is low enough to allow 3 cycles of concentration of the UHS cooling towers, and still remain within the EPRI recommended maximum limit of 150 mg/l (Ref. 7.11).

For both Figures 1 and 2, each media filter is sized to supply (2) UHS cooling towers at their design flow rates of 856.5 gpm per tower and the demineralized water system and the design flow of 107 gpm.

Figure 1 requires an increase in the forward flow rate through the on-line filters from 5 gpm/ft^2 to about 7.5 gpm/ft^2 to accommodate the increased flow required for backwashing one of the filters. While this velocity is not recommended over a long period, it is deemed to be acceptable for the relatively short time during the backwash cycle. This would require a gradual increase in flow rate through the on-line filters to prevent "break-through" of dirty water from the filters.

Alternatively in Figure 2, the water supplied to the UHS towers could be temporarily diverted to provide water to the filter being backwashed. Since the UHS tower basins have a 3-day storage capacity, this capacity could be drawn down during the backwash cycle, and subsequently made up after the backwash has been completed. The additional makeup flow to the cooling towers would then be provided by the third media filter, while maintaining the forward flow velocity through the filters at a constant 5 gpm/ft^2.

Raw Water Pumps

The calculated pump sizes are based on the maximum flow and the maximum total developed head for all flow paths evaluated. This results in a pump size of approximately 2,900 gpm at 584 ft. TDH for Figure 1, and 2,000 gpm at 616 ft TDH for Figure 2.

Due to the decreased flow rate in Figure 2, the required motor horsepower is reduced by approximately 144 h.p. [534-390].

The recommended pump size is 2,900 gpm at a total developed head of 584 feet requiring 550 BHP. Three pumps of this size would be adequate for the flows and head losses calculated for Figure 1. Detailed calculations including development of a hydraulic model of the system will be required to match pump performance with the system resistances at lower flow conditions and various system alignments prior to specifying the pumps.

7 References

7.1 U.S. EPR Final Safety Analysis Report, Rev. 0.

7.2 Response to RFI SL-BER-053 dated 7/29/08 (Attachment 9)

7.3 Calvert Cliffs Unit 3 COLA.

7.4 Drawing 12198-004-RWSS-003, Sheet 1, Rev. 1, "Conceptual Raw Water Supply System Main Header Bell Bend Nuclear Power Plant Unistar Nuclear Pennsylvania" (Attachment 2). [Unverified]

7.5 Drawing 12198-004-RWSS-003, Sheet 2, Rev. 1, "Conceptual Raw Water Supply System Main Header Bell Bend Nuclear Power Plant Unistar Nuclear Pennsylvania" (Attachment 2). [Unverified]

7.6 "Flow of Fluids Through Valves, Fittings and Pipe", Technical Paper No. 410, Crane Company, 21st Printing, 1982.

7.7 Sargent & Lundy LLC Mechanical Engineering Guideline MES-2.11, Rev. 8, "Recommended Allowable Velocities in Piping Systems."

7.8 Sargent & Lundy LLC Mechanical Engineering Guideline MES-2.16, Rev. 4., "Pressure Drop Across Fittings, Valves, and Discontinuities."

7.9 Sargent & Lundy LLC Mechanical Engineering Guideline MES-21.2, Rev. 2, "Sizing Miscellaneous Horizontal and Vertical Centrifugal Pumps."

7.10 ASME B16.9-2003, "Factory Made Wrought Buttwelding Fittings" (Table I11 shown as Attachment 4).

7.11 "Design and Operating Guidelines Manual for Cooling-Water Treatment; Treatment of Recirculated Cooling Water", EPRI Research Project 1261-1 Final Report, Electric Power Research Institute, March 1982 (EPRI Report Cover Sheet and Table 5-1 shown as Attachment 5).

7.12 Betz Handbook of Industrial Water Conditioning, 6th Edition, Betz Laboratories Inc., 1962 (Pages 39-41 shown as Attachment 6).

7.13 The NALCO Water Handbook, 1979, Nalco Chemical Company (Pages 9-18 through 9-21 shown as Attachment 7).

7.14 Cameron Hydraulic Data, 16th Edition, Ingersoll-Rand.

7.15 Drawing 12198-004-RWS-002, Rev. 0, "Conceptual Raw Water Supply System Intake Structure Bell Bend Nuclear Power Plant". [Unverified]

7.16 Email dated 2/15/2008 from M. Cain (Unistar) to G. Wrobel (Unistar), "FW:Comments on RFI SL-BER-051." (Attachment 8)

7.17 Calculation 2008-07674, Rev. 1, "Conceptual Sizing of the Potable Water System."

7.18 Calculation 2008-08550, Rev. 1, "Bell Bend Unit 1 Water Balance." [Unverified]

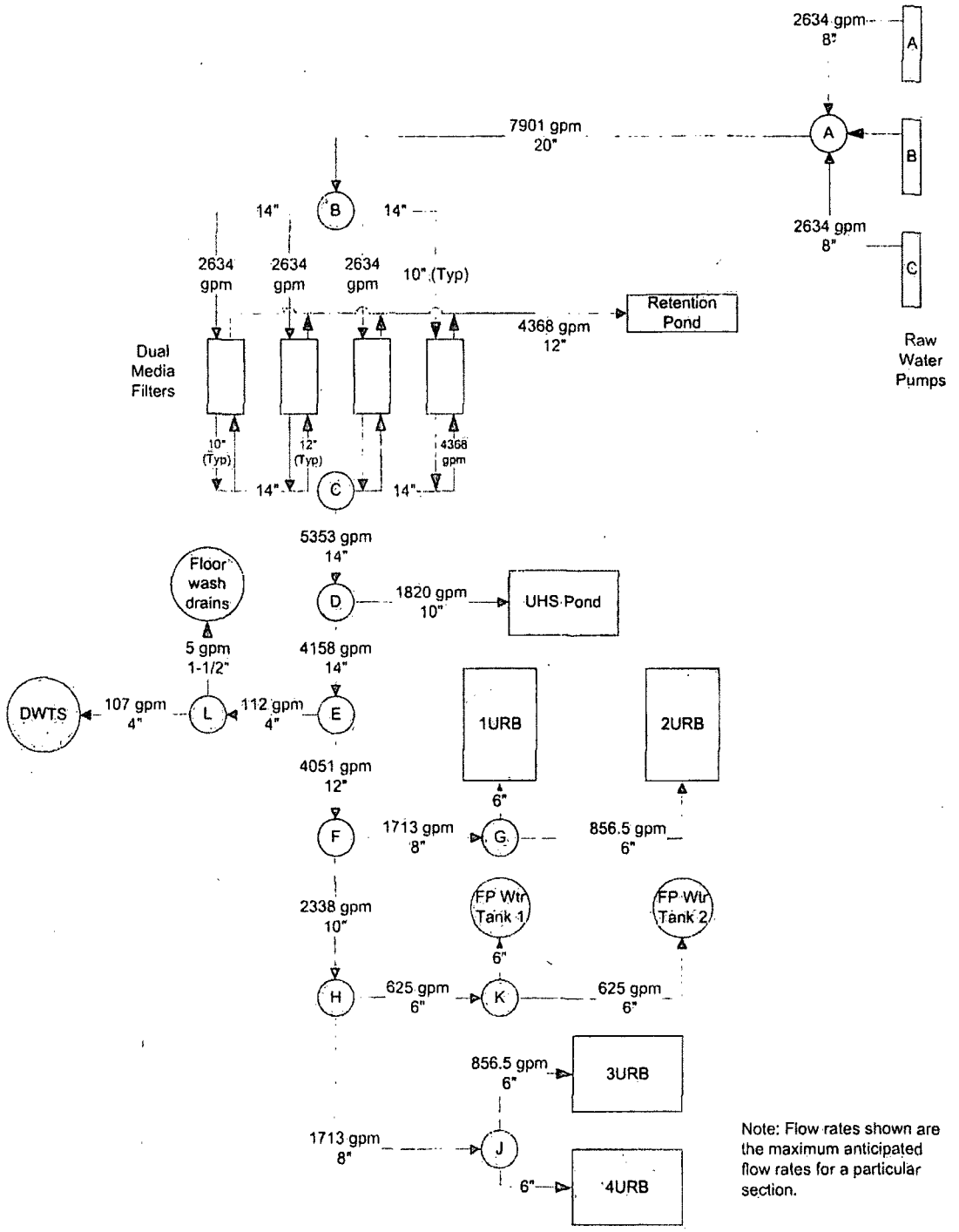
7.19 Drawing 12198-004-CSK-006, Rev. 4, "Conceptual Grading and Drainage Plan Sheet 6 Bell Bend Nuclear Power Plant Unistar Nuclear, Pennsylvania".

7.20 Drawing 12198-004-CWS-003, Rev. 1, "Conceptual Retention Basin General Arrangement Bell Bend Nuclear Power Plant Unistar Nuclear Pennsylvania".

8 Software

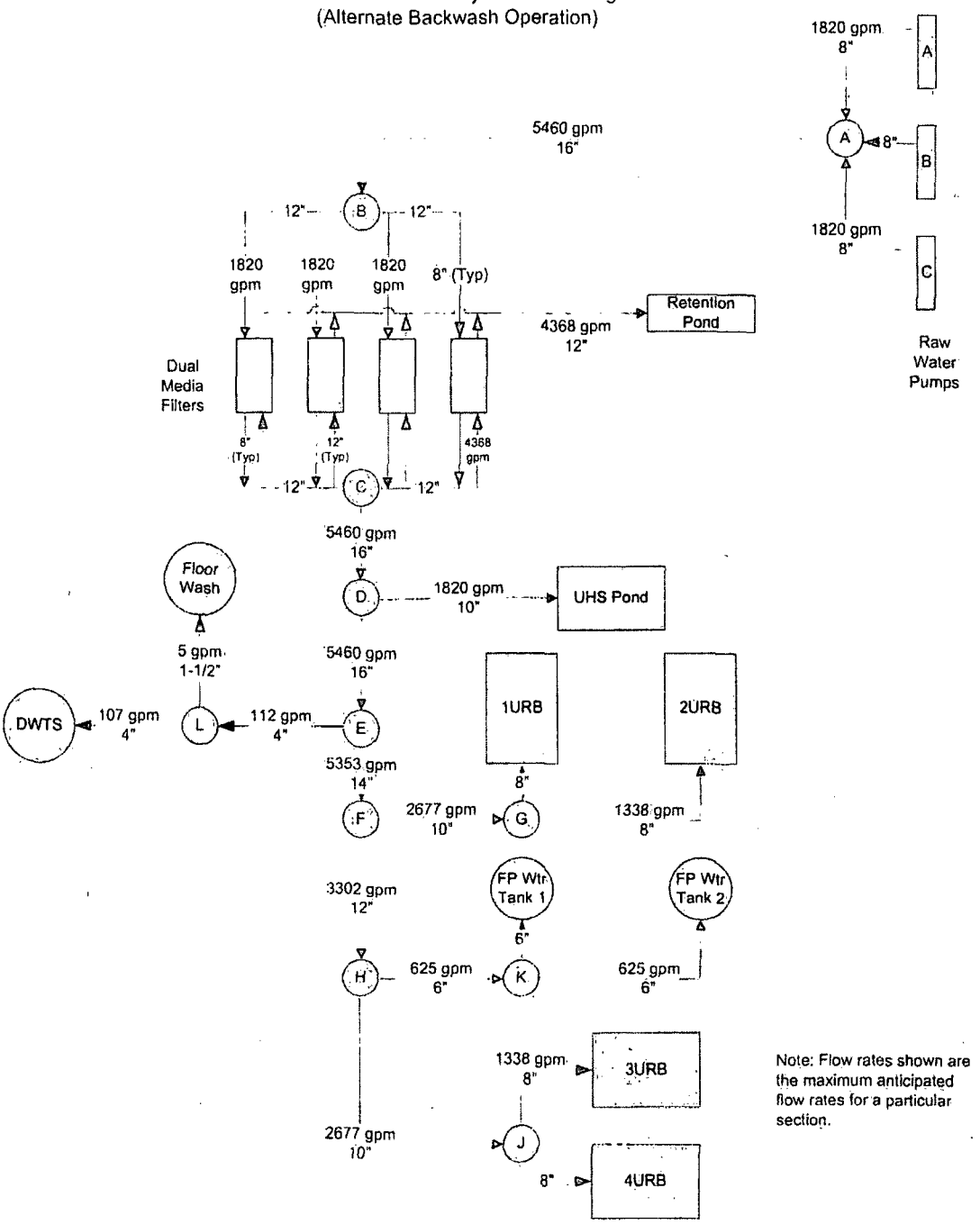
This calculation was performed using Microsoft Excel Version 11.0 on S&L Laptop Computer No. ZL4578 using Microsoft Windows XP Professional Version 5.1.2600.

Figure 1
Bell Bend Raw Water System Flow Diagram
(Filter Backwash Concurrent with Continuous Flow to UHS Towers and DWTS)



Note: Flow rates shown are the maximum anticipated flow rates for a particular section.

Figure 2
Bell Bend Raw Water System Flow Diagram
(Alternate Backwash Operation)



Note: Flow rates shown are the maximum anticipated flow rates for a particular section.

CS pipe absolute roughness (ε), ft	0.00015
Absolute viscosity (μ), centipoise	1.299
Density (ρ), lb/ft^3	62.41
Water velocity, ft/sec	10

Pipe Reducers	d_1	d_2	β	fitting end-end dist	$\theta/2$	$\sin(\theta/2)$	K_2
8" x 6" reducer	6.065	7.981	0.76	6.00	0.16	0.16	0.160
10" x 8" reducer	7.981	10.02	0.80	7.00	0.14	0.14	0.105
20" x 14" reducer	13.124	18.812	0.70	20.00	0.14	0.14	0.244
12" x 10" reducer	10.020	11.938	0.84	8.000	0.12	0.12	0.057
14" x 12" reducer	11.938	13.124	0.91	13.000	0.05	0.05	0.009
4" x 1-1/2" reducer	1.610	4.026	0.40	4.000	0.29	0.29	7.597

Reducing Tees	Run Flow (Q_3, Q_4)	Branch Flow (Q_2, Q_5)	Run dia. (d_3, d_4)	Branch dia. (d_2, d_5)	Run Area (A_3, A_4)	Branch Area (A_2, A_5)	A_5/A_3 A_5/A_4	Q_2/Q_3 Q_5/Q_4	K
20" x 8" red Tee; conv. flow through branch	7901	2634	18.812	7.981	277.95	50.03	0.18	0.33	3
14" x 10" red. Tee; diverg. flow through branch	5353	1820	13.124	10.020	135.28	78.85	0.58	0.34	0.975
14" x 10" red. Tee; diverg. flow through run	5353	0	13.124	10.020	135.28	78.85	0.58	0.00	0.04
14" x 10" red. Tee; diverg. flow through branch	5268	2634	13.124	10.020	135.28	78.85	0.58	0.50	1.1
14"x 10" red. Tee; conv. flow through branch	5268	2634	13.124	10.020	135.28	78.85	0.58	0.50	0.8
14"x 4" red. Tee; diverg flow through branch	4158	107	13.124	4.026	135.28	12.73	0.09	0.03	1.2
14" x 2" red. Tee; diverg. flow thru run	4158	107	13.124	2.067	135.28	3.36	0.02	0.03	0.0025
12" x 8" red. Tee; diverg. flow through run	4051	1713	11.938	7.981	111.93	50.03	0.45	0.42	0
10" x 6" red. Tee; diverg. flow through run	2338	625	10.020	6.065	78.85	28.89	0.37	0.27	0
10" x 6" red Tee; diverg. flow through branch	2338	625	10.020	6.065	78.85	28.89	0.37	0.27	1.1
14" x 12" red. Tee; diverg. flow through branch	4368	4368	13.124	11.938	135.28	111.93	0.83	1.00	1.3

Water Demand	Flowrate (gpm)	Required Pipe Internal Area (ft^2)	Required Pipe ID (in.)
Pump A/B/C	2634	0.587	10.373
Makeup Demineralizers	107	0.024	2.091
Floor wash	5	0.001	0.452
Fire Protection Water Storage Tank	625	0.139	5.053
UHS Makeup (per tower)	857	0.191	5.915
UHS Makeup Header (two towers)	1713	0.382	8.365
Filter backwash	4368	0.973	13.358
Makeup to UHS Pond	1820	0.405	8.623
Pump Header to Node B	7901	1.760	17.966

Resistance Losses	Flow (gpm)	L (ft)	d (in)	D (ft)	v (ft/sec)	ε/D	Re	f	K	h_L	Refs.
Pump A/B/C suction losses											
Screen head loss (assume 1 ft)	2634									1.00	
Inlet bell (assume 10"; r/d=0.02)	2634		10.020	0.84	10.72				0.28	0.50	
Subtotal										1.50	
Pump A/B/C Discharge to Header (Node A)											
8" pipe (Sch 40)	2634	74	7.981	0.67	16.89	0.00023	8.02E+05	0.015		7.39	
8" swing check valve (Qty 1)	2634		7.981	0.67	16.89				0.75	3.32	K from Table MES-2.16-01
8" gate valve, full port (Qty 1)	2634		7.981	0.67	16.89				0.12	0.53	K from Table MES-2.16-1
90° elbow (8 inch; r/d=1.5) (Qty 4)	2634		7.981	0.67	16.89				0.21	3.72	K from Table MES-2.16-02
strainer (assume max. 10 psid)	2634									23.10	
20" pipe (Sch 40)	7901		18.812	1.57	9.12						
20" x 8" red Tee; conv. flow through branch (Qty. 1)									3.00	3.88	K from Table MES-2.16-03a
Subtotal										41.95	
Node A-B											
20" pipe (Sch 40)	7901	10492	18.812	1.57	9.12	0.00010	1.02E+06	0.013		112.39	
90° elbow (20 inch; r/d=1.5) (Qty 10)	7901		18.812	1.57	9.12				0.18	2.35	K from Table MES-2.16-02
45° elbow (20 inch; r/d=1.5) (Qty 4)	7901		18.812	1.57	9.12				0.13	0.67	K from Table MES-2.16-02
Subtotal										115.41	
Node B-C											
20" x 14" reducer	5267		18.812	1.57	6.08				0.244	0.14	K from Crane pg. A-26
14" pipe (Sch 40)	5267	20	13.124	1.09	12.49	0.00014	9.76E+05	0.014		0.62	
10" pipe (Sch 40)	2634	10	10.020	0.84	10.72	0.00018	6.39E+05	0.015		0.32	
14" x 10" red. Tee; diverg. flow through branch (Qty 1)									1.10	2.67	K from Table MES-2.16-03a
90° elbow (10 inch; r/d=1.5) (Qty 2)	2634		10.020	0.84	10.72				0.21	0.75	K from Table MES-2.16-02
10" globe valve; full port (Qty 2)	2634		10.020	0.84	10.72				6.00	21.40	K from Table MES-2.16-01
bed pressure drop (assume 10 psid)										23.10	
14"x 10" red. Tee; converging flow through branch (Qty 1)									0.80	1.94	K from Table MES-2.16-03a
Subtotal										50.93	
Node C-D											
14" pipe (Sch. 40)	5353	186	13.124	1.094	12.70	0.00014	9.92E+05	0.015		6.39	
14" x 14" Std. Tee; diverging flow through branch (Qty 1)									0.90	2.25	K from Table MES-2.16-02
Subtotal										8.64	

Resistance Losses	Flow (gpm)	L (ft)	d (in)	D (ft)	v (ft/sec)	d/D	Re	f	K	h_L	Refs.
Node D to UHS Pond											
10" pipe (Sch 40)	1820	811	10.020	0.84	7.41	0.00018	4.42E+05	0.015		12.41	
14" x 10" red. Tee; diverging flow through branch (Qty 1)									0.98	2.44	K from Table MES-2.16-03a
90° elbow (10 inch; r/d=1.5) (Qty 4)	1820		10.020	0.84	7.41				0.21	0.72	K from Table MES-2.16-02
45° elbow (10 inch; r/d=1.5) (Qty 2)	1820		10.020	0.84	7.41				0.15	0.26	K from Table MES-2.16-02
10" butterfly valve (Qty 1)	1820		10.020	0.84	7.41				0.53	0.45	K from Crane pg. A-28
10" gate valve (Qty 3)	1820		10.020	0.84	7.41				0.12	0.31	K from Table MES-2.16-01
Exit to pond	1820		10.020	0.84	7.41				1.00	0.85	K from Crane pg. A-28
Subtotal										17.42	
Node D-E											
14" pipe (Sch 40)	4156	1951	13.124	1.094	9.86	0.00014	7.70E+05	0.0145		39.07	
14" x 10" red. Tee; diverging flow through run (Qty 1)									0.04	0.10	K from Table MES-2.16-03
Subtotal										39.17	
Node E-L											
4" pipe (Sch 40)	112	222	4.026	0.336	2.82	0.00045	6.77E+04	0.02		1.64	
14"x 4" red. Tee; diverg flow through branch (Qty 1)									1.20	1.81	K from Table MES-2.16-03a
Subtotal										3.45	
Node L to DWTS											
4" pipe (Sch 40)	107	14	4.026	0.336	2.70	0.00045	6.46E+04	0.02		0.09	
4" std Tee; diverging flow through run (Qty 1)									0.24	0.03	K from Table MES-2.16-02
4" gate valve; full port (Qty 2)	107		4.026	0.336	2.70				0.16	0.04	K from Table MES-2.16-01
4" globe valve; full port (Qty 1)	107		4.026	0.336	2.70				8.00	0.90	K from Table MES-2.16-01
4" square edged orifice (β=0.65)	107		4.026	0.336	2.70				7.21	0.81	Crane TP-410 pg. A-20
Subtotal										1.88	
Node L to Floor Wash											
4" std Tee; diverging flow through branch (Qty 1)									1.2	0.15	K from Table MES-2.16-02
4" x 1-1/2" reducer (Qty 1)	5		4.026	0.34	0.13				7.597	0.002	K from Crane pg. A-26 Formula 1
1-1/2" pipe (Sch 40)	5	525	1.610	0.134	0.79	0.00112	7.55E+03	0.033		1.25	
1-1/2" std Tee; diverging flow through run (Qty 1)									1.056	0.01	K from Table MES-2.16-02
90° elbow (1-1/2 inch; r/d=1.5) (Qty 2)									1.98	0.04	K from Table MES-2.16-02
1-1/2" globe valve									13.2	0.13	K from Table MES-2.16-01
Subtotal										1.57	
Node E-F											
14" x 2" Red. Tee; diverg. flow thru run (Qty 1)									0.0025	0.00378	K from Table MES-2.16-03a
14" x 12" reducer	4051		13.124	1.094	9.61				0.009	0.01	K from Crane pg. A-26 Formula 1
12" pipe (Sch 40)	4051	341	11.938	0.995	11.61	0.00015	8.25E+05	0.014		10.05	
Subtotal										10.07	
Node F-H											
8" pipe (Sch 40)			7.981	0.665		0.00023	0.00E+00				
12" x 8" red. Tee; diverg. flow through run (Qty 1)									0.000	0.00	K from Table MES-2.16-03a
12" x 10" reducer	2338		11.938	0.995	6.70				0.057	0.04	K from Crane pg. A-26 Formula 1
10" pipe (Sch 40)	2338	1196	10.020	0.835	9.51	0.00018	5.67E+05	0.015		30.19	
Subtotal										30.23	

Resistance Losses	Flow (gpm)	L (ft)	d (in)	D (ft)	v (ft/sec)	ε/D	Re	f	K	h_L	Refs.
Node H-J											
8" pipe (Sch 40)	1713	468	7.981	0.665	10.99	0.00023	5.22E+05	0.0155		20.44	
10" x 8" reducer	1713		10.020	0.835	6.97				0.105	0.08	K from Crane pg. A-26 Formula 1
10" x 6" red. Tee; diverg. flow through run (Qty 1)									0.00	0.00	K from Table MES-2.16-03a
Subtotal										20.52	
Node J to 3URB											
Wye; 8 inch; diverging flow (Qty 1)									0.40	0.76	K from Table MES-2.16-02
45° elbow (8 inch; r/d=1.5) (Qty 1)									0.16	0.22	K from Table MES-2.16-02
8" x 6" reducer (Qty 1)	857		7.981	0.665	5.49				0.16	0.07	K from Crane pg. A-26 Formula 1
6" pipe (Sch 40)	857	142	6.065	0.505	9.51	0.00030	3.43E+05	0.0165		6.51	
6" gate valve; full bore (Qty 2)	857		6.065	0.505	9.51				0.132	0.37	K from Table MES-2.16-01
6" globe valve; full bore (Qty 1)	857		6.065	0.505	9.51				6.6	9.27	K from Table MES-2.16-01
6" square edged orifice (β=0.65)	857		6.065	0.505	9.51				7.21	10.13	
6" butterfly valve (Qty 1)	857		6.065	0.505	9.51				0.7425	1.04	K from Crane pg. A-28
6" swing check valve (Qty 1)	857		6.065	0.505	9.51				0.825	1.16	K from Table MES-2.16-01
6" std Tee; converg flow through run (Qty 1)	857		6.065	0.505	9.51				0.4455	0.63	K from Table MES-2.16-02
exit loss to basin	857		6.065	0.505	9.51				1	1.41	K from Crane pg. A-29
Subtotal										31.56	
Node H to FP Water Storage Tank 2											
10" x 6" red Tee; diverge flow through branch (Qty 1)									1.10	1.55	K from Table MES-2.16-03a
6" pipe (Sch 40)	625	143	6.065	0.505	6.94	0.00030	2.51E+05	0.017		3.60	
6" x 6" Std. Tee; diverging flow through run (Qty 1)									0.204	0.16	K from Table MES-2.16-02
6" butterfly valve (Qty 1)	625		6.065	0.505	6.94				0.765	0.57	K from Crane pg. A-28
6" gate valve (Qty 3)	625		6.065	0.505	6.94				0.136	0.31	K from Table MES-2.16-01
Exit loss to tank	625		6.065	0.505	6.94				1	0.75	
Subtotal										6.92	
Node C to Retention Basin											
14" pipe (Sch 40)	4368	20	13.124	1.094	10.36	0.00014	8.09E+05	0.014		0.43	
12" pipe (Sch 40)	4368	361.5	11.938	0.995	12.52	0.00015	8.90E+05	0.014		12.38	
14" x 12" red Tee; diverg flow through branch (Qty 1)									1.30	0.00	K from Table MES-2.16-03a
12" globe valve; full port (Qty 2)	4368		11.938	0.995	12.52				5.6	27.27	K from Table MES-2.16-01
12" std. Tee; converg flow through branch (Qty 1)	4368		11.938	0.995	12.52				0.406	0.99	K from Table MES-2.16-02
90° elbow (12 inch; r/d=1.5) (Qty 2)	4368		11.938	0.995	12.52				0.196	0.95	K from Table MES-2.16-02
Filter pressure drop (assume 10 psid)										23.10	
Subtotal										65.12	

Intake structure min. water elev., ft.	484
Pump datum elev., ft	484
Plant grade elev., ft	673
UHS Pond top of dike elev., ft.	674
W/W Retention Basin max. water elev., ft.	678.5
FP Water Tank Lvl (above grade), ft.	20
Demin Tie In (above grade), ft	3
UHS Tower Basin Lvl (above grade), ft.	10
Floor wash hose bibbs (above grade), ft.	4
Static suction head	0
Pump suction resistance losses, ft	1.50
10% margin	0.15
Total Suction Head	-1.65

Demand	Max GPM (3 pump op)	Design GPM (1 pump op)	Discharge Elevation (ft)	Max Discharge Pressure (psig)
UHS Cooling Tower Basin	3426	1713	683	0
Demineralizers	107	107	676	10
Floor wash	0	0	677	35
Fire Protection Water Storage Tank	0	0	693	0
UHS Pond	0	0	674	0
Filter Backwash to Retention Basin	4368	0	678.5	0
Total Flow	7901	1820		
10% margin	790	182		
Flow per pump	**2897**	**2002**		

Flow Path	RW Pumps to 3URB	RW Pumps to Demin Water	RW Pumps to FP Tank	RW Pumps to Retention Basin	RW Pumps to UHS Pond	RW Pumps to Floor Wash
Head at discharge	0	23.1	0	0	0	80.85
Friction Losses	348.48	261.42	303.32	273.41	234.35	261.12
10% margin	34.85	26.14	30.33	27.34	23.44	26.11
Static Discharge Head	199	192	209	195	190	193
Total Discharge Head (ft)	582	503	543	495	448	561
Total Developed Head (ft)	**584**	**504**	**544**	**497**	**449**	**563**

Pump motor horsepower (0.8 efficiency)	**534**

CS pipe absolute roughness (ε), ft	0.00015
Absolute viscosity (μ), centipoise	1.299
Density (ρ), lb/ft³	62.41
Water velocity, ft/sec	10

Pipe Reducers / Increaser	d_1	d_2	β	fitting end-end dist	θ/2	sin(θ/2)	K_2
14" x 12" reducer	11.938	13.124	0.91	13.000	0.05	0.05	0.009
10" x 8" reducer	7.981	10.020	0.80	7.00	0.14	0.14	0.105
12" x 10" reducer	10.02	13.124	0.76	8.00	0.19	0.19	0.187
16" x 12" reducer	11.938	15.000	0.80	14.00	0.11	0.11	0.079
16" x 14" reducer	13.124	15.000	0.87	14.00	0.07	0.07	0.021
12" x 16" increaser	11.938	15.000	0.80	14.00	0.11	0.11	0.095
4" x 1-1/2" reducer	1.61	4.026	0.40	4.00	0.29	0.29	7.597

Reducing Tees	Run Flow (Q_3, Q_4)	Branch Flow (Q_2, Q_5)	Run dia. (d_3, d_4)	Branch dia. (d_2, d_5)	Run Area (A_3, A_4)	Branch Area (A_2, A_5)	A_5/A_3 A_5/A_4	Q_5/Q_3 Q_5/Q_4	K
16" x 8" red Tee: conv. flow through branch	5460	1820	15.000	7.981	176.71	50.03	0.28	0.33	1.25
16" x 10" red. Tee; diverg. flow through branch	5460	1820	15.000	10.020	176.71	78.85	0.45	0.33	1.1
16" x 10" red. Tee; diverg. flow through run	5460	0	15.000	10.020	176.71	78.85	0.45	0.00	0.04
12" x 8" red. Tee; diverg. flow through branch	3640	1820	11.938	7.981	111.93	50.03	0.45	0.50	1.3
12"x 8" Red. Tee; conv. flow through branch	3640	1820	11.938	7.981	111.93	50.03	0.45	0.50	1.25
16"x 4" red. Tee; diverg flow through branch	5460	107	15.000	4.026	176.71	12.73	0.07	0.02	1.2
16" x 2" red. Tee; diverg. flow through run	5460	107	15.000	2.067	176.71	3.36	0.02	0.02	0.025
14" x 10" red. Tee; diverg flow through run	5353	2677	13.124	10.020	135.28	78.85	0.58	0.50	0.025
12" x 6" red. Tee; diverg. flow through run	3302	625	11.938	6.065	111.93	28.89	0.26	0.19	0
12" x 6" red Tee; diverg. flow through branch	3302	625	11.938	6.065	111.93	28.89	0.26	0.19	1.2

Water Demand	Flowrate (gpm)	Required Pipe Internal Area (ft²)	Required Pipe ID (in.)
Pump A/B/C	1820	0.406	8.623
Makeup Demineralizers	107	0.024	2.091
Floor wash	5	0.001	0.452
Fire Protection Water Storage Tank	625	0.139	5.053
UHS Makeup (per tower)	1338	0.298	7.394
UHS Makeup Header (two towers)	2677	0.596	10.457
Filter backwash	4368	0.973	13.358
Makeup to UHS Pond	1820	0.406	8.623
Pump Header to Node B	5460	1.217	14.935

Resistance Losses	Flow (gpm)	L (ft)	d (in)	D (ft)	v (ft/sec)	ε/D	Re	f	K	h_L	Refs.
Pump A/B/C suction losses											
Screen head loss (assume 1 ft)	1820									1.00	
Inlet bell (assume 10°; r/d=0.02)	1820		10.020	0.84	7.41				0.28	0.24	
Subtotal										1.24	
Pump A/B/C Discharge to Header (Node A)											
8" pipe (Sch 40)	1820	74	7.981	0.67	11.67	0.00023	5.5E+05	0.0155		3.65	
8" swing check valve (Qty 1)	1820		7.981	0.67	11.67				0.78	1.64	K from Table MES-2.16-01
8" gate valve, full port (Qty 1)	1820		7.981	0.67	11.67				0.12	0.26	K from Table MES-2.16-01
90° elbow (8 inch; r/d=1.5) (Qty 4)	1820		7.981	0.67	11.67				0.22	1.84	K from Table MES-2.16-02
strainer (assume max. 10 psid)	1820									23.10	
16" pipe (Sch 40)	5460		15.000	1.25	9.91	0.00012	8.9E+05	0.0135			
16" x 8" red Tee; conv. flow through branch (Qty. 1)									1.25	1.91	K from Table MES-2.16-03a
Subtotal										32.39	
Node A-B											
16" pipe (Sch 40)	5460	10492	15.000	1.25	9.91	0.00012	8.9E+05	0.0135		172.92	
90° elbow (16 inch; r/d=1.5) (Qty 10)	5460		15.000	1.25	9.91				0.19	2.88	K from Table MES-2.16-02
45° elbow (16 inch; r/d=1.5) (Qty 4)	5460		15.000	1.25	9.91				0.14	0.82	K from Table MES-2.16-02
16" std. Tee; converg. through branch (Qty 1)	5460		15.000	1.25	9.91				0.39	0.60	K from Table MES-2.16-02
Subtotal										177.23	
Node B-C											
16" x 12" reducer	3640		15.000	1.25	6.61				0.08	0.05	K from Crane pg. A-26 Formula 1
12" pipe (Sch 40)	3640	20	11.938	0.99	10.43	0.00015	7.4E+05	0.0145		0.49	
8" pipe (Sch 40)	1820	10	7.981	0.67	11.67	0.00023	5.5E+05	0.0155		0.49	
12" x 8" red. Tee; diverg. flow through branch (Qty 1)									1.30	2.20	K from Table MES-2.16-03a
90° elbow (8 inch; r/d=1.5) (Qty 2)	1820		7.981	0.67	11.67				0.22	0.92	K from Table MES-2.16-02
8" globe valve; full port (Qty 2)	1820		7.981	0.67	11.67				6.20	26.24	K from Table MES-2.16-01
bed pressure drop (assume 10 psid)										23.10	
12"x 8" Red. Tee; converg. flow through branch (Qty 1)	1820								1.25	2.11	K from Table MES-2.16-03a
12" x 16" increaser	3640		15.000	1.25	6.61				0.09	0.06	K from Crane pg. A-26 Formula 3
Subtotal										55.67	

Resistance Losses	Flow (gpm)	L (ft)	d (in)	D (ft)	v (ft/sec)	ε/D	Re	f	K	h_L	Refs.
Node C-D											
16" pipe (Sch 40)	5460	186	15.000	1.250	9.91	0.00012	8.9E+05	0.014		3.18	
16" std. Tee; diverg. Flow through branch (Qty 1)	5460		15.000	1.250	9.91				0.84	1.28	K from Table MES-2.16-02
Subtotal										4.46	
Node D to UHS Pond											
10" pipe (Sch 40)	1820	811	10.020	0.84	7.41	0.00018	4.4E+05	0.015		12.41	
16" x 10" red. Tee; diverging flow through branch (Qty 1)	1820								1.10	1.68	K from Table MES-2.16-03a
90° elbow (10 inch; r/d=1.5) (Qty 4)	1820		10.020	0.84	7.41				0.21	0.72	K from Table MES-2.16-02
45° elbow (10 inch; r/d=1.5) (Qty 2)	1820		10.020	0.84	7.41				0.15	0.26	K from Table MES-2.16.02
10" butterfly valve (Qty 1)	1820		10.020	0.84	7.41				0.53	0.45	K from Crane pg. A-28
10" gate valve (Qty 3)	1820		10.020	0.84	7.41				0.12	0.31	K from Table MES-2.16-01
Exit to pond	1820		10.020	0.84	7.41				1.00	0.85	K from Crane pg. A-29
Subtotal										16.66	
Node D-E											
16" pipe (Sch 40)	5460	1951	15.000	1.250	9.91	0.00012	8.9E+05	0.014		33.35	
16" x 10" red. Tee; diverging flow through run (Qty 1)									0.04	0.06	K from Table MES-2.16-03a
Subtotal										33.41	
Node E-L											
4" pipe (Sch 40)	112	222	4.026	0.336	2.92	0.00045	6.8E+04	0.02		1.64	
16"x 4" red. Tee; diverg flow through branch (Qty 1)									1.20	1.83	K from Table MES-2.16-03a
Subtotal										3.47	
Node L to DWTS											
4" pipe (Sch 40)	107	14	4.026	0.336	2.70	0.00045	6.5E+04	0.02		0.09	
4" std. Tee; diverging flow through run (Qty 1)									0.24	0.03	K from Table MES-2.16-02
4" gate valve; full port (Qty 2)	107		4.026	0.336	2.70				0.16	0.04	K from Table MES-2.16-01
4" globe valve; full port (Qty 1)	107		4.026	0.336	2.70				8.00	0.90	K from Table MES-2.16-01
4" square edged orifice (β=0.65)	107		4.026	0.336	2.70				7.21	0.81	Crane pg. A-20
Subtotal										1.88	
Node L to Floor Wash											
4" std. Tee; diverging flow through branch (Qty 1)									1.2	0.15	K from Table MES-2.16-02
4" x 1-1/2" reducer (Qty 1)	5		4.026	0.336	0.13				7.597	0.002	K from Crane pg. A-26 Formula 1
1-1/2" pipe (Sch 40)	5	525	1.610	0.134	0.79	0.00112	7.55E+03	0.033		1.25	
1-1/2" std Tee; diverging flow through run (Qty 1)									1.056	0.01	K from Table MES-2.16-02
90° elbow (1-1/2 inch; r/d=1.5) (Qty 2)									1.98	0.04	K from Table MES-2.16-02
1-1/2" globe valve									13.2	0.13	K from Table MES-2.16-01
Subtotal										1.57	

Resistance Losses	Flow (gpm)	L (ft)	d (in)	D (ft)	v (ft/sec)	ε/D	Re	f	K	h_L	Refs.
Node E-F											
16" x 14" reducer	5353		15.000	1.25	9.72				0.021	0.03	K from Crane pg. A-26 Formula 1
14" pipe (Sch 40)	5353	341	13.124	1.094	12.70	0.00014	9.9E+05	0.014		10.93	
16" x 2" red. Tee; diverg. flow thru run (Qty 1)									0.025	0.04	K from Table MES-2.16-03a
Subtotal										11.00	
Node F-H											
14" x 10" red. Tee; diverg flow through run (Qty 1)									0.03	0.06	K from Table MES-2.16-03a
14" x 12" reducer (Qty 1)									0.009	0.02	K from Crane pg. A-26 Formula 1
12" pipe (Sch 40)	3302	1196	11.938	0.995	9.46	0.00015	6.7E+05	0.0145		24.24	
Subtotal										24.33	
Node H-J											
10" pipe (Sch 40)	2677	468	10.020	0.835	10.89	0.00018	6.5E+05	0.015		15.48	
12" x 10" reducer (Qty 1)									0.187	0.26	K from Crane pg. A-26 Formula 1
12" x 6" red. Tee; diverg. flow through run (Qty 1)									0.00	0.00	K from Table MES-2.16-03a
Subtotal										15.74	
Node J to 3URB											
Wye; 10 inch; diverging flow (Qty 1)									0.39	0.72	K from Table MES-2.16-02
45° elbow; (10 inch; r/d=1.5) (Qty 1)									0.15	0.17	K from Table MES-2.16-02
10" x 8" reducer	1338		10.020	0.835	5.44				0.10	0.05	K from Crane pg. A-26 Formula 1
8" pipe (Sch 40)	1338	142	7.981	0.665	8.58	0.00023	4.1E+05	0.016		3.91	
8" gate valve; full bore (Qty 2)	1338		7.981	0.665	8.58				0.128	0.29	K from Table MES-2.16-01
8" globe valve; full bore (Qty 1)	1338		7.981	0.665	8.58				6.4	7.32	K from Table MES-2.16-01
8" square edged orifice (β=0.65)	1338		7.981	0.665	8.58				7.21	8.24	
8" butterfly valve (Qty 1)	1338		7.981	0.665	8.58				0.72	0.82	K from Crane pg. A-28
8" swing check valve (Qty 1)	1338		7.981	0.665	8.58				0.8	0.91	K from Table MES-2.16-01
8" std Tee; converg.through run (Qty 1)	1338		7.981	0.665	8.58				0.432	0.49	K from Table MES-2.16-02
exit loss to basin	1338		7.981	0.665	8.58				1	1.14	K from Crane pg. A-29
Subtotal										24.07	

Resistance Losses	Flow (gpm)	L (ft)	d (in)	D (ft)	v (ft/sec)	ε/D	Re	f	K	h_L	Refs.
Node H to FP Water Storage Tank 2											
12" x 6" red Tee; diverge through branch (Qty 1)									1.200	1.67	K from Table MES-2.16-03a
6" pipe (Sch 40)	625	143	6.065	0.505	6.94	0.00030	2.5E+05	0.017		3.60	
6" butterfly valve (Qty 1)	625		6.065	0.505	6.94				0.765	0.57	K from Crane pg. A-28
6" gate valve (Qty 3)	625		6.065	0.505	6.94				0.138	0.31	K from Table MES-2.16-01
Exit loss to tank	625		6.065	0.505	6.94				1	0.75	K from Crane pg. A-29
Subtotal										6.89	
Node C to Retention Basin											
12" pipe (Sch 40)	4368	361.5	11.938	0.995	12.52	0.00015	8.9E+05	0.014		12.38	
12" globe valve; full port (Qty 2)	4368		11.938	0.995	12.52				5.6	27.27	K from Table MES-2.16-01
12" std. Tee; diverg through branch (Qty 1)	4368		11.938	0.995	12.52				0.84	2.04	K from Table MES-2.16-02
12" std. Tee; converg through branch (Qty 1)	4368		11.938	0.995	12.52				0.406	0.99	K from Table MES-2.16-02
90° elbow (r/d=1.5) (Qty 2)	4368		11.938	0.995	12.52				0.198	0.95	K from Table MES-2.16-02
Filter pressure drop (assume 10 psid)										23.10	
Subtotal										66.74	

Intake structure min. water elev., ft.	484
Pump datum elev., ft	484
Plant grade elev., ft	673
UHS Pond top of dike elev, ft.	674
W/W Retention Basin max water elev., ft.	678.5
FP Water Tank Lvl (above grade), ft.	20
Demin Tie In (above grade), ft	3
UHS Tower Basin Lvl (above grade), ft.	10
Floor wash hose bibbs (above grade), ft.	4
Static suction head	0
Pump suction resistance losses, ft	1.24
10% margin	0.12
Total Suction Head	-1.36

Demand	Max GPM (3 pump op)	Design GPM (1 pump op)	Discharge Elevation (ft)	Max Discharge Pressure (psig)
UHS Cooling Tower Basin	985	1713	683	0
Demineralizers	107	107	676	10
Floor wash	0	0	677	35
Fire Protection Water Storage Tank	0	0	693	0
UHS Pond	0		674	0
Filter Backwash to Retention Basin	4368	0	678.5	0
Total Flow	5460	1820		
10% margin	546	182		
Flow per pump	**2002**	**2002**		

Flow Path	RW Pumps to 3URB	RW Pumps to Demin Water	RW Pumps to FP Tank	RW Pumps to Retention Basin	RW Pumps to UHS Pond	RW Pumps to Floor Wash
Head at discharge	0	23.1	0	0	0	80.85
Friction Losses	378.30	308.51	345.38	332.03	286.42	308.20
10% margin	37.83	30.85	34.54	33.20	28.64	30.82
Static Discharge Head	199	192	209	195	190	193
Total Discharge Head (ft)	615	554	589	560	505	613
Total Developed Head (ft)	**616**	**556**	**590**	**561**	**506**	**614**

Pump motor horsepower (0.8 efficiency)	**390**

	A	B	C	D	E	F	G	H	I	J	K
1											
2											
3	CS Pipe assumed roughness (ft)	0.00015									
4	Absolute viscosity (μ) centipoise	1.200									
5	Density (ρ) lb/ft³	62.4									
6	Flow velocity, ft/sec	10									
7											
8	Pipe Reducers	d_1	d_2	θ	fitting and and dia	θ/2	sin(θ/2)	K_e			
9	3" x 10" reducer	4.063	27.981	=B4*C9	10	=ATAN((C9-B9)/2/E9)	=SIN(F9)	=0.8*G9*(1-G9^2)/H9^4			
10	10" x 16" reducer	9.981	15.02	=B4*C10	17	=ATAN((C10-B10)/2/E10)	=SIN(F10)	=0.8*G10*(1-G10^2)/H10^4			
11	20" x 14" reducer	19.124	13.812	=B4*C11	20	=ATAN((C11-B11)/2/E11)	=SIN(F11)	=0.8*G11*(1-G11^2)/H11^4			
12	12" x 10" reducer	11.02	11.938	=B4*C12	4	=ATAN((C12-B12)/2/E12)	=SIN(F12)	=0.8*G12*(1-G12^2)/H12^4			
13	16" x 12" reducer	15.938	13.124	=B4*C13	13	=ATAN((C13-B13)/2/E13)	=SIN(F13)	=0.8*G13*(1-G13^2)/H13^4			
14	6" x 1-1/2" reducer	1.61	6.078	=B4*C14	1	=ATAN((C14-B14)/2/E14)	=SIN(F14)	=0.8*G14*(1-G14^2)/H14^4			
15											
16	Reducing Tees	Run Flow (Q_1, Q_3)	Branch Flow (Q_2, Q_4)	Run dia. (d_1, d_3)	Branch dia. (d_2, d_4)	Run Area (A_1, A_3)	Branch Area (A_2, A_4)	A_2/A_1 A_4/A_3	Q_2/Q_1 Q_4/Q_3	K	
17	20" x 8" red Tee conv. flow through branch	7901	2634	19.813	7.981	=PI()/2*E17^2/4	=PI()/2*F17^2/4	=G17/E17	=H17/E17	1	
18	24" x 12" red. Tee diverg. flow through branch	5263	1320	23.124	11.02	=PI()/2*E18^2/4	=PI()/2*F18^2/4	=G18/E18	=H18/E18	0.975	
19	18" x 10" red Tee diverg. flow through run	1320	0	17.124	10.02	=PI()/2*E19^2/4	=PI()/2*F19^2/4	=G19/E19	=H19/E19	0.54	
20	18" x 10" red. Tee diverg. flow through branch	5268	7934	17.124	10.02	=PI()/2*E20^2/4	=PI()/2*F20^2/4	=G20/E20	=H20/E20	1.1	
21	14" x 10" red. Tee conv. flow through branch	5268	2634	13.124	10.02	=PI()/2*E21^2/4	=PI()/2*F21^2/4	=G21/E21	=H21/E21	1.2	
22	14" x 4" red. Tee diverg. flow through branch	1158	107	13.124	3.929	=PI()/2*E22^2/4	=PI()/2*F22^2/4	=G22/E22	=H22/E22	1.2	
23	14" x 2" red. Tee diverg. flow through run	1158	137	13.124	2.067	=PI()/2*E23^2/4	=PI()/2*F23^2/4	=G23/E23	=H23/E23	0.0025	
24	12" x 6" red. Tee diverg. flow through run	4051	1713	11.938	5.981	=PI()/2*E24^2/4	=PI()/2*F24^2/4	=G24/E24	=H24/E24	0	
25	12" x 6" red. Tee, diverg. flow through run	2338	525	11.02	5.065	=PI()/2*E25^2/4	=PI()/2*F25^2/4	=G25/E25	=H25/E25	0	
26	12" x 6" red Tee, diverg. flow through branch	2338	525	11.02	5.065	=PI()/2*E26^2/4	=PI()/2*F26^2/4	=G26/E26	=H26/E26	1.1	
27	12" x 12" red. Tee, diverg. flow through branch	4368	1320	11.938	11.938	=PI()/2*E27^2/4	=PI()/2*F27^2/4	=G27/E27	=H27/E27	1.3	
28											
29											
30	Water Demand	Flowrate (gpm)	Required Pipe Internal Area (ft²)	Required Pipe ID (in)							
31	Pump Min Q	=B30/2	=B31/(60*7.48)	=(G31/(C31*PI()/4))^1/2							
32	Makeup Demineralizers	107	=B32/(60*7.48)	=(G32/(C32*PI()/4))^1/2							
33	Floor wash	3	=B33/(60*7.48)	=(G33/(C33*PI()/4))^1/2							
34	Fire Protection Water Storage Tank	625	=B34/(60*7.48)	=(G34/(C34*PI()/4))^1/2							
35	RMS Makeup (per tower)	558.1	=B35/(60*7.48)	=(G35/(C35*PI()/4))^1/2							
36	SSD Makeup Header (two towers)	=2*B35	=B36/(60*7.48)	=(G36/(C36*PI()/4))^1/2							
37	Filter backwash	4368	=B37/(60*7.48)	=(G37/(C37*PI()/4))^1/2							
38	Makeup to UHS Pond	1320	=B38/(60*7.48)	=(G38/(C38*PI()/4))^1/2							
39	Pump Header to Node D	=B31+B32+B37	=B39/(60*7.48)	=(G39/(C39*PI()/4))^1/2							

	A	B	C	D	E	F	G	H	I	J	K
40											
41											
42	Resistance Loss Info	Flow (gpm)	L (ft)	d (in)	D (ft)	v (ft/sec)	xD	Re	f	K	h_L
43											
44	Pump A/B/C section losses										
45	Screen head loss (assume 1 ft)	=B31									1
46	Total loss (assume 10% up-to 0 ft)	=B31		10.02	=D46/12	=(B46)/(A(1.43*60*Pi)/(E46^2))				2.29	=A46*E46^2/(2*32.2)
47	Subtotal										=SUM(K45:K46)
48											
49	Pump A/B/C Discharge to Header (Node A)										
50	14" pipe (Sch 40)	=(4*B33+B32+B37)/3	=J50+J51	7.981	=D50/12	=(B50)/(A(1.43*60*Pi)/(E50^2))	=5313/E50	=123.9*(D50/E50)*(B50/(B50+B51))	0.014		=J50*C50/E50/2/g*E50^2/32.2
51	14" swing check valve (Qty 1)	=B50		7.981	=D50/12	=(B50)/(A(1.43*60*Pi)/(E51^2))				=J50*50	=J51*C51/E51^2/(2*32.2)
52	14" gate valve full port (Qty 1)	=B50		7.981	=D50/12	=(B50)/(A(1.43*60*Pi)/(E52^2))				=J50*50	=J52*C52/E52^2/(2*32.2)
53	90° elbow (8 inch, rd=1.5) (Qty 4)	=B50		7.981	=D50/12	=(B50)/(A(1.43*60*Pi)/(E53^2))				=J50*50	=J53*C53/E53^2/(2*32.2)
54	Strainer (assume max. 10 psid)	=B50									23.1
55	20" pipe (Sch 40)	=3*B31		18.812	=D55/12	=(B55)/(A(1.43*60*Pi)/(E55^2))					
56	20" x 8" red Tee, carry flow through branch (Qty 1)									=J19	=J56*C56/E56^2/(2*32.2)
57	Subtotal										=SUM(K50:K56)
58											
59	Node A-B										
60	20" pipe (Sch 40)	=(4*B33+B32+B37	=J59+J58+J57+J51+J50+J35+J17+J12+J31+J30+J29+J24+J23+J18+J13+J32+J27)	18.812	=D60/12	=(B60)/(A(1.43*60*Pi)/(E60^2))	=5313/E60	=123.9*(D60/E60)*(B60/(B60+B61))	0.013		=J60*C60/E60/2/g*E60^2/32.2
61	20" elbow (23 inch, rd=1.5) (Qty 10)	=B60		=D60	=D60/12	=(B61)/(A(1.43*60*Pi)/(E61^2))				=J60*20	=J61*C61/E61^2/(2*32.2)
62	18" elbow (23 inch, rd=1.5) (Qty 4)	=B60		=D60	=D60/12	=(B62)/(A(1.43*60*Pi)/(E62^2))				=J60*20	=J62*C62/E62^2/(2*32.2)
63	Subtotal										=SUM(K60:K62)
64											
65	Node B-C										
66	20" x 16" reducer	=2*(4*B33+B32+B37)/3		15.882	=D66/12	=(B66)/(A(1.43*60*Pi)/(E66^2))				=J19	=J66*C66/E66^2/(2*32.2)
67	16" pipe (Sch 40)	=2*(4*B33+B32+B37)/3	22	15.124	=D67/12	=(B67)/(A(1.43*60*Pi)/(E67^2))	=5313/E67	=123.9*(D67/E67)*(B67/(B67+B68))	0.014		=J67*C67/E67/2/g*E67^2/32.2
68	10" pipe (Sch 40)	=(4*B33+B32+B37)/3	15	10.02	=D68/12	=(B68)/(A(1.43*60*Pi)/(E68^2))	=5313/E68	=123.9*(D68/E68)*(B68/(B68+B67))	0.015		=J68*C68/E68/2/g*E68^2/32.2
69	16" x 10" red. Tee, diverg. flow through branch (Qty 1)									=J20	=J69*(E67^2)/(E68^2)/2*32.2
70	90° elbow (10 inch, rd=1.5) (Qty 2)	=B68		10.02	=D70/12	=(B70)/(A(1.43*60*Pi)/(E70^2))				=J70*50	=J70*C70/E70^2/(2*32.2)
71	10" gate valve full port (Qty 2)	=B68		10.02	=D71/12	=(B71)/(A(1.43*60*Pi)/(E71^2))				=J70*100	=J71*C71/E71^2/(2*32.2)
72	Zero pressure drop (assume 1.0 psid)										23.1
73	16" x 10" red. Tee, converging flow through branch (Qty 1)									=J21	=J73*(E67^2)/(E68^2)/2*32.2
74	Subtotal										=SUM(K66:K73)
75											
76	Node C-D										
77	16" pipe (Sch 40)	=(1*B33+B32+B37)/(1+0.25)	150	15.124	=D77/12	=(B77)/(A(1.43*60*Pi)/(E77^2))	=5313/E77	=123.9*(D77/E77)*(B77/(B77+B78))	0.015		=J77*C77/E77/2/g*E77^2/32.2
78	16" x 16" Eq. Tee, diverging flow through branch (Qty 1)									=J0*177	=J78*(E77^2)/(2*32.2)
79	Subtotal										=SUM(K77:K78)
80											
81	Node D to UHS Pond										
82	10" pipe (Sch 40)	=B33	=4+137+461+130+4+60	10.02	=D80/12	=(B82)/(A(1.43*60*Pi)/(E82^2))	=5313/E82	=123.9*(D80/E82)*(B33/(B33+B34))	0.015		=J82*C82/E82/2/g*E82^2/32.2
83	16" x 10" red. Tee, diverging flow through branch (Qty 1)									=J18	=J83*(E77^2)/(2*32.2)
84	90° elbow (10 inch, rd=1.5) (Qty 4)	=B33		10.02	=D84/12	=(B84)/(A(1.43*60*Pi)/(E84^2))				=J70*40	=J84*C84/E84^2/(2*32.2)
85	10" elbow (10 inch, rd=1.5) (Qty 2)	=B33		10.02	=D85/12	=(B85)/(A(1.43*60*Pi)/(E85^2))				=J70*20	=J85*C85/E85^2/(2*32.2)
86	10" butterfly valve (Qty 1)	=B33		10.02	=D86/12	=(B86)/(A(1.43*60*Pi)/(E86^2))				=J70*52	=J86*C86/E86^2/(2*32.2)
87	10" gate valve (Qty 3)	=B33		10.02	=D87/12	=(B87)/(A(1.43*60*Pi)/(E87^2))				=J70*52	=J87*C87/E87^2/(2*32.2)
88	Exit to pond	=B33		=D84	=D88/12	=(B88)/(A(1.43*60*Pi)/(E88^2))				1.0	=J88*C88/E88^2/(2*32.2)
89	Subtotal										=SUM(K82:K88)

	A	B	C	D	E	F	G	H	I	J	K
42	Resistance Losses	Flow (gpm)	L (ft)	d (in)	D (ft)	v (ft/sec)	uD	Re	f	K	hL
90											
91	Node D-E										
92	14" pipe (Sch 40)	[illegible]	[illegible]	13.124	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]
93	14" x 10" std. Tee, diverging flow through run (Qty 1)									[illegible]	[illegible]
94	Subtotal										[illegible]
95											
96	Node E-L										
97	6" pipe (Sch 40)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]
98	14" x 4" std. Tee, diverg flow through branch (Qty 1)									[illegible]	[illegible]
99	Subtotal										[illegible]
100											
101	Node L to DWTS										
102	1" pipe (Sch 40)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]
103	4" x 3 Tee, diverging flow through run (Qty 1)									[illegible]	[illegible]
104	4" gate valve, full port (Qty 2)	[illegible]		[illegible]	[illegible]	[illegible]				[illegible]	[illegible]
105	4" globe valve, full port (Qty 1)	[illegible]		[illegible]	[illegible]	[illegible]				[illegible]	[illegible]
106	4" square edged orifice (Sch 5S)	[illegible]		[illegible]	[illegible]	[illegible]				[illegible]	[illegible]
107	Subtotal										[illegible]
108											
109	Node L to Floor Wash										
110	6" std Tee, diverging flow through branch (Qty 1)									[illegible]	[illegible]
111	6" x 1-1/2" reducer (Qty 1)	[illegible]		[illegible]	[illegible]	[illegible]				[illegible]	[illegible]
112	1-1/2" pipe (Sch 80)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]
113	1-1/2" std Tee, diverging flow through run (Qty 1)									[illegible]	[illegible]
114	90° elbow (1-1/2 inch nominal) (Qty 3)									[illegible]	[illegible]
115	1-1/2" globe valve									[illegible]	[illegible]
116	Subtotal										[illegible]
117											
118	Node E-F										
119	14" x 2" Red. Tee, diverg flow through run (Qty 1)									[illegible]	[illegible]
120	14" x 12" reducer	[illegible]		[illegible]	[illegible]	[illegible]				[illegible]	[illegible]
121	12" pipe (Sch 40)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]
122	Subtotal										[illegible]
123											
124	Node F-H										
125	8" pipe (Sch 40)			[illegible]	[illegible]		[illegible]	[illegible]			
126	12" x 8" std. Tee, diverg flow through run (Qty 1)									[illegible]	[illegible]
127	12" x 12" reducer	[illegible]		[illegible]	[illegible]	[illegible]				[illegible]	[illegible]
128	10" pipe (Sch 40)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]
129	Subtotal										[illegible]
130											
131	Node H-J										
132	8" pipe (Sch 40)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]
133	10" x 8" reducer	[illegible]		[illegible]	[illegible]	[illegible]				[illegible]	[illegible]
134	10" x 6" std. Tee, diverg flow through run (Qty 1)									[illegible]	[illegible]
135	Subtotal										[illegible]

	A	B	C	D	E	F	G	H	I	J	K
42	Resistance Losses	Flow (gpm)	L (ft)	d (in)	D (ft)	v (ft/sec)	L/D	Re	f	K	h_L
136											
137	Node J to M/R										
138	Wye 8 inch, diverging flow (Qty 1)									=20*138	=138*F138^2/2*32.2)
139	45° elbow (8 inch, std.) (Qty 4)									=32*139	=139*F139^2/2*32.2)
140	8" x 6" reducer (Qty 1)	=B35		7.981	=D140/12	=(B140/(7.48*60*PI()*E140^2))				=K8	=F140*K140^2/2*32.2)
141	8" pipe (Sch 40)	=B35	=(B2+B4+6)	8.065	=D141/12	=(B141/(7.48*60*PI()*E141^2))	=L141/D141	=122.9*(D141*F141*62.3)/(55.56*E141)	=G141/H141		=141*C141/D141*F141^2/2*32.2)
142	8" gate valve, full bore (Qty 2)	=B141		8.065	=D142/12	=(B142/(7.48*60*PI()*E142^2))				=8*141	=F142*K142/2*32.2)
143	8" globe valve, full bore (Qty 1)	=B141		8.065	=D143/12	=(B143/(7.48*60*PI()*E143^2))				=400*141	=143*K143/2*32.2)
144	8" square edged orifice (B=0.65)	=B141		8.065	=D144/12	=(B144/(7.48*60*PI()*E144^2))				=(1-POWER(0.65,2))/POWER(0.65,4)	=144*K144^2/2*32.2)
145	8" butterfly valve (Qty 1)	=B141		8.065	=D145/12	=(B145/(7.48*60*PI()*E145^2))				=45*141	=145*K145^2/2*32.2)
146	8" swing check valve (Qty 1)	=B141		8.065	=D146/12	=(B146/(7.48*60*PI()*E146^2))				=50*141	=146*K146^2/2*32.2)
147	8" std Tee, combining flow through run (Qty 1)	=B141		8.065	=D147/12	=(B147/(7.48*60*PI()*E147^2))				=27*141	=147*K147^2/2*32.2)
148	Net loss to basin	=B141		8.065	=D148/12	=(B148/(7.48*60*PI()*E148^2))				1	=148*K148^2/2*32.2)
149	Subtotal										=SUM(K138:K148)
150											
151	Node K to FP Water Storage Tank										
152	10" x 8" std Tee, diverging flow through branch (Qty 1)									=56	=152*F152^2/2*32.2)
153	10" pipe (Sch 40)	=B154	=(32+68+35+6)	9.846	=D153/12	=(B153/(7.48*60*PI()*E153^2))	=L153/D153	=122.9*(D153*F153*62.3)/(55.56*E153)	=G153/H153		=153*C153/D153*F153^2/2*32.2)
154	8" x 8" std Tee, diverging flow through run (Qty 1)									=12*153	=154*F154^2/2*32.2)
155	8" butterfly valve (Qty 1)	=B34		8.065	=D155/12	=(B155/(7.48*60*PI()*E155^2))				=45*153	=155*F155^2/2*32.2)
156	8" gate valve (Qty 2)	=B34		8.065	=D156/12	=(B156/(7.48*60*PI()*E156^2))				=8*153	=156*F156^2/2*32.2)
157	Net loss to tank	=B34		8.065	=D157/12	=(B157/(7.48*60*PI()*E157^2))				1	=157*F157^2/2*32.2)
158	Subtotal										=SUM(K152:K157)
159											
160	Node C to Retention Basin										
161	18" pipe (Sch 40)	=B37	20	17.124	=D161/12	=(B161/(7.48*60*PI()*E161^2))	=L161/D161	=122.9*(D161*F161*62.3)/(55.56*E161)	=G161/H161		=161*C161/D161*F161^2/2*32.2)
162	12" pipe (Sch 40)	=B37	=(B31/2+210+6+4)	11.938	=D162/12	=(B162/(7.48*60*PI()*E162^2))	=L162/D162	=122.9*(D162*F162*62.3)/(55.56*E162)	=G162/H162		=162*C162/D162*F162^2/2*32.2)
163	18" x 12" std Tee, diverging flow through branch (Qty 1)									=27	=163*F163^2/2*32.2)
164	12" gate valve, full port (Qty 2)	=B162		11.938	=D164/12	=(B164/(7.48*60*PI()*E164^2))				=400*162	=164*F164^2/2*32.2)
165	12" std Tee, combining flow through branch (Qty 1)	=B162		11.938	=D165/12	=(B165/(7.48*60*PI()*E165^2))				=20*162	=165*F165^2/2*32.2)
166	90° elbow (12 inch, std.) (Qty 2)	=B162		=D162	=D166/12	=(B166/(7.48*60*PI()*E166^2))				=16*162	=166*F166^2/2*32.2)
167	Filter pressure drop (assume 10 psid)										=2.31*19
168	Subtotal										=SUM(K159:K167)

	A	B
1	Intake structure min. water elev., ft.	484
2	Pump datum elev., ft	484
3	Plant grade elev., ft	673
4	UHS Pond top of dike elev., ft.	674
5	WW Retention Basin max. water elev., ft.	678.5
6	FP Water Tank Lvl (above grade), ft.	20
7	Demin Tk lv (above grade), ft	3
8	UHS Tower Basin Lvl (above grade), ft.	10
9	Floor wash hose bibbs (above grade), ft.	4
10		
11	Static suction head	=B1-B2
12	Pump suction resistance losses, ft	='Line Loss (Fig 1)'!K47
13	10% margin	=B12*0.1
14	Total Suction Head	=B11-(B12+B13)
15		
16		
17	Demand	Max GPM (3 pump op)
18	UHS Cooling Tower Basin	='4*'Line Loss (Fig 1)'!B35
19	Demineralizers	='Line Loss (Fig 1)'!B32
20	Floor wash	0
21	Fire Protection Water Storage Tank	0
22	UHS Pond	0
23	Filter Backwash to Retention Basin	='Line Loss (Fig 1)'!B37
24	Total Flow	=SUM(B18:B23)
25	10% margin	=0.1*B24
26	Flow per pump	=SUM(B24:B25)/3
27		
28		
29	Flow Path	RW Pumps to 3URB
30	Head at discharge	=E18*2.31
31	Friction Losses	='Line Loss (Fig 1)'!K57+'Line Loss (Fig 1)'!K63+'Line Loss (Fig 1)'!K74+'Line Loss (Fig 1)'!K79+'Line Loss (Fig 1)'!K94+'Line Loss (Fig 1)'!K122+'Line Loss (Fig 1)'!K129+'Line Loss (Fig 1)'!K135+'Line Loss (Fig 1)'!K149
32	10% margin	=B31*0.1
33	Static Discharge Head	=D18-B1
34	Total Discharge Head (ft)	=SUM(B30,B33)
35		
36		
37	Total Developed Head (ft)	=B34-B14
38		
39		
40	Pump motor horsepower (0.8 efficiency)	=MAX(26:26)*MAX(37:37)/(3960*0.8)

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17	Design GPM (1 pump op)
18	='Line Loss (Fig 1)'!B36
19	='Line Loss (Fig 1)'!B32
20	0
21	0
22	0
23	0
24	=SUM(C18:C23)
25	=0.1*C24
26	=SUM(C24:C25)
27	
28	
29	RW Pumps to Demin Water
30	=E19*2.31
31	='Line Loss (Fig 1)'!K57+'Line Loss (Fig 1)'!K63+'Line Loss (Fig 1)'!K74+'Line Loss (Fig 1)'!K78+'Line Loss (Fig 1)'!K94+'Line Loss (Fig 1)'!K99+'Line Loss (Fig 1)'!K107
32	=C31*0.1
33	=D19-B1
34	=SUM(C30:C33)
35	
36	
37	=C34-B14
38	
39	
40	

	D	E
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17	Discharge Elevation (ft)	Max Discharge Pressure (psig)
18	=B3+B8	0
19	=B3+B7	10
20	=B3+B9	35
21	=B3+B6	0
22	=B4	0
23	=B5	0
24		
25		
26		
27		
28		
29	RW Pumps to FP Tank	RW Pumps to Retention Basin
30	=E21*2.31	=E23*2.31
31	=Line Loss (Fig 1)!K57+Line Loss (Fig 1)!K63+Line Loss (Fig 1)!K74+Line Loss (Fig 1)!K79+Line Loss (Fig 1)!K94+Line Loss (Fig 1)!K122+Line Loss (Fig 1)!K129+Line Loss (Fig 1)!K158	=Line Loss (Fig 1)!K57+Line Loss (Fig 1)!K63+Line Loss (Fig 1)!K74+Line Loss (Fig 1)!K168
32	=D31*0.1	=0.1*E31
33	=D21-B1	=D23-B1
34	=SUM(D30:D33)	=SUM(E30:E33)
35		
36		
37	=D34-B14	=E34-B14
38		
39		
40		

	F	G
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29	RW Pumps to UHS Pond	RW Pumps to Floor Wash
30	=E22^2.31	=E20^2.31
31	=Line Loss (Fig 1)!K57+Line Loss (Fig 1)!K63+Line Loss (Fig 1)!K74+Line Loss (Fig 1)!K79+Line Loss (Fig 1)!K89	=Line Loss (Fig 1)!K57+Line Loss (Fig 1)!K63+Line Loss (Fig 1)!K74+Line Loss (Fig 1)!K79+Line Loss (Fig 1)!K94+Line Loss (Fig 1)!K99+Line Loss (Fig 1)!K116
32	=0.1*F31	=0.1*G31
33	=D22-B1	=D20-B1
34	=SUM(F30:F33)	=SUM(G30:G33)
35		
36		
37	=F34-B14	=G34-B14
38		
39		
40		

	A	B	C	D	E	F	G	H	I	J	K
1											
2	CS pipe absolute roughness (ε), ft	0.00015									
3	Absolute viscosity (μ), centipoise	1.299									
4	Density (ρ), lb/ft³	62.41									
5	Water velocity, ft/sec	10									
6											
7											
8	Pipe Reducers / Increaser	d_1	d_2	β	fitting and end dist	θ/2	sin(θ/2)	K_c			
9	14" x 12" reducer	11.938	13.124	=B9/C9	13	=ATAN((C9-B9)/2/E9)	=SIN(F9)	=0.8*G9*(1-D9^2)/D9^4			
10	10" x 8" reducer	7.981	10.02	=B10/C10	7	=ATAN((C10-B10)/2/E10)	=SIN(F10)	=0.8*G10*(1-D10^2)/D10^4			
11	12" x 10" reducer	10.02	13.124	=B11/C11	8	=ATAN((C11-B11)/2/E11)	=SIN(F11)	=0.8*G11*(1-D11^2)/D11^4			
12	16" x 12" reducer	11.938	15	=B12/C12	14	=ATAN((C12-B12)/2/E12)	=SIN(F12)	=0.8*G12*(1-D12^2)/D12^4			
13	16" x 14" reducer	13.124	15	=B13/C13	14	=ATAN((C13-B13)/2/E13)	=SIN(F13)	=0.8*G13*(1-D13^2)/D13^4			
14	12" x 16" increaser	11.938	15	=B14/C14	14	=ATAN((C14-B14)/2/E14)	=SIN(F14)	=2.6*G14*(1-D14^2)/(2*D14^4)			
15	4" x 1-1/2" reducer	1.61	4.026	=B15/C15	4	=ATAN((C15-B15)/2/E15)	=SIN(F15)	=0.8*G15*(1-D15^2)/D15^4			
16											
17	Reducing Tees	Run Flow (Q_c, Q_c)	Branch Flow (Q_b, Q_b)	Run dia. (d_c, d_c)	Branch dia. (d_b, d_b)	Run Area (A_c, A_c)	Branch Area (A_b, A_b)	A_b/A_c A_b/A_c	Q_b/Q_c Q_b/Q_c	K	
18	16" x 8" red Tee; conv. flow through branch	5400	1820	15	7.981	=PI()*D18^2/4	=PI()*E18^2/4	=G18/F18	=C18/B18	1.25	
19	16" x 10" red. Tee; diverg. flow through branch	5400	1820	15	10.02	=PI()*D19^2/4	=PI()*E19^2/4	=G19/F19	=C19/B19	1.1	
20	16" x 10" red. Tee; diverg. flow through run	5400	0	15	10.02	=PI()*D20^2/4	=PI()*E20^2/4	=G20/F20	=C20/B20	0.04	
21	12" x 8" red. Tee; diverg. flow through branch	3640	1820	11.938	7.981	=PI()*D21^2/4	=PI()*E21^2/4	=G21/F21	=C21/B21	1.3	
22	12" x 8" Red. Tee; conv. flow through branch	3640	1820	11.938	7.981	=PI()*D22^2/4	=PI()*E22^2/4	=G22/F22	=C22/B22	1.25	
23	16" x 4" red. Tee; diverg. flow through branch	5460	107	15	4.026	=PI()*D23^2/4	=PI()*E23^2/4	=G23/F23	=C23/B23	1.2	
24	16" x 2" red. Tee, diverg. flow through run	5460	107	15	2.067	=PI()*D24^2/4	=PI()*E24^2/4	=G24/F24	=C24/B24	0.025	
25	14" x 10" red. Tee; diverg flow through run	5353	2677	13.124	10.02	=PI()*D25^2/4	=PI()*E25^2/4	=G25/F25	=C25/B25	0.025	
26	12" x 6" red. Tee; diverg. flow through run	3302	625	11.938	6.065	=PI()*D26^2/4	=PI()*E26^2/4	=G26/F26	=C26/B26	0	
27	12" x 6" red Tee; diverg. flow through branch	3302	625	11.938	6.065	=PI()*D27^2/4	=PI()*E27^2/4	=G27/F27	=C27/B27	1.2	
28											
29	Water Demand	Flowrate (gpm)	Required Pipe Internal Area (ft²)	Required Pipe ID (in)							
30	Pump A/B/C	=1713+107	=B30/(8815*60*7.48)	=(SQRT(C30*4/PI()))*12							
31	Makeup Demineralizers	107	=B31/(8815*60*7.48)	=(SQRT(C31*4/PI()))*12							
32	Floor wash	5	=B32/(8815*60*7.48)	=(SQRT(C32*4/PI()))*12							
33	Fire Protection Water Storage Tank	625	=B33/(8815*60*7.48)	=(SQRT(C33*4/PI()))*12							
34	UHS Makeup (per tower)	1333.25	=B34/(8815*60*7.48)	=(SQRT(C34*4/PI()))*12							
35	UHS Makeup Header (two towers)	=2*B34	=B35/(8815*60*7.48)	=(SQRT(C35*4/PI()))*12							
36	Filter backwash	=1275+(107+1713)	=B36/(8815*60*7.48)	=(SQRT(C36*4/PI()))*12							
37	Makeup to UHS Pond	1820	=B37/(8815*60*7.48)	=(SQRT(C37*4/PI()))*12							
38	Pump Header to Node B	=2*B30	=B38/(8815*60*7.48)	=(SQRT(C38*4/PI()))*12							
39											

	A	B	C	D	E	F	G	H	I	J	K
40	Resistance losses	flow (gpm)	L (ft)	d (in)	D (ft)	v (ft/sec)	e/D	Re	f	K	h
41											
42	Pump A/B/C suction losses										
43	Sensor head loss (assume 1 ft)	=B30									1
44	inlet bell (assume 10"; rd=0.02)	=B30		10.02	=D44/12	=(B44)*4/(7.48*60*Pi()*E44^2)				0.28	=J44*E44^2/(2*32.2)
45	Subtotal										=SUM(K43:K44)
46											
47	Pump A/B/C Discharge to Header (Node A)										
48	6" pipe (Sch 40)	=B30	=(30+10+14)	7.981	=D48/12	=(B48)*4/(7.48*60*Pi()*E48^2)	=5832/E48	=123.9*(D48*E48*5854)/5853	0.0135		=I48*(C48/E48)*E48^2/(2*32.2)
49	6" swing check valve (Qty 1)	=B30		7.981	=D49/12	=(B49)*4/(7.48*60*Pi()*E49^2)				=50*K48	=J49*E49^2/(2*32.2)
50	3" gate valve, full port (Qty 1)	=B30		7.981	=D50/12	=(B50)*4/(7.48*60*Pi()*E50^2)				=8*K48	=J50*E50^2/(2*32.2)
51	30° elbow (8 inch, rd=1.5) (Qty 4)	=B30		7.981	=D51/12	=(B51)*4/(7.48*60*Pi()*E51^2)				=14*K48	=4*J51*E51^2/(2*32.2)
52	strainer (assume mod. 10 psid)	=B30									23.1
53	16" pipe (Sch 40)	=2*B30		15	=D53/12	=(B53)*4/(7.48*60*Pi()*E53^2)	=5832/E53	=123.9*(D53*E53*5854)/5853	0.0135		
54	16" x 8" red Tee; conv. flow through branch (Qty. 1)									=J16	=J54*E53^2/(2*32.2)
55	Subtotal										=SUM(K48:K54)
56											
57	Node A-B										
58	16" pipe (Sch 40)	=B58	=100+1338+1677+1158+638+217+872+523+500+224+1296+1235+187+174+392/2)	15	=D58/12	=(B58)*4/(7.48*60*Pi()*E58^2)	=5832/E58	=123.9*(D58*E58*5854)/5853	0.0135		=I58*(C58/E58)*E58^2/(2*32.2)
59	30° elbow (16 inch; rd=1.5) (Qty 10)	=B58		=D58	=D59/12	=(B59)*4/(7.48*60*Pi()*E59^2)				=10*K58	=10*J59*E59^2/(2*32.2)
60	45° elbow (16 inch; rd=1.5) (Qty 4)	=B58		=D58	=D60/12	=(B60)*4/(7.48*60*Pi()*E60^2)				=4*K58	=4*J60*E60^2/(2*32.2)
61	16" std. Tee; converg. through branch (Qty 1)	=B58		=D58	=D61/12	=(B61)*4/(7.48*60*Pi()*E61^2)				=20*K58	=20*J61*E61^2/(2*32.2)
62	Subtotal										=SUM(K58:K61)
63											
64	Node B-C										
65	16" x 12" reducer	=2*B61/3		15	=D65/12	=(B65)*4/(7.48*60*Pi()*E65^2)				=K12	=J65*E65^2/(2*32.2)
66	12" pipe (Sch 40)	=B65	20	11.938	=D66/12	=(B66)*4/(7.48*60*Pi()*E66^2)	=5832/E66	=123.9*(D66*E66*5854)/5853	0.0145		=K20*C66*(E66/D66)*E66^2/(2*32.2)
67	8" pipe (Sch 40)	=B65/2	10	7.981	=D67/12	=(B67)*4/(7.48*60*Pi()*E67^2)	=5832/E67	=123.9*(D67*E67*5854)/5853	0.0135		=K10*C67*(E67/D67)*E67^2/(2*32.2)
68	12" x 8" red. Tee, diverg. flow through branch (Qty 1)									=J21	=J68*(E66^2)/(2*32.2)
69	30° elbow (8 inch; rd=1.5) (Qty 2)	=B67		=D67	=D69/12	=(B69)*4/(7.48*60*Pi()*E69^2)				=14*K67	=2*J69*E69^2/(2*32.2)
70	8" globe valve full port (Qty 2)	=B67		7.981	=D70/12	=(B70)*4/(7.48*60*Pi()*E70^2)				=400*K67	=2*J70*E70^2/(2*32.2)
71	bod pressure drop (assume 10 psid)										23.1
72	12"x 8" Red. Tee; converg. flow through branch (Qty 1)	=B67								=J22	=J72*(E66^2)/(2*32.2)
73	12" x 16" increaser	=B65		15	=D73/12	=(B73)*4/(7.48*60*Pi()*E73^2)				=K14	=J73*E73^2/(2*32.2)
74	Subtotal										=SUM(K65:K73)
75											

	A	B	C	D	E	F	G	H	I	J	K
40	Resistance Losses	Flow (gpm)	L (ft)	d (in)	D (ft)	v (ft/sec)	e/D	Re	f	K	h_L
76	Node C-D										
77	15" pipe (Sch 40)	=3*B30	100	15	=D77/12	=(B77)*4/(7.48*60*PI()*(D77^2)	=$E$17	=(123.9*(D77*F77*$E$4)/$E$3	0.014		=F77*C77*(F77^2)/(E77^2*32.2)
78	16" std. Tee, diverg. Flow through branch (Qty 1)	=B77		15	=D78/12	=(B78)*4/(7.48*60*PI()*(E78^2)				=K0*F77	=F78*F78^2/(2*32.2)
79	Subtotal										=SUM(K77:K78)
80											
81	Node D to UHS Pond										
82	10" pipe (Sch 40)	=B37	=4+152+461+130+4+60	10.02	=D82/12	=(B82)*4/(7.48*60*PI()*(E82^2)	=$E$82	=(123.9*(D82*F82*$E$4)/$E$3	0.015		=F82*C82*F82^2/(E82^2*32.2)
83	10" x 10" std. Tee, diverging flow through branch (Qty 1)	=B37								=J19	=J83*F83^2/(2*32.2)
84	90° elbow (10 inch; r/d=1.5) (Qty 4)	=B37		10.02	=D84/12	=(B84)*4/(7.48*60*PI()*(E84^2)				=14*K2	=4*J84*F84^2/(2*32.2)
85	45° elbow (10 inch; r/d=1.5) (Qty 2)	=B20		10.02	=D85/12	=(B85)*4/(7.48*60*PI()*(E85^2)				=10*K2	=2*J85*F85^2/(2*32.2)
86	10" butterfly valve (Qty 1)	=B54		10.02	=D86/12	=(B86)*4/(7.48*60*PI()*(E86^2)				=35*K2	=J86*F86^2/(2*32.2)
87	14" gate valve (Qty 3)	=B82		=D82	=D87/12	=(B87)*4/(7.48*60*PI()*(E87^2)				=8*K2	=3*J87*F87^2/(2*32.2)
88	Exit to pond	=B86		=D86	=D88/12	=(B88)*4/(7.48*60*PI()*(E88^2)				1	=J88*F88^2/(2*32.2)
89	Subtotal										=SUM(K82:K88)
90											
91	Node D-E										
92	16" pipe (Sch 40)	5460	=(392/2-186+174+138+322+4+3)	15	=D92/12	=(B92)*4/(7.48*60*PI()*(E92^2)	=$E$92	=(123.9*(D92*F92*$E$4)/$E$3	0.014		=F92*C92*F92^2/(E92^2*32.2)
93	16" x 10" std. Tee, diverging flow through run (Qty 1)									=J20	=J93*F92^2/(2*32.2)
94	Subtotal										=SUM(K92:K93)
95											
96	Node E-L										
97	4" pipe (Sch 40)	112	222	4.026	=D97/12	=(B97)*4/(7.48*60*PI()*(E97^2)	=$E$97	=(123.9*(D97*F97*$E$4)/$E$3	0.02		=F97*C97*F97^2/(E97^2*32.2)
98	15"x 4" std. Tee, diverg flow through branch (Qty 1)									=J23	=J98*F97^2/(2*32.2)
99	Subtotal										=SUM(K97:K98)
100											
101	Node L to DRYS										
102	4" pipe (Sch 40)	107	14	4.026	=D102/12	=(B102)*4/(7.48*60*PI()*(E102^2)	=$E$102	=(123.9*(D102*F102*$E$4)/$E$3	0.02		=F102*C102*F102^2/(E102^2*32.2)
103	4" std. Tee, diverging flow through run (Qty 3)									=12*K2	=J103*F93^2/(2*32.2)
104	4" gate valve, full port (Qty 2)	=B31		4.026	=D104/12	=(B104)*4/(7.48*60*PI()*(E104^2)				=8*K2	=2*J104*F104^2/(2*32.2)
105	4" globe valve, full port (Qty 1)	=B31		4.026	=D105/12	=(B105)*4/(7.48*60*PI()*(E105^2)				=400*K2	=J105*F105^2/(2*32.2)
106	4" square edged orifice (β=0.65)	=B31		4.026	=D106/12	=(B106)*4/(7.48*60*PI()*(E106^2)				=(1-POWER(0.65,2))/(POWER(0.67,2)*POWER(0.65,4))	=J106*F106^2/(2*32.2)
107	Subtotal										=SUM(K102:K104)
108											
109	Node L to Floor Wash										
110	4" std. Tee, diverging flow through branch (Qty 1)									=60*K2	=J110*F97^2/(2*32.2)
111	4" x 1-1/2" reducer (Qty 1)	5		4.026	=D111/12	=(B111)*4/(7.48*60*PI()*(E111^2)				=4*K2	=J111*F111^2/(2*32.2)
112	1-1/2" pipe (Sch 40)	5	=(216+310+4)	1.61	=D112/12	=(B112)*4/(7.48*60*PI()*(E112^2)	=$E$112	=(123.9*(D112*F112*$E$4)/$E$3	0.039		=F112*C112*F112^2/(E112^2*32.2)
113	1-1/2" std Tee; diverging flow through run (Qty 1)									=32*K2	=J113*F112^2/(2*32.2)
114	90° elbow (1-1/2 inch; r/d=1.5) (Qty 2)									=60*K2	=2*J114*F112^2/(2*32.2)
115	1-1/2" globe valve									=40*K2	=J115*F112^2/(2*32.2)
116	Subtotal										=SUM(K110:K115)
117											
118	Node E-F										
119	16" x 14" reducer	=3*B30-B31		15	=D119/12	=(B119)*4/(7.48*60*PI()*(E119^2)				=4*K2	=J119*F119^2/(2*32.2)
120	14" pipe (Sch 40)	=B119	341	13.124	=D120/12	=(B120)*4/(7.48*60*PI()*(E120^2)	=$E$120	=(123.9*(D120*F120*$E$4)/$E$3	0.014		=F120*C120*F120^2/(E120^2*32.2)
121	16" x 2" red. Tee, diverg. flow thru run (Qty 1)									=J21*K2	=J121*F120^2/(2*32.2)
122	Subtotal										=SUM(K119:K121)
123											

	A	B	C	D	E	F	G	H	I	J	K
40	Resistance Losses	Flow (gpm)	L (ft)	d (in)	D (ft)	v (ft/sec)	e/D	Re	f	K	h_L
124	Node F 44										
125	14" x 10" std. Tee, diverg flow through run (Qty 1)									=J25	=J125*F125*2/(2*32.2)
126	14" x 12" reducer (Qty 1)									=J9	=J126*F126*2/(2*32.2)
127	12" pipe (Sch 40)	=B35+B33	=258+812+516	11.938	=D127/12	=(B127)*4/(7.48*60*Pi()*(E127)^2)	=3832/E127	=123.9*(D127*F127*B34)/B33	0.0145		=(J127*C127*F127*2/(E127*2*32.2)
128	Subtotal										=SUM(K124:K127)
129											
130	Node N J										
131	10" pipe (Sch 40)	=B35	468	10.02	=D131/12	=(B131)*4/(7.48*60*Pi()*(E131)^2)	=3832/E131	=123.9*(D131*F131*B34)/B33	0.015		=J131*C131*F131*2/(E131*2*32.2)
132	12" x 10" reducer (Qty 1)									=J11	=J132*F132*2/(2*32.2)
133	12" x 6" std. Tee, diverg. flow through run (Qty 1)									=J26	=J133*F133*2/(2*32.2)
134	Subtotal										=SUM(K130:K133)
135											
136	Node J to SURB										
137	Wye, 10 inch, diverging flow (Qty 1)									=251131	=J137*F137*2/(2*32.2)
138	45° elbow: (10 inch r/d=1.5) (Qty 1)									=101131	=J138*F138*2/(2*32.2)
139	10" x 8" reducer	1338		10.02	=D139/12	=(B139)*4/(7.48*60*Pi()*(E139)^2)				=H10	=J139*F139*2/(2*32.2)
140	8" pipe (Sch 40)	1338	=(92+48+4)	7.981	=D140/12	=(B140)*4/(7.48*60*Pi()*(E140)^2)	=3832/E140	=123.9*(D140*F140*B34)/B33	0.018		=J140*C140*F140*2/(E140*2*32.2)
141	8" gate valve, full bore (Qty 2)	1338		7.981	=D141/12	=(B141)*4/(7.48*60*Pi()*(E141)^2)				=8*1140	=2*J141*F141*2/(2*32.2)
142	8" globe valve, full bore (Qty 1)	1338		7.981	=D142/12	=(B142)*4/(7.48*60*Pi()*(E142)^2)				=400*1140	=J142*F142*2/(2*32.2)
143	8" square edged orifice (β=0.65)	1338		7.981	=D143/12	=(B143)*4/(7.48*60*Pi()*(E143)^2)				=(1/POWER(0.65,2)-1)/POWER(0.67,2)*POWER(0.65,4)	=J143*F143*2/(2*32.2)
144	8" butterfly valve (Qty 1)	1338		7.981	=D144/12	=(B144)*4/(7.48*60*Pi()*(E144)^2)				=45*1140	=J144*F144*2/(2*32.2)
145	8" swing check valve (Qty 1)	1338		7.981	=D145/12	=(B145)*4/(7.48*60*Pi()*(E145)^2)				=50*1140	=J145*F145*2/(2*32.2)
146	8" std Tee, converg through run (Qty 1)	1338		7.981	=D146/12	=(B146)*4/(7.48*60*Pi()*(E146)^2)				=27*1140	=J146*F146*2/(2*32.2)
147	exit loss to basin	1338		7.981	=D147/12	=(B147)*4/(7.48*60*Pi()*(E147)^2)				1	=J147*F147*2/(2*32.2)
148	Subtotal										=SUM(K137:K147)
149											
150	Node R to FP Water Storage Tank 2										
151	12" x 6" std Tee, diverge through branch (Qty 1)									=J27	=J151*F151*2/(2*32.2)
152	6" pipe (Sch 40)	=B33	=(33+68+3814)	6.065	=D152/12	=(B152)*4/(7.48*60*Pi()*(E152)^2)	=3832/E152	=123.9*(D152*F152*B34)/B33	0.017		=J152*C152*F152*2/(E152*2*32.2)
153	6" butterfly valve (Qty 1)	=B33		6.065	=D153/12	=(B153)*4/(7.48*60*Pi()*(E153)^2)				=45*1152	=J153*F153*2/(2*32.2)
154	6" gate valve (Qty 3)	629		6.065	=D154/12	=(B154)*4/(7.48*60*Pi()*(E154)^2)				=8*1152	=3*J154*F154*2/(2*32.2)
155	Exit loss to tank	=B33		6.065	=D155/12	=(B155)*4/(7.48*60*Pi()*(E155)^2)				1	=J155*F155*2/(2*32.2)
156	Subtotal										=SUM(K151:K155)
157											
158	Node C to Retention Basin										
159	12" pipe (Sch 40)	=B36	=(251/2+210+4+4)	11.938	=D159/12	=(B159)*4/(7.48*60*Pi()*(E159)^2)	=3832/E159	=123.9*(D159*F159*B34)/B33	0.014		=J159*C159*F159*2/(E159*2*32.2)
160	12" globe valve, full port (Qty 2)	=B159		11.938	=D160/12	=(B160)*4/(7.48*60*Pi()*(E160)^2)				=400*1159	=2*J160*F160*2/(2*32.2)
161	12" std. Tee, diverg through branch (Qty 1)	=B36		11.938	=D161/12	=(B161)*4/(7.48*60*Pi()*(E161)^2)				=60*1159	=J161*F161*2/(2*32.2)
162	12" std Tee, converg through branch (Qty 1)	=B159		11.938	=D162/12	=(B162)*4/(7.48*60*Pi()*(E162)^2)				=29*1159	=J162*F162*2/(2*32.2)
163	90° elbow (r/d=1.5) (Qty 2)	=B159		=D159	=D163/12	=(B163)*4/(7.48*60*Pi()*(E163)^2)				=13*1159	=2*J163*F163*2/(2*32.2)
164	Filter pressure drop (assume 10 psid)										=2*31*10
165	Subtotal										=SUM(K159:K164)
166											

	A	B
1	Intake structure min. water elev., ft.	481
2	Pump datum elev., ft	484
3	Plant grade elev., ft.	673
4	UHS Pond top of dike elev, ft.	674
5	WW Retention Basin max water elev., ft.	678.5
6	FP Water Tank Lvl (above grade), ft.	20
7	Demin Tk In (above grade), ft	3
8	UHS Tower Basin Lvl (above grade), ft.	10
9	Floor wash hose bibbs (above grade), ft.	4
10		
11	Static suction head	=B1-B2
12	Pump suction resistance losses, ft	='Line Loss (Fig 2)'!K45
13	10% margin	=B12*0.1
14	Total Suction Head	=B11-(B12+B13)
15		
16		
17	Demand	Max GPM (3 pump op)
18	UHS Cooling Tower Basin	985
19	Demineralizers	107
20	Floor wash	0
21	Fire Protection Water Storage Tank	0
22	UHS Pond	0
23	Filter Backwash to Retention Basin	4388
24	Total Flow	=SUM(D18:B23)
25	10% margin	=0.1*B24
26	Flow per pump	=SUM(B24:B25)/3
27		
28		
29	Flow Path	RW Pumps to 3URB
30	Head of discharge	=E18*2.31
31	Friction Losses	='Line Loss (Fig 2)'!K55+'Line Loss (Fig 2)'!K62+'Line Loss (Fig 2)'!K74+'Line Loss (Fig 2)'!K79+'Line Loss (Fig 2)'!K94+'Line Loss (Fig 2)'!K122+'Line Loss (Fig 2)'!K128+'Line Loss (Fig 2)'!K134+'Line Loss (Fig 2)'!K148
32	10% margin	=B31*0.1
33	Static Discharge Head	=D18-B1
34	Total Discharge Head (ft)	=SUM(B30:B33)
35		
36		
37	Total Developed Head (ft)	=B34-B14
38		
39		
40	Pump motor horsepower (0.8 efficiency)	=MAX(26:26)*MAX(37:37)/(3960*0.8)

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17	Design GPM (1 pump op)
18	1713
19	107
20	0
21	0
22	
23	0
24	=SUM(C18:C23)
25	=0.1*C24
26	=SUM(C24:C25)
27	
28	
29	RW Pumps to Demin Water
30	=E19*2.31
31	=Line Loss (Fig 2)!K55+Line Loss (Fig 2)!K62+Line Loss (Fig 2)!K74+Line Loss (Fig 2)!K79+Line Loss (Fig 2)!K94+Line Loss (Fig 2)!K99+Line Loss (Fig 2)!K107
32	=C31*0.1
33	=D19-B1
34	=SUM(C30:C33)
35	
36	
37	=C34-B14
38	
39	
40	

	D	E
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17	Discharge Elevation (ft)	Max Discharge Pressure (psig)
18	=B3+B8	0
19	=B3+B7	10
20	=B3+B9	35
21	=B3+B6	0
22	=B4	0
23	=B5	0
24		
25		
26		
27		
28		
29	RW Pumps to FP Tank	RW Pumps to Retention Basin
30	=E21*2.31	=E23*2.31
31	=Line Loss (Fig 2)!K55+Line Loss (Fig 2)!K62+Line Loss (Fig 2)!K74+Line Loss (Fig 2)!K79+Line Loss (Fig 2)!K94+Line Loss (Fig 2)!K122+Line Loss (Fig 2)!K128+Line Loss (Fig 2)!K156	=Line Loss (Fig 2)!K55+Line Loss (Fig 2)!K62+Line Loss (Fig 2)!K74+Line Loss (Fig 2)!K165
32	=D31*0.1	=0.1*E31
33	=D21-B1	=D23-D1
34	=SUM(D30:D33)	=SUM(E30:E33)
35		
36		
37	=D34-G14	=E34-B14
38		
39		
40		

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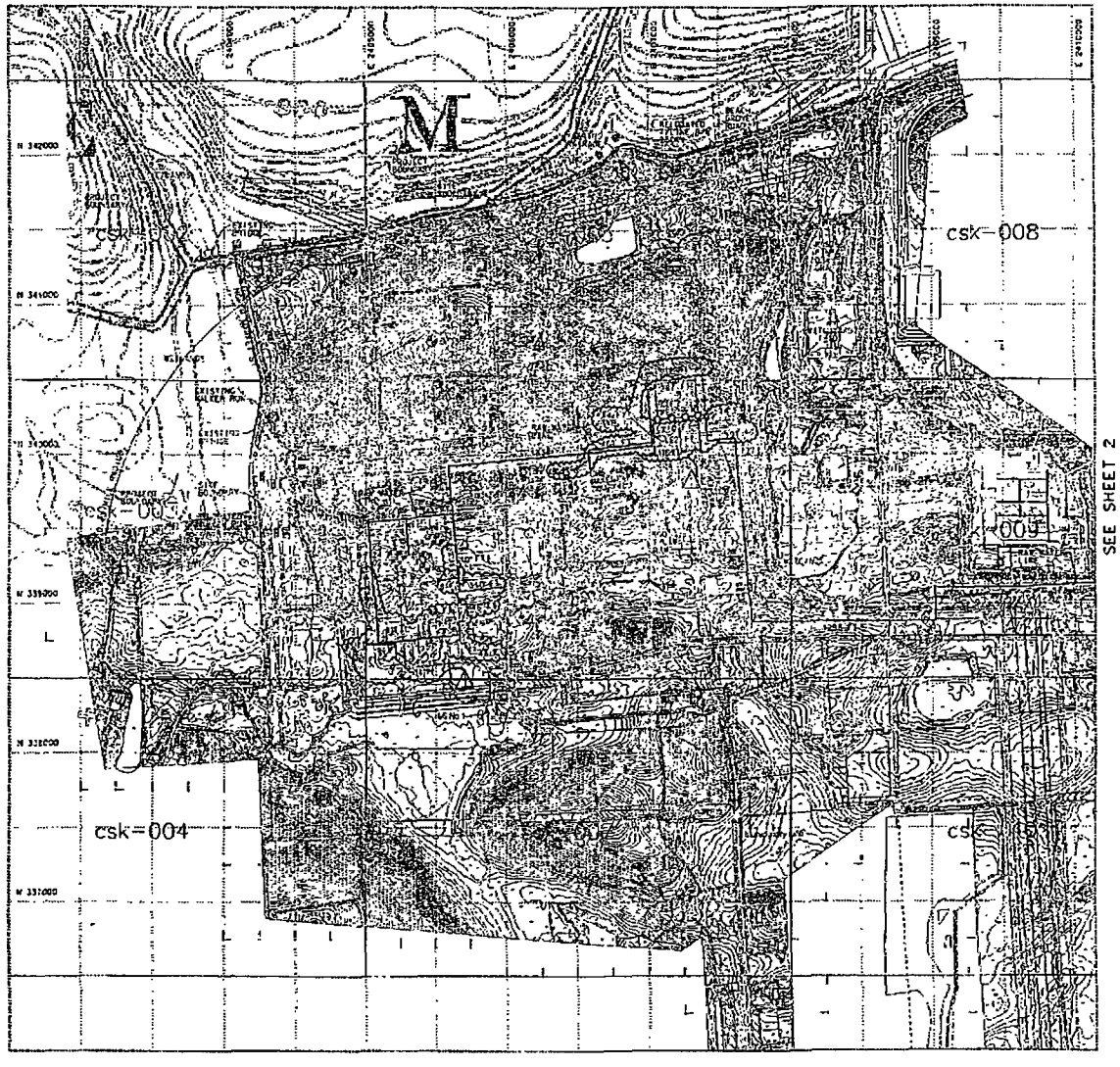
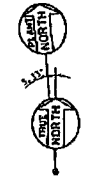
29	RW Pumps to UHS Pond	RW Pumps to Floor Wash
30	=E22*2.31	=E20*2.31
31	=Line Loss (Fig 2)!K55+Line Loss (Fig 2)!K62+Line Loss (Fig 2)!K74+Line Loss (Fig 2)!K79+Line Loss (Fig 2)!K89	=Line Loss (Fig 2)!K55+Line Loss (Fig 2)!K62+Line Loss (Fig 2)!K74+Line Loss (Fig 2)!K79+Line Loss (Fig 2)!K94+Line Loss (Fig 2)!K99+Line Loss (Fig 2)!K116
32	=0.1*F31	=0.1*G31
33	=D22-B1	=D20-B1
34	=SUM(F30:F33)	=SUM(G30:G33)
35		
36		
37	=F34-B14	=G34-B14
38		
39		
40		





300' 0 300' 600'
GRAPHIC SCALE

NOT NUCLEAR SAFETY RELATED

NOT FOR CONSTRUCTION

REFERENCE DRAWINGS

1. SK-12198-004-001, SHEET 1 OF 3 REV. 0
2. 12198-004-CSK-001, SHEET 1 OF 4 REV. 5
3. 12198-004-CSK-005, SHEET 1 OF 4 REV. 5

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DRAWING RELEASE RECORD

REV.	DATE REL'D.	PREPARED	REVIEWED	APPROVED	PURPOSE	FILM
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0	05/12/2008	M.ERICKSON	L.ANDERSON		CDR FOR QAR	
0	05/23/2008	M.ERICKSON	L.ANDERSON		REV. 0 FOR CONCEPTUAL DESIGN ISSUE	
1	07/31/2008	[illegible]	[illegible]		REVISED FOR CALC 2008-07916 REV 1	

SCALE 1"=300'
PROJECT NUMBER 12198-004

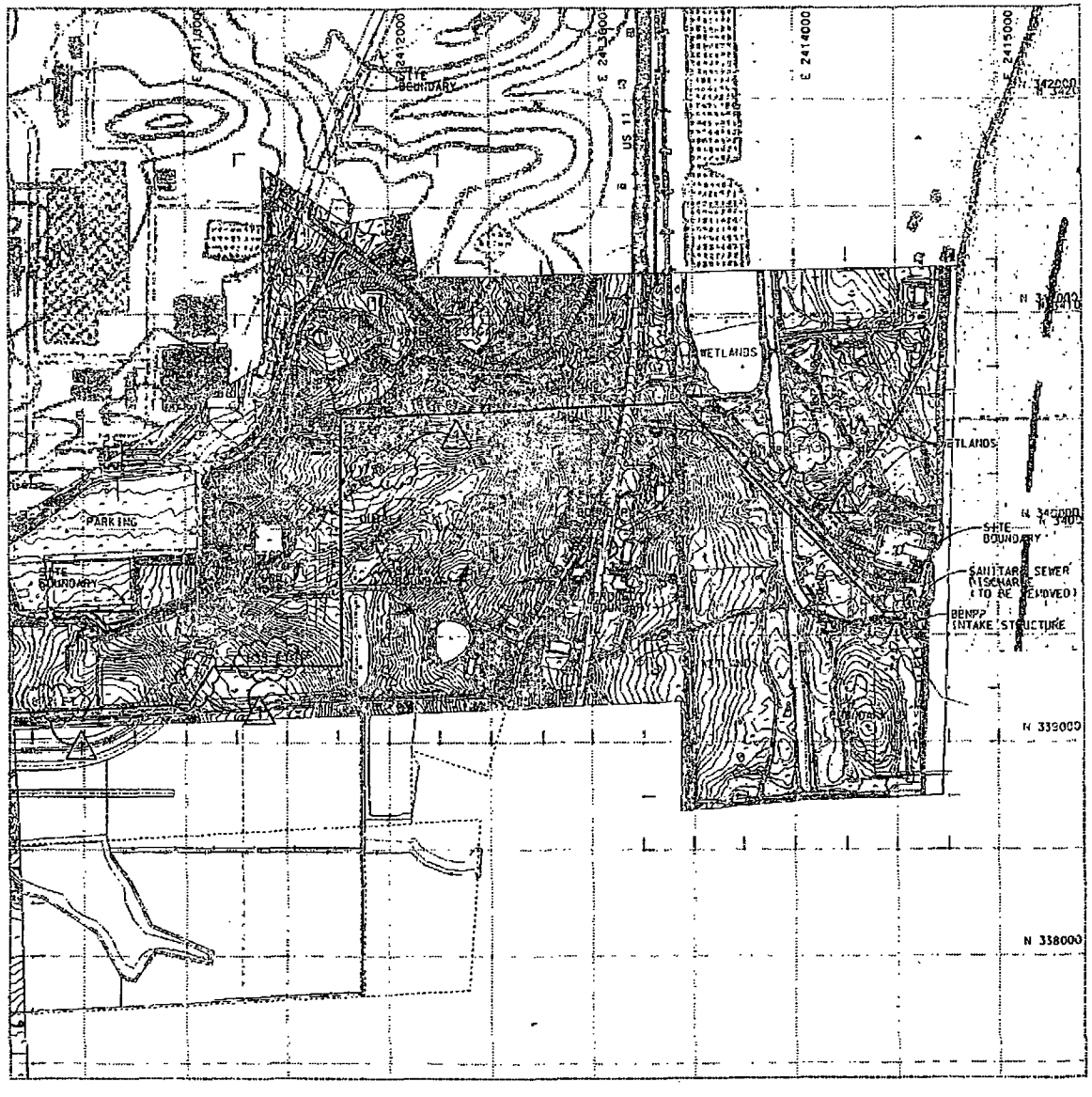
CONCEPTUAL
RAW WATER SUPPLY SYSTEM
MAIN HEADER

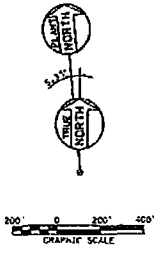
BELL BEND NUCLEAR POWER PLANT
UNISTAR NUCLEAR
PENNSYLVANIA

Sargent & Lundy

DRAWING NO. 12198-004-RWSS-003 REV. 1

SHEET 1 OF 2





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2. 12198-004-CSR-009, SHT. 1 REV. 5
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SCALE 1"=200'

PROJECT NUMBER 12198-004

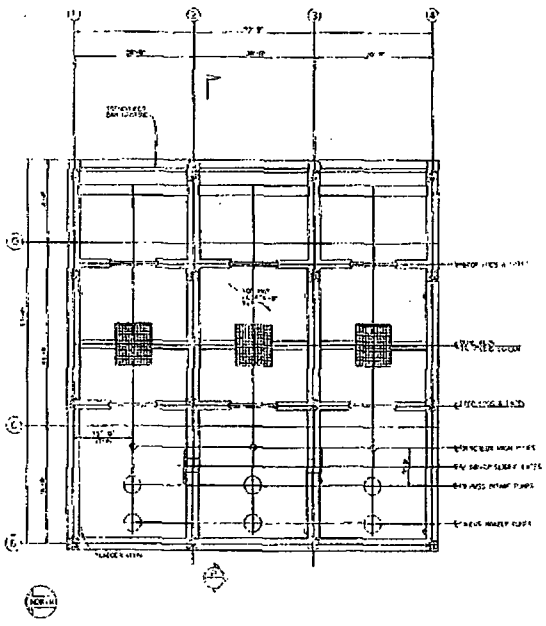
CONCEPTUAL
RAW WATER SUPPLY SYSTEM
MAIN HEADER

BELL BEND NUCLEAR POWER PLANT
UNISTAR NUCLEAR
PENNSYLVANIA

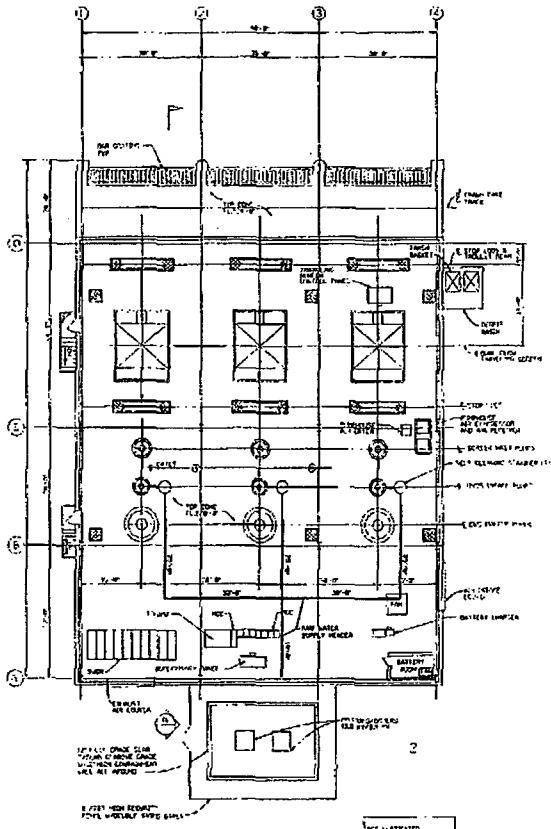
Sargent & Lundy LLC

DRAWING NO. 12198-004-RVSS-003 REV. 1

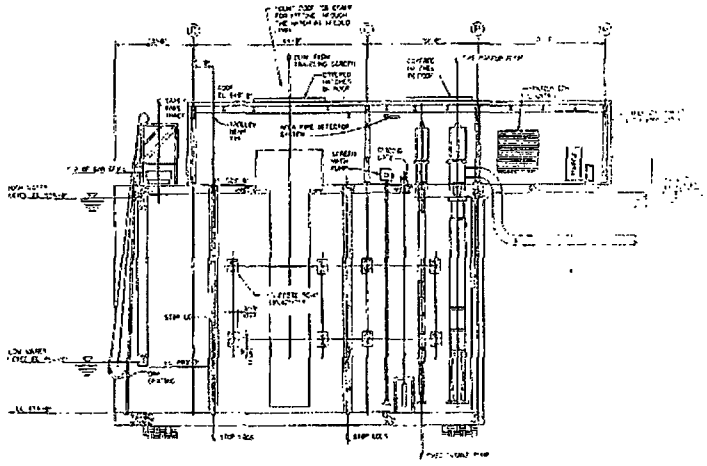
SHEET 2 OF 2



LOWER PLAN



UPPER PLAN



SECTION A-A

NOT FOR CONSTRUCTION

NON-SAFETY RELATED

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SCALE: NONE

PROJECT NUMBER: 12199-004

CONCEPTUAL
RAW WATER SUPPLY SYSTEM
INTAKE STRUCTURE
BELL BEND NUCLEAR POWERPLANT
UNISTAR NUCLEAR
PENNSYLVANIA

Sargent & Lundy

DRAWING NO. 12199-004-RWSS-002 REV. 0

SHEET 1 OF 1

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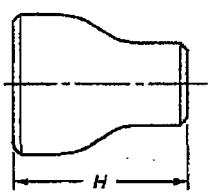
Page 1 of 1



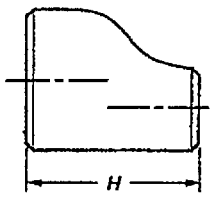


Table I11 Dimensions of Reducers

Nominal Pipe Size (NPS)	Outside Diameter at Bevel		End-to-End, *H*
	Large End	Small End	
3/4 × 1/2	1.05	0.84	1.50
3/4 × 3/8	1.05	0.68	1.50
1 × 3/4	1.32	1.05	2.00
1 × 1/2	1.32	0.84	2.00
1 1/4 × 1	1.66	1.32	2.00
1 1/4 × 3/4	1.66	1.05	2.00
1 1/4 × 1/2	1.66	0.84	2.00
1 1/2 × 1 1/4	1.90	1.66	2.50
1 1/2 × 1	1.90	1.32	2.50
1 1/2 × 3/4	1.90	1.05	2.50
1 1/2 × 1/2	1.90	0.84	2.50
2 × 1 1/2	2.38	1.90	3.00
2 × 1 1/4	2.38	1.66	3.00
2 × 1	2.38	1.32	3.00
2 × 3/4	2.38	1.05	3.00
2 1/2 × 2	2.88	2.38	3.50
2 1/2 × 1 1/2	2.88	1.90	3.50
2 1/2 × 1 1/4	2.88	1.66	3.50
2 1/2 × 1	2.88	1.32	3.50
3 × 2 1/2	3.50	2.88	3.50
3 × 2	3.50	2.38	3.50
3 × 1 1/2	3.50	1.90	3.50
3 × 1 1/4	3.50	1.66	3.50
3 1/2 × 3	4.00	3.50	4.00
3 1/2 × 2 1/2	4.00	2.88	4.00
3 1/2 × 2	4.00	2.38	4.00
3 1/2 × 1 1/2	4.00	1.90	4.00
3 1/2 × 1 1/4	4.00	1.66	4.00
4 × 3 1/2	4.50	4.00	4.00
4 × 3	4.50	3.50	4.00
4 × 2 1/2	4.50	2.88	4.00
4 × 2	4.50	2.38	4.00
4 × 1 1/2	4.50	1.90	4.00
5 × 4	5.56	4.50	5.00
5 × 3 1/2	5.56	4.00	5.00
5 × 3	5.56	3.50	5.00
5 × 2 1/2	5.56	2.88	5.00
5 × 2	5.56	2.38	5.00
6 × 5	6.62	5.56	5.50
6 × 4	6.62	4.50	5.50
6 × 3 1/2	6.62	4.00	5.50
6 × 3	6.62	3.50	5.50
6 × 2 1/2	6.62	2.88	5.50
8 × 6	8.62	6.62	6.00
8 × 5	8.62	5.56	6.00
8 × 4	8.62	4.50	6.00
8 × 3 1/2	8.62	4.00	6.00
10 × 8	10.75	8.62	7.00
10 × 6	10.75	6.62	7.00
10 × 5	10.75	5.56	7.00
10 × 4	10.75	4.50	7.00
12 × 10	12.75	10.75	8.00
12 × 8	12.75	8.62	8.00
12 × 6	12.75	6.62	8.00
12 × 5	12.75	5.56	8.00
14 × 12	14.00	12.75	13.00
14 × 10	14.00	10.75	13.00
14 × 8	14.00	8.62	13.00
14 × 6	14.00	6.62	13.00
16 × 14	16.00	14.00	14.00
16 × 12	16.00	12.75	14.00
16 × 10	16.00	10.75	14.00
16 × 8	16.00	8.62	14.00
18 × 16	18.00	16.00	15.00
18 × 14	18.00	14.00	15.00
18 × 12	18.00	12.75	15.00
18 × 10	18.00	10.75	15.00

Design and Operating Guidelines Manual for Cooling-Water Treatment

Treatment of Recirculated Cooling Water

CS-2276
First Edition
Research Project 1261-1

Final Report, March 1982

Prepared by

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Heat, Waste, and Water Management Program
Coal Combustion Systems Division

Table 5-1

OPERATING GUIDELINES FOR COOLING TOWER SYSTEMS IN ELECTRIC POWER PLANTS

Constituent	Limits	
	Without Scale Inhibitors	With Scale Inhibitors
pH (pH units)	6.8 - 7.2	7.8 - 8.4
Total Alkalinity (mg/l as $CaCO_3$)	30 - 50	200 - 250
Calcium Sulfate (mg/l of Ca as $CaCO_3$)	Maintain Ca<900	Maintain Ca<900
Silica (mg/l as SiO_2)	150	150
Magnesium Silicate (mg/l of Mg as $CaCO_3$ and mg/l of silica as SiO_2)	Mg x SiO_2<35,000	Mg x SiO_2<75,000
Suspended Solids (mg/l)	150	150
Total Dissolved Solids (mg/l)	60,000	60,000
Calcium Phosphate (mg/l as PO_4)	Maintain Orthophosphate <5	Insufficient data
Scale Inhibitor (mg/l)	Zero	As required on an individual basis per supplier's recommendation

These guidelines are discussed in more detail in the following sections.

pH

The recommended pH ranges result from a compromise of the following considerations:

- Materials of construction for system components.
- Biocide and/or chemical additive usage.
- Concentration limits for total dissolved solids and alkalinity.

The pH ranges indicated in Table 5-1 are the result of discussions with chemical suppliers (2) and are based on relationships to other "rule of thumb" guidelines.

BETZ HANDBOOK OF INDUSTRIAL WATER CONDITIONING

SIXTH EDITION

1962

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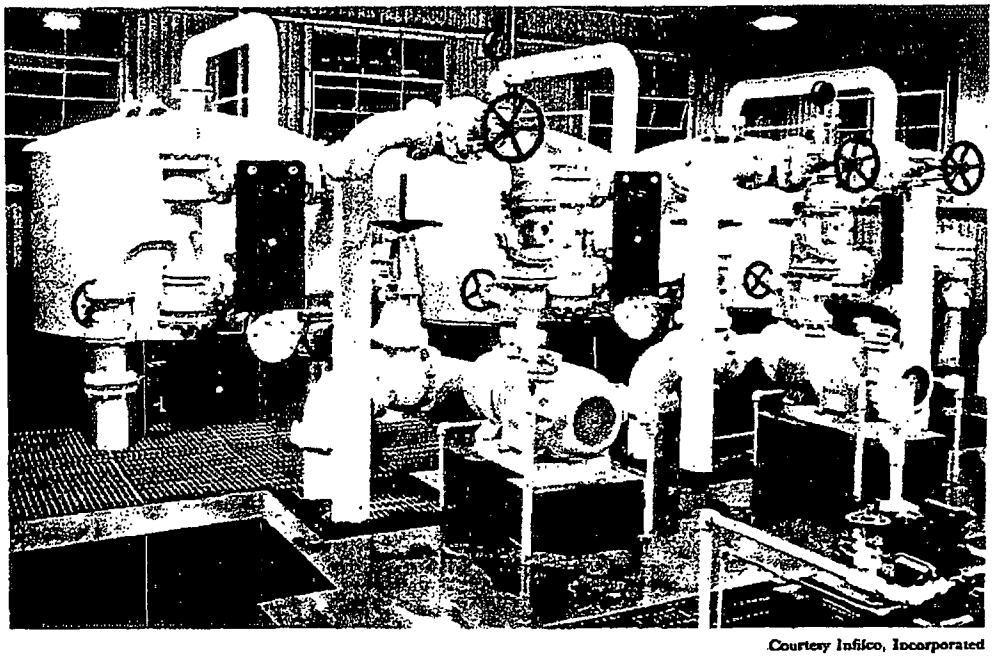

Courtesy Infilco, Incorporated

Figure 6-2 • Battery of Pressure Filters with Pilot Operated Diaphragm Valves

rates are employed, the freeboard above the filter surface should equal the inches of vertical rise per minute.

5. Certain control devices are required to insure maximum efficiency in filter operation. Rate-of-flow controllers automatically maintain uniform delivery of filtered water, operating from Venturi tubes in the effluent line. Backwash rate-of-flow controllers are used similarly to provide proper wash conditions. Rate-of-flow and loss-of-head gages are also considered necessary for most efficient operation. It is possible to group most gages, together with the operating controls, on operating tables for convenience for either manual or automatic operation.

New concepts in automatic gravity filtration are offered by several manufacturers that reduce the need for various controllers and manual operations previously required on standard gravity filters. Their application to industrial water filtration problems is increasing.

PRESSURE FILTERS. Pressure filters are somewhat more widely used than gravity filters in industrial water conditioning. Pressure filters possess the advantage that they may be placed in the line under pressure and thus eliminate double pumping. The use of pressure filters is required in conjunction with hot process softening to permit high temperature operation and to avoid thermal loss. The general design of pressure filters is essentially the same as gravity filters with respect to filter medium, supporting bed, underdrain system and control devices. The filter shell, of course, differs from a gravity filter and wash water troughs are not employed.

Pressure filters may be of the vertical or

horizontal type. The filter shells are steel, cylindrical in shape, with dished heads. Vertical filters range in diameter from 1 to 10 feet with capacities from 2.4 gpm to 235 gpm at a filter rate of 3 gal per sq ft per minute. Horizontal filters, usually 8 feet in diameter, may be 10 to 25 feet long with capacities from 218 gpm to 570 gpm. The general trend is away from horizontal pressure filters because certain areas of the filter bed adjacent to the shell are inactive during filtration and backwashing. One vendor has redesigned the horizontal unit with cells thereby improving operations.

Figure 6-3

Filter and Backwash Rates for Vertical Pressure Filters

Diameter, ft	Area Sq Ft	Filter Rate* gpm	Backwash Rate† gpm
3	7.1	21	106
4	12.6	38	189
5	19.6	59	295
6	28.3	85	425
7	38.5	116	578
8	50.3	150	755
9	63.6	190	954
10	78.5	235	1180

* Filter rate of 3 gal per sq ft per minute
† Backwash rate of 15 gal per sq ft per minute

Figure 6-4

Typical Filter Bed Layers and Sizes For Pressure Filters

SAND	12" layer—sand, 0.45-0.50 mm effective size
	10" layer—sand, 0.80-1.20 mm effective size
	4" layer—gravel, ¼"-⅛"
	4" layer—gravel, ½"-¼"
	8" layer—gravel, 1"-½"
	4" layer—gravel, 1½"-1"
ANTHRAFILT	18" layer—No. 1 Anthrafilt, 0.6-0.8 mm
	9" layer—No. 2 Anthrafilt, 3/32"-3/16"
	9" layer—No. 4 Anthrafilt, 5/16"-9/16"
	4" layer—No. 6 Anthrafilt, 13/16"-1⅝"

FILTER OPERATION

After backwashing, and placing a filter in operation, the water is filtered to waste for the first few minutes. This procedure rids the system of possible suspended solids remaining in the underdrain system after backwashing and also permits a small amount of suspended matter to accumulate on the bed. As soon as the filter produces clear water, the unit is returned to service.

During operation, the suspended matter removed by the filter accumulates on the surface and the increased frictional resistance is shown by the loss-of-head gage. When loss-of-head reaches 5 psi, it is advisable to backwash the filter to remove the mat on the bed surface. While industrial filtration rates are usually 3 gal per sq ft of filter area per minute, backwash rates are much higher in order to lift the suspended matter from the surface and expand the filter bed. Backwash rates of 12-15 gals per sq ft per minute are employed for sand and rates of 8-12 gals per sq ft per minute for anthracite. The backwashing is continued for 5 to 10 minutes, then the filter is returned to service, following filtering to waste until the water is clear.

Surface washers are of assistance in maintaining maximum filter efficiency. These units consist of horizontal arms, equipped with nozzles, supported just above the surface of the filter bed. High pressure backwash water supplied to the washer causes rotation of the arms and water leaving the nozzles impinges on the media, and loosens the accumulated suspended matter.

APPLICATIONS

Filtration is a requirement in the clarification of turbid waters for most industrial uses. In the preparation of domestic supplies, process water, boiler feedwater and, in fact, for almost every use it is necessary that the water be freed of objectionable suspended solids. While both coagulation and sedimentation may be employed for the removal of a portion of the suspended matter, filtration normally also is required to complete the production of a water of satisfactory quality.

Filtration is also employed as a part of other water treatment processes. For example, all of the precipitation methods of softening employ filtration as a final step in the process. Filtration is employed following hot phosphate

softening
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LIMITATIO

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softening as well as both hot and cold lime and lime-soda softening, except in some special cases.

Filtration ahead of exchange softeners and demineralizers is standard practice. Filtration is also a final step in certain iron removal methods and in the removal of oil from condensate.

LIMITATIONS

Filtration, without coagulation and sedimentation, is usually an unsatisfactory method for completely removing turbidity and suspended solids. In such an application, the filter provides only the removal of the larger particles.

Pressure filters are favored where double pumping can be avoided by placing the filter under line pressure. Pressure filters also usually require less space for installation. Pressure filters are required with hot process operation and prevent thermal loss in filtration and backwashing. Oxygen pickup is also prevented by the use of pressure filters.

Disadvantages in pressure filtration are that the appearance of the filter effluent and the filter medium are not under observation, backwashing effectiveness cannot be observed and loss of filter medium cannot be noted. Wash water troughs cannot be provided in pressure filters for as effective removal of backwash solids as in gravity filters. Pressure filters are more difficult to inspect and clean. The replacement of filter medium, gravel and underdrain systems presents more of a problem.

However, the most pertinent criticism of pressure filters in comparison with gravity filters is the inability of the operator to observe the effectiveness of the filtering and backwashing operations. While pressure filters are capable of providing an effluent of as high quality as gravity filters, this inability to maintain constant observation of the process may result in the production of an effluent of poorer quality than is obtained with gravity filters. Consequently, gravity filters are preferred where the conditions of the installation permit their use and where a water of highest quality is desired. Any malfunctioning of a gravity filter may be quickly observed and corrected. The selection between the two types must be made after a study of the conditions and problems involved in the particular installation.

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E. Nordell, "Water Treatment for Industrial and Other Uses", 2nd Ed., pp. 363-387, Reinhold Publishing Corp., New York, N.Y. (1961)

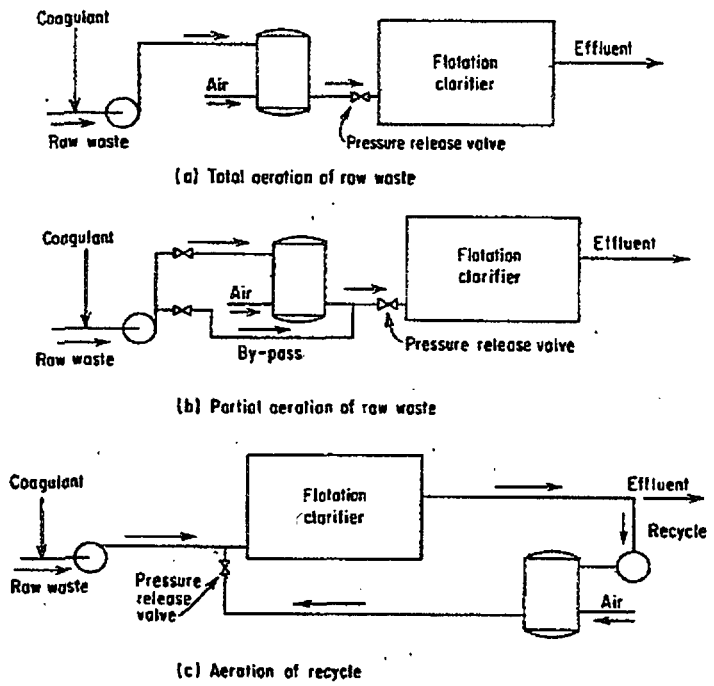


Figure 9.23 Several operating schemes for air flotation clarification.

Flotation is also practiced by application of dispersed air into a vessel containing water with oily or solid particulates. Air is mechanically entrained and dispersed through the liquid as fine bubbles in contrast to release of dissolved gas from solution. The dispersed air flotation design is especially suitable for treating oily wastewater (Figure 9.24).

FILTRATION

Granular Media Filtration

Granular media filtration is generally applicable for removal of suspended solids in the 5-50 mg/l range where an effluent of less than 1 JTU is required. Sand filters have been used for many years as a final polishing step in municipal and industrial water plants where the clarifier effluent contains 5-20 mg/l of suspended solids. In areas where a very low turbidity raw water source is available, some plants use granular media filtration as the only treatment process for solids removal, particularly for industrial process water. Granular media filters are also being used to filter cooling water sidestreams to reduce suspended solids buildup where effluent clarity is not critical. Granular media filters may handle suspended solids up to 1000 mg/l and provide about 90% removal.

A number of mechanisms are
physical and others chemical. Tl
and straining.

Adsorption is dependent on
solids and the filter media. It is a
properties as size, shear strength
by the chemical characteristics of
media. The amount of surface
3000–5000 sq ft/cu ft of media.
filters, is the major factor control
of good filter design is to minimiz
occurs because straining causes c
(particularly on sand filters), wit
media. The filter media in essen
loss increases exponentially with

Of the several types of filtratio
most common is silica sand, but
single medium such as silica san
according to size, the smallest par
ward through the sand, which is
surface, and filtration typically oc
by upward washing with water or
lically classifies the bed, keeping
loaded into a filter with the larger
this coarse to fine grading wou
solids storage would allow longer
izes the bed, the washed sand w

If a single medium bed is used
flow. Water is applied into the
coarser grain medium, resulting

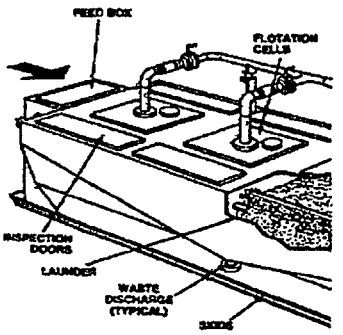
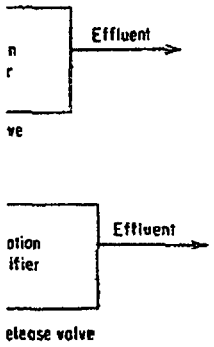
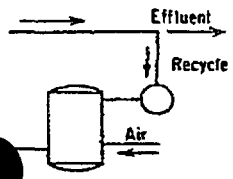


Figure 9.24 Dispersed air flotation,
of Wemco Division, Envirotech Corporat





on clarification.

persed air into a vessel contain-
nechanically entrained and dis-
ıtrast to release of dissolved gas
ı is especially suitable for treat-

for removal of suspended solids
s than 1 JTU is required. Sand
polishing step in municipal and
ıent contains 5-20 mg/l of sus-
ity raw water source is available,
ɔnly treatment process for solids
:. Granular media filters are also
ıs to reduce suspended solids
ınular media filters may handle
about 90% removal.

A number of mechanisms are involved in solids removal by filtration, some physical and others chemical. These filtration mechanisms include adsorption and straining.

Adsorption is dependent on the physical characteristics of the suspended solids and the filter media. It is a function of filter media grain size and such floc properties as size, shear strength, and adhesiveness. Adsorption is also affected by the chemical characteristics of the suspended solids, the water, and the filter media. The amount of surface exposed for adsorption is enormous—about 3000–5000 sq ft/cu ft of media. Straining, which occurs in all granular media filters, is the major factor controlling the length of filter runs. A major objective of good filter design is to minimize straining since it leads to rapid head loss. This occurs because straining causes cake formation on the surface of the filter bed (particularly on sand filters), with the deposited cake then acting as the filter media. The filter media in essence becomes finer as the cake forms, and head loss increases exponentially with time.

Of the several types of filtration media used to remove suspended solids, the most common is silica sand, but crushed anthracite is also widely used. When a single medium such as silica sand is used, it will classify in the filtration vessel according to size, the smallest particles rising to the top. When water flows downward through the sand, which is the traditional path, solids form a mat on the surface, and filtration typically occurs in the top few inches. The sand is cleaned by upward washing with water or with water and air (backwash), and this hydraulically classifies the bed, keeping the finest material on top. If the sand could be loaded into a filter with the larger grains at the top and the smaller at the bottom, this coarse to fine grading would allow in-depth penetration. The increased solids storage would allow longer filter runs. However, since backwashing fluidizes the bed, the washed sand would again return to a fine to coarse grading.

If a single medium bed is used, the only path to coarse to fine filtration is upflow. Water is applied into the bottom of the bed. Solids can penetrate the coarser grain medium, resulting in deeper bed filtration. Backwashing occurs in

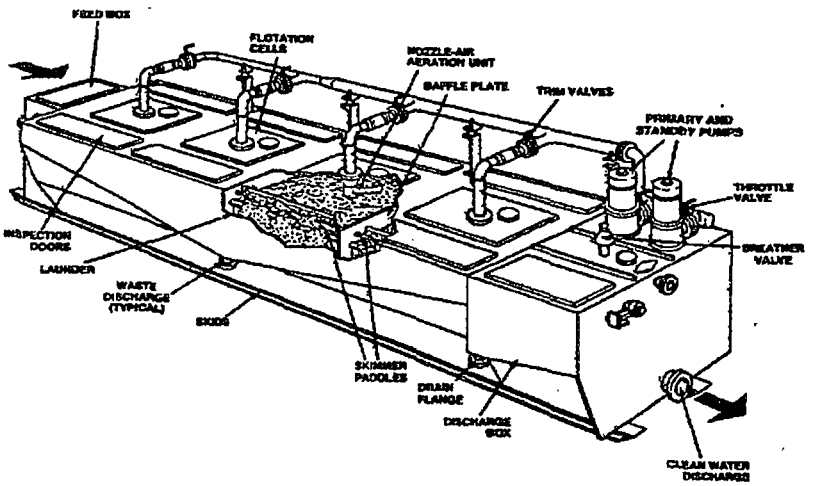


Figure 9.24 Dispersed air flotation, typically used for clarification of oily waste. *(Courtesy of Wemco Division, Envirotech Corporation.)*

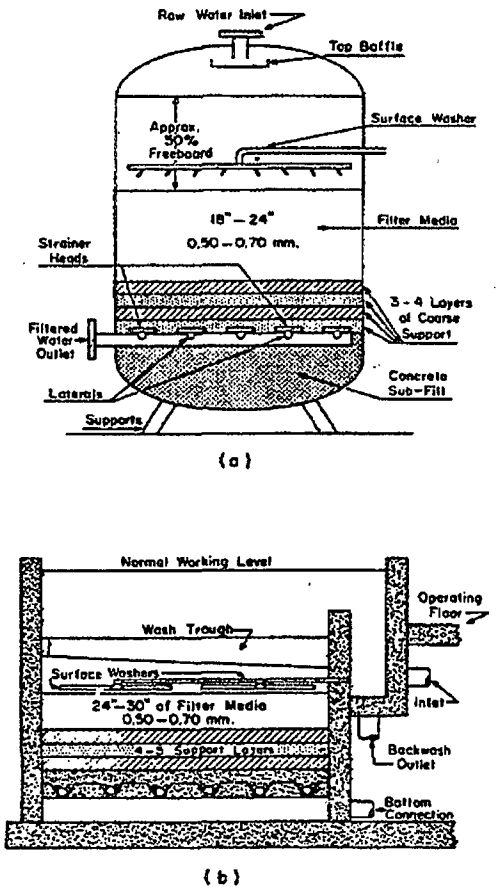


Figure 9.25 Schematic details of filtration units. (*a*) Pressure filter, vertical cylindrical design, fabricated of steel. Usually limited to 10'-0" diameter. (*b*) Gravity filter, usually of concrete construction; used in larger municipal and industrial plants.

the same direction as the filtration. The bed is classified fine at the top to coarse at the bottom. Upflow filters operate at up to 5 gpm/sq ft.

Typical single medium filters operate downflow at 2 gpm/sq ft of bed area in potable water service, and up to 3 gpm/sq ft in industrial filtration. The filter bed is 24 to 30" deep, supported on several courses of graded gravel (Figure 9.25*a* and *b*).

Silica sand normally has a grain size of 0.5 to 0.8 mm. Anthracite is usually about 0.7 mm. Smaller grains filter better, but filter runs are short. Larger grains allow longer filter runs, but if the flow is too high, hydraulic breakthrough will occur. A coarse filter media will produce acceptable effluent and reasonable filter runs if its depth is increased.

MULTI-MEDIA FILTER BEDS

A stacked media bed or two l
coarse to fine filtration in a dow
different grain sizes and different
is used in conjunction with silic
gravity of 1.6 and a grain size o
gravity of 2.65 and a grain size of
the fine sand after backwashing.
placed above 10" of sand. The c
and provides longer filter runs a
effluent. Under normal conditi
effluent at flow rates up to 5 gp

Just as coarse-to-fine dual med
further improvement can be ga
media under the sand. Garnet wi
size settling faster than the silica
multi-media contains 18" of 1.0–
4" of 0.2–0.4 mm garnet. This fi
deeper penetration and longer f

To design a filter for maxim
desired quality of effluent. The s
effluent of 0.1 JTU is different

Flow rate through a filter is cri
the number of filters required. G
the filter increases. The flow rat
size. As the media starts to load
increases until shear forces tear t
Most filters are designed to be b
point determined by head loss.
when the head loss reaches abo
loss of 15 to 20 ft is tolerable.

In a finer grain media, since
first few inches, increasing bed
hydraulic distribution. But in c
coarser the media the deeper m

Water temperature affects filu
viscosity is 44% higher than at 7
with cold water, since increased
move solids. Floc formation is m
ity at a given plant may vary se
surface, but penetrate deeply in

The best method of determin
tion/flocculation program is by o
is shown in Figure 9.26. Chemi
separate flash mix tank ahead o
used to determine filterability, b

Septum Filters

Where suspended solids conce
used. These filters are often ref
this material is usually used as
used. The septum filter (Figure
a slurry to a porous septum to p
solids. In most cases water bei
pressure; in special designs wh

MULTI-MEDIA FILTER BEDS

A stacked media bed or two layers (dual media) is one answer to providing coarse to fine filtration in a downflow pattern. The two materials selected have different grain sizes and different specific gravities. Normally, ground anthracite is used in conjunction with silica sand. The anthracite grains with a specific gravity of 1.6 and a grain size of 1 mm settle slower than sand with a specific gravity of 2.65 and a grain size of 0.5 mm, so the coarse anthracite rests on top of the fine sand after backwashing. In a typical dual media bed, 20" of anthracite is placed above 10" of sand. The coarse anthracite allows deeper bed penetration and provides longer filter runs at higher filter rates. The finer sand polishes the effluent. Under normal conditions, this dual media can produce acceptable effluent at flow rates up to 5 gpm/sq ft of bed area.

Just as coarse-to-fine dual media is more effective than a single medium filter, further improvement can be gained by introducing a third, smaller, heavier media under the sand. Garnet with a specific gravity of 4.5 and a very fine grain size settling faster than the silica sand can be used as the bottom layer. A typical multi-media contains 18" of 1.0–1.5 mm anthracite, 8" of 0.5 mm silica sand, and 4" of 0.2–0.4 mm garnet. This filter operates at higher flow rates and provides deeper penetration and longer filter runs than a single or dual media filter.

To design a filter for maximum performance, the first consideration is the desired quality of effluent. The selection of filter design required to produce an effluent of 0.1 JTU is different from that required to produce 1.0 JTU.

Flow rate through a filter is critical, since it limits the throughput and dictates the number of filters required. Generally, as flow rate increases, penetration into the filter increases. The flow rate is limited by the head available and the media size. As the media starts to load with solids, the net velocity at a given flow rate increases until shear forces tear the solids apart and they escape into the effluent. Most filters are designed to be backwashed before this breakthrough occurs at a point determined by head loss. Typically, single media filters are backwashed when the head loss reaches about 10 ft. In deep bed filtration, a terminal head loss of 15 to 20 ft is tolerable.

In a finer grain media, since solids removal is primarily accomplished in the first few inches, increasing bed depth is of little value except for improving hydraulic distribution. But in coarse filters where penetration is wanted, the coarser the media the deeper must be the bed for equivalent effluent quality.

Water temperature affects filter performance due to viscosity. At 32°F, water viscosity is 44% higher than at 72°F. Backwashing, on the other hand, improves with cold water, since increased viscosity more effectively scours the bed to remove solids. Floc formation is much slower at low temperatures so the filterability at a given plant may vary seasonally. In the summer, floc may stay on the surface, but penetrate deeply into the filter in the winter.

The best method of determining filter media selection for a chemical coagulation/flocculation program is by operation of a pilot test column. A typical column is shown in Figure 9.26. Chemicals can be fed directly to the column or into a separate flash mix tank ahead of the column. Various laboratory tests have been used to determine filterability, but none are as accurate as the pilot test column.

Septum Filters

Where suspended solids concentrations are very low, septum filtration can be used. These filters are often referred to as DE (diatomaceous earth) filters since this material is usually used as a filter precoat, although other filter aids can be used. The septum filter (Figure 9.27) relies on a thin layer of precoat applied as a slurry to a porous septum to produce a filtering surface to strain the suspended solids. In most cases water being filtered is pumped through the filter under pressure; in special designs where low head loss is possible the water may be

ıssified fine at the top to coarse
gpm/sq ft.
ɯ at 2 gpm/sq ft of bed area in
lustrial filtration. The filter bed
of graded gravel (Figure 9.25*a*

0.8 mm. Anthracite is usually
er runs are short. Larger grains
h, hydraulic breakthrough will
ɔtable effluent and reasonable

MAURY A PRESSBURGER/Sargentlundy
02/18/2008 01:56 PM

To JAS S DEVGUN/Sargentlundy@Sargentlundy, JEFFERY SALTARELLI/Sargentlundy@Sargentlundy, RICHARD P POSPIECH/Sargentlundy@Sargentlundy, HOWARD L ANDERSON/Sargentlundy@Sargentlundy, DANIEL C KOCUNIK/Sargentlundy@Sargentlundy, RONALD H COOK/Sargentlundy@Sargentlundy
cc
bcc
Subject Fw: Comments on RFI SL-BER-051

See attachments for Susquehanna water chemistry. For water/chemical treatment, what other info do we require. Need to know today and thanks.
---- Forwarded by MAURY A PRESSBURGER/Sargentlundy on 02/18/2008 01:54 PM ----

ROBERT A HAMEETMAN/Sargentlundy
02/15/2008 02:17 PM

To MAURY A PRESSBURGER/Sargentlundy@Sargentlundy
cc
Subject Fw: Comments on RFI SL-BER-051

----- Forwarded by ROBERT A HAMEETMAN/Sargentlundy on 02/15/2008 02:14 PM -----

"Cain, Michael" <Michael.Cain@unistarnuclear.com>
02/15/2008 09:43 AM

To "Wrobel, George" <George.Wrobel@unistarnuclear.com>, "van Noordennen, Gerry" <Gerry.vanNoordennen@constellation.com>
cc "Scholtes, Heather M" <Heather.Scholtes@constellation.com>, <ROBERT.A.HAMEETMAN@sargentlundy.com>, "SELZ Lannis N (AREVA NP INC)" <Lannis.Selz@areva.com>, "Antonio Fernandez" <antonio.fernandez@Rizzoassoc.com>, "Hunter, Mark T" <Mark.T.Hunter@unistarnuclear.com>
Subject FW: Comments on RFI SL-BER-051

Does this get posted to the ftp?

Also this seems to be related to a number of individual RFIs requesting information about water sources and by extension water quality.

The bottom line is that the raw water source at Bell Bend is the river. Water chemistry data is above. Raw water feeds D/I, FP, Circ Water and so on. Potable water is likely to come from another source. The need for treatment of raw water is an engineer's determination on a system by system basis.

It seems like we need to distribute this information broadly to AREVA, S&L and eventually B&V via some form so that they stop writing multiple RFIs each from a slightly different, but equally narrow perspective.

Heather is going to contact all of you about participating in a conference call on Tuesday morning. Please prepare.

MC

From: Fields, Jerome S [mailto:jsfields@pplweb.com]
Sent: Thursday, February 14, 2008 8:40 AM
To: Wrobel, George
Cc: Fehmida.Mesania@Rizzoassoc.com; Harpster, Terry L; Cain, Michael; Hunter, Mark Thomas
Subject: Comments on RFI SL-BER-051

George,

In response to questions on Susquehanna SES station water chemistry, I have the following comments;

Service Water, Circulating Water, and Blowdown are essentially the same water, that is river water usually between 3 to 5 cycles of concentration. Several parameters are measured including total suspended solids (TSS). TSS is of interest because the station's NPDES permit has TSS limits. Total dissolved solids listed in the RFI is not calculated. My source for this information is Jim Wolfer, Plant Chemistry.

Blowdown data is included in Ecology III Annual Water Quality and Fishes reports which you have copies of through 2006. I am attaching the 2007 water sample quarterly data since the annual report is not expected until later this year. These data are in four separate reports instead of combined in one table as in the annual reports.

This is the last open item I had from this week's RFI meeting. If I missed anything please let me know.

Thanks,

Jerry

<<river data 07-11.doc>> <<river data 07-8.doc>> <<river data 07-5.doc>> <<river data 07-3.doc>>

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river data 07-11.doc river data 07-8.doc river data 07-5.doc river data 07-3.doc

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888-522-5455 / FAX 570-384-5250

LABORATORY REPORT

LIMS ID		WAT-07-00459	WAT-07-00461	WAT-07-00460
Location / Plant		SSES-ENVIRONMENTAL	SSES-ENVIRONMENTAL	SSES-ENVIRONMENTAL
Sample Date		3/15/07	3/15/07	3/15/07
Sample Time		0839	0719	0847
Sample Description		SSES	Blowdown	Bell Bend
Parameter	Units			
Temperature	C	2.40	23.90	2.40
Dissolved Oxygen	mg/L	13.00	8.30	12.90
River Level	ft	497.0		
pH Lab		7.62	8.75	7.54
Conductivity - Lab	umho	187	646	188
Total Alkalinity	mg/L	39.0	135	38.0
PHT Alkalinity	mg/L	0.0	6.0	0.0
Total Suspended Solids	mg/L	152	63.0	82.0
Ammonia as N by ISE	mg/L	<0.20	<0.20	<0.20
Silicon Dioxide	mg/L	3.31	8.62	3.25
Bicarbonate as CaCO3	mg/L	39.0	123	38.0
Carbonate as CaCO3	mg/L	0.0	7.2	0.0
Chloride	mg/L	22.3	86.4	22.3
Fluoride	mg/L	<0.05	<0.10	N.D.
Nitrate as NO3	mg/L	3.0	10.6	3.0
Nitrate as N	mg/L	0.7	2.4	0.7
Phosphorus as PO4	mg/L	0.736	1.975	0.712
Sulfate	mg/L	12.5	52.3	12.4
Aluminum, Dissolved	ug/L	N.D.	<100	N.D.
Aluminum, Total	ug/L	2740	1430	2700
Barium, Total	ug/L	58	95	55
Beryllium, Total	ug/L	N.D.	N.D.	N.D.
Calcium, Dissolved	mg/L	17.3	62.8	17.7
Calcium, Total	mg/L	17.9	64.6	18.3
Chromium, Total	ug/L	<10	<10	<10
Copper, Dissolved	ug/L	N.D.	<20	N.D.
Copper, Total	ug/L	<20	<20	<20
Iron, Dissolved	mg/L	0.04	0.06	0.04
Iron, Total	mg/L	5.86	3.67	5.58
Magnesium, Dissolved	mg/L	3.45	13.0	3.42
Magnesium, Total	mg/L	4.29	13.7	4.31
Manganese, Dissolved	ug/L	42	43	44
Manganese, Total	ug/L	257	227	231
Nickel, Total	ug/L	<10	<10	<10
Potassium, Dissolved	mg/L	1.46	4.04	1.45
Potassium, Total	mg/L	1.86	4.28	1.83
Silver, Total	ug/L	N.D.	N.D.	N.D.
Sodium, Dissolved	mg/L	12.6	46.8	12.7
Sodium, Total	mg/L	12.3	47.3	12.4
Strontium, Total	ug/L	54	227	54
Vanadium, Total	ug/L	N.D.	N.D.	<10
Zinc, Dissolved	ug/L	<20	<20	<20
Zinc, Total	ug/L	26	24	24

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LABORATORY REPORT

LIMS ID		WAT-07-00796	WAT-07-00798	WAT-07-00797
Location / Plant		SSES-Environmental	SSES-Environmental	SSES-Environmental
Sample Date		5/21/07	5/21/07	5/21/07
Sample Time		0750	0906	0756
Sample Description		SSES	Blowdown	Bell Bend
Parameter	Units			
Temperature	C	15.50	19.00	15.50
Dissolved Oxygen	mg/L	10.30	9.10	10.30
River Level	ft	489.1		
pH Lab		8.20	8.91	8.13
Conductivity - Lab	umho	279	843	278
Total Alkalinity	mg/L	65.0	213	65.0
PHT Alkalinity	mg/L	0.0	14.0	0.0
Total Suspended Solids	mg/L	6.0	17.5	<4.0
Ammonia as N by ISE	mg/L	<0.20	<0.20	<0.20
Silicon Dioxide	mg/L	0.22	1.82	0.18
Bicarbonate as CaCO3	mg/L	65.0	185	65.0
Carbonate as CaCO3	mg/L	0.0	16.8	0.0
Chloride	mg/L	29.0	96.6	28.7
Fluoride	mg/L	0.07	0.22	0.07
Nitrate as NO3	mg/L	1.3	4.7	1.2
Nitrate as N	mg/L	0.3	1.1	0.3
Phosphorus as PO4	mg/L	0.117	1.702	0.120
Sulfate	mg/L	24.1	83.2	24.0
Aluminum, Dissolved	ug/L	<100	<100	N.D.
Aluminum, Total	ug/L	112	361	<100
Barium, Total	ug/L	28	90	28
Beryllium, Total	ug/L	N.D.	N.D.	N.D.
Calcium, Dissolved	mg/L	28.4	93.6	28.1
Calcium, Total	mg/L	28.3	94.2	28.4
Chromium, Total	ug/L	N.D.	N.D.	N.D.
Copper, Dissolved	ug/L	<20	N.D.	N.D.
Copper, Total	ug/L	N.D.	<20	N.D.
Iron, Dissolved	mg/L	0.03	0.10	0.03
Iron, Total	mg/L	0.58	1.59	0.51
Magnesium, Dissolved	mg/L	6.22	20.1	6.13
Magnesium, Total	mg/L	6.24	20.4	6.26
Manganese, Dissolved	ug/L	53	28	51
Manganese, Total	ug/L	100	193	97
Nickel, Total	ug/L	<10	<10	N.D.
Potassium, Dissolved	mg/L	1.58	4.74	1.41
Potassium, Total	mg/L	1.60	4.74	1.47
Silver, Total	ug/L	N.D.	N.D.	N.D.
Sodium, Dissolved	mg/L	17.2	56.6	16.8
Sodium, Total	mg/L	16.9	56.5	16.9
Strontium, Total	ug/L	103	341	103
Vanadium, Total	ug/L	N.D.	N.D.	N.D.
Zinc, Dissolved	ug/L	<20	<20	N.D.
Zinc, Total	ug/L	<20	<20	N.D.

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LABORATORY REPORT

LIMS ID		WAT-07-01344	WAT-07-01346	WAT-07-01345
Location / Plant		SSES-Environmental	SSES-Environmental	SSES-Environmental
Sample Date		08/23/07	08/23/07	08/23/07
Sample Time		0853	0737	0900
Sample Description		SSES	Blowdown	Bell Bend
Parameter	Units			
Temperature	C	19.50	22.60	19.70
Dissolved Oxygen	mg/L	8.00	7.90	8.00
River Level	ft	486.8		
pH Lab		7.74	8.80	7.71
Conductivity - Lab	umho	348	898	365
Total Alkalinity	mg/L	58.0	168	64.0
PHT Alkalinity	mg/L	0.0	13.0	0.0
Total Suspended Solids	mg/L	39.6	24.6	6.0
Ammonia as N by ISE	mg/L	<0.20	<0.20	<0.20
Silicon Dioxide	mg/L	1.96	5.63	2.06
Bicarbonate as CaCO3	mg/L	58.0	142	64.0
Carbonate as CaCO3	mg/L	0.0	15.6	0.0
Chloride	mg/L	38.2	112	39.6
Fluoride	mg/L	0.10	0.25	0.10
Nitrate as NO3	mg/L	1.9	5.1	2.0
Nitrate as N	mg/L	0.4	1.2	0.4
Phosphorus as PO4	mg/L	0.000	3.160	0.092
Sulfate	mg/L	48.8	137	51.2
Aluminum, Dissolved	ug/L	N.D.	<100	N.D.
Aluminum, Total	ug/L	127	359	<100
Barium, Total	ug/L	32	93	34
Beryllium, Total	ug/L	N.D.	N.D.	N.D.
Calcium, Dissolved	mg/L	29.6	79.9	30.6
Calcium, Total	mg/L	29.0	81.8	30.7
Chromium, Total	ug/L	N.D.	N.D.	N.D.
Copper, Dissolved	ug/L	N.D.	N.D.	N.D.
Copper, Total	ug/L	N.D.	N.D.	N.D.
Iron, Dissolved	mg/L	0.06	0.08	0.07
Iron, Total	mg/L	0.71	1.94	0.73
Magnesium, Dissolved	mg/L	10.0	27.0	10.5
Magnesium, Total	mg/L	9.99	27.7	10.6
Manganese, Dissolved	ug/L	145	42	147
Manganese, Total	ug/L	223	446	223
Nickel, Total	ug/L	<10	<10	<10
Potassium, Dissolved	mg/L	2.24	5.80	2.32
Potassium, Total	mg/L	2.24	5.88	2.34
Silver, Total	ug/L	N.D.	N.D.	N.D.
Sodium, Dissolved	mg/L	23.0	66.4	24.2
Sodium, Total	mg/L	22.7	67.2	24.1
Strontium, Total	ug/L	167	457	177
Vanadium, Total	ug/L	N.D.	<10	N.D.
Zinc, Dissolved	ug/L	N.D.	N.D.	N.D.
Zinc, Total	ug/L	N.D.	<20	N.D.

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LABORATORY REPORT

LIMS ID		WAT-07-01687	WAT-07-01689	WAT-07-01688
Location / Plant		SSES-Environmental	SSES-Environmental	SSES-Environmental
Sample Date		11/7/07	11/7/07	11/7/07
Sample Time		0658	0746	0649
Sample Description		SSES	Blowdown	Bell Bend
Parameter	Units			
Temperature	C	8.50	18.00	8.60
Dissolved Oxygen	mg/L	11.00	9.00	11.40
River Level	ft	488.3		
pH Lab		7.78	8.64	7.67
Conductivity - Lab	umho	261	720	262
Total Alkalinity	mg/L	60.0	173	60.0
PHT Alkalinity	mg/L	0.0	5.0	0.0
Total Suspended Solids	mg/L	5.8	29.0	6.0
Ammonia as N by ISE	mg/L	<0.20	<0.20	<0.20
Silicon Dioxide	mg/L	4.46	14.16	4.45
Bicarbonate as CaCO3	mg/L	60.0	163	60.0
Carbonate as CaCO3	mg/L	0.0	6.0	0.0
Chloride	mg/L	24.1	74.4	24.3
Fluoride	mg/L	0.05	0.17	0.06
Nitrate as NO3	mg/L	2.5	<0.5	2.4
Nitrate as N	mg/L	0.6	<0.1	0.5
Phosphorus as PO4	mg/L	0.132	3.567	0.172
Sulfate	mg/L	28.6	83.3	28.9
Aluminum, Dissolved	ug/L	N.D.	<100	N.D.
Aluminum, Total	ug/L	103	489	104
Barium, Total	ug/L	30	84	31
Beryllium, Total	ug/L	N.D.	N.D.	N.D.
Calcium, Dissolved	mg/L	27.6	81.5	27.8
Calcium, Total	mg/L	27.5	82.1	28.1
Chromium, Total	ug/L	N.D.	<10	N.D.
Copper, Dissolved	ug/L	N.D.	N.D.	N.D.
Copper, Total	ug/L	N.D.	N.D.	N.D.
Iron, Dissolved	mg/L	0.28	0.67	0.28
Iron, Total	mg/L	0.83	2.89	0.89
Magnesium, Dissolved	mg/L	6.08	17.4	6.09
Magnesium, Total	mg/L	6.06	17.6	6.18
Manganese, Dissolved	ug/L	102	43	99
Manganese, Total	ug/L	129	292	137
Nickel, Total	ug/L	N.D.	<10	N.D.
Potassium, Dissolved	mg/L	1.76	5.22	1.71
Potassium, Total	mg/L	1.76	5.29	1.79
Silver, Total	ug/L	N.D.	N.D.	N.D.
Sodium, Dissolved	mg/L	14.8	46.8	14.6
Sodium, Total	mg/L	14.6	46.6	14.7
Strontium, Total	ug/L	110	314	112
Vanadium, Total	ug/L	N.D.	N.D.	N.D.
Zinc, Dissolved	ug/L	N.D.	N.D.	N.D.
Zinc, Total	ug/L	N.D.	<20	N.D.

UniStar
NUCLEAR ENERGY

July 28, 2008

Robert Hameetman
Sargent & Lundy Engineers
55 E. Monroe Street
Chicago, IL 60603

RFI #08-278

Subject: Response to RFI SL-BER-053, from Robert Hameetman to George Wrobel, dated February 12, 2008.

Attached is the subject RFI and the UniStar Nuclear response.

Sincerely,

G. van Noordennen

G. van Noordennen

xc: J. Price, w/o
B. Perdue
R. Hameetman, S&L
T. Barnett, S&L

UniStar NUCLEAR

REQUEST FOR INFORMATION (RFI)

RFI NUMBER: SL-BER-053	DATE: February 12, 2008
PROJECT NUMBER: 759	PROJECT NAME: Berwick
SCHEDULE ACTIVITY ID: PL231045310	
ORIGINATOR: Richard Posplech (S&L)	PHONE/FAX: 312-269-2207
PROJECT MANAGER APPROVAL:	
SUPERVISOR APPROVAL:	
TO: George. Wrobel@unistarnuclear.com CC Michael.cain@unistarnuclear.com, Bob Hameetman (S&L), Jeff Saltarelli (S&L), Maury Pressburger (S&L), Jas Devgun (S&L), Howard Anderson (S&L)	
REFERENCE SECTION(S):	REV.: N/A
SPECIFICATION(S): N/A	REV.: N/A

INFORMATION REQUESTED:

Please confirm that it is acceptable to use the following flows listed in the Calvert Cliffs Unit 3 ER Section 3.3 Plant Water Use for our conceptual designs:

1) 20 gpm (max) into Waste Water Retention Basin from Waste Water Treatment Plant
2) 55 gpm (max) into Waste Water Retention Basin from Miscellaneous Low Volume Waste
3) 779 gpm (max) into Waste Water Retention Basin from Reverse Osmosis
4) 276 gpm (max) into Waste Water Retention Basin from Membrane Filtration
5) 80 gpm (max) for the makeup water to the Demineralizer
6) 625 gpm (max) to the Fire Water Storage Tanks from Raw Water
7) 1,880 gpm (max) from ESWS Blowdown. We are currently routing this flow to the Waste Water Retention Basin per the standard design. If the ESWS blowdown should be routed to the 30-day UHS pond, please notify us.
8) 3,764 gpm (max) for the non-safety related makeup water to the ESWS Cooling Towers from the Raw Water System.
9) 36 gpm (max) for the Potable and Sanitary Water Systems

Please, confirm that the UHS pond supply makeup water is for all four UHS cooling tower basins, simultaneously under LOCA conditions; and the UHS pond is sized to contain the safety related ESWS makeup water inventory required for 30 days under LOCA conditions.

Please provide the required makeup flow rate to the 30-day UHS pond.

We are currently routing the CWS and ESWS blowdowns to the wastewater retention basin per the standard design with the water from the retention basin ultimately discharged to the river. Please confirm.

RESPONSE REQUIRED BY:	February 25, 2008
IMPACTS:	Conceptual Designs

RESPONSE INFORMATION

TO:	Bob Hameetman	FROM:	Gwan Noordenne
OF:	S+L	OF:	UniStar

RESPONSE INFORMATION:

Please see the attached table with information on water flows.

Flow information for the following water streams, which appear on the table, has been provided from either the most current revision to the Calvert Cliffs RCOLA or the USEPR FSAR:

- ESWS Cooling Tower Evaporation (USEPR FSAR)
- ESWS Cooling Tower Drift
- Demineralized Water Distribution System Makeup
- Fire Water Distribution System Makeup
- Floor Wash Drains
- Potable and Sanitary Water Distribution System (Plant Users only) Makeup
- Miscellaneous Low Volume Waste
- Start-up Temporary Storage Discharge
- Treated Liquid Radwaste
- Sanitary Waste (plant users only)

Sargent & Lundy is responsible for providing flow information for the following combined or component water streams, which also appear in the attached table:

- Susquehanna River Water Demand
- River Intake Screen Cleaning Water
- Raw Water Supply System Makeup
  - RWSS Pump Strainer Cleaning Water
  - RWSS Filter Backwash
  - ESWS Makeup
  - ESWS Blowdown
  - Power Plant Makeup
  - UHS Storage Pond Makeup
- Circulating Water System (makeup, evaporation, drift and blowdown)
- Potable and Sanitary Water Distribution System (non-plant users only) Makeup
- Effluent Discharge to Susquehanna River
- Waste Water Retention Basin Discharge
  - RWSS Filter Backwash Discharge
  - Demineralizer Feed RO Reject
  - ESWS and CWS CT Blowdown
- River Intake Screen Cleaning Water Discharge
- RWSS Pump Strainer Cleaning Water Discharge
- Sanitary Waste (non-plant users only)

Prepared by: Gwan Noordenne

Reviewed by: MA

APPROVED FOR USE: T. Demitrack per cont call w/GVN	DATE: 7-29-08

UniStar Response for RFI SL-BER-053

Please use the attached table to calculate the revised water balance for plant operations.

Bell Bend Anticipated Water Use

Water Streams	Average Flow [a] gpm (lpm)	Maximum Flow [b] gpm (lpm)	Source of Information
Susquehanna River Water Demand	25,729 (97,384)	28,179 (106,656)	S&L
River Intake Screen Cleaning Water	—	—	S&L
Raw Water Supply System (RWSS)	1,921 (7,271)	4,371 (16,544)	S&L
RWSS Pump Strainer Cleaning Water	—	—	S&L
RWSS Filter Backwash	91 (344)	208 (787)	S&L
Essential Service Water System(ESWS)/Ultimate Heat Sink (UHS) Makeup	1,713 (7,124)	3,426 (12,967)	S&L
ESWS Cooling Tower Evaporation	1,142 (4,322)	2,284 (8,645)	USEPR FSAR Table 9.2.5-2
ESWS Cooling Tower Drift[f]	2 (8)	4 (15)	Calvert Cliffs RCOLA/Bechtel
ESWS Cooling Tower Blowdown	569 (2,154)	1,138 (4,307)	S&L based on 3 cycles of concentration
Power Plant Makeup	117 (443)	737 (2,790)	S&L
Demineralized Water Distribution System	107 (405)	107 (405)	Calvert Cliffs RCOLA/Bechtel + 27 gpm for RO (S&L)
Fire Water Distribution System	5 (19)	625 (2,366)	Calvert Cliffs RCOLA/Bechtel
Floor Wash Drains	5 (19)	5 (19)	Calvert Cliffs RCOLA/Bechtel
UHS Storage Pond	—	—	S&L
Circulating Water Supply System (CWS)	23,808 (90,113)	23,808 (90,113)	S&L
CWS Cooling Tower Evaporation	15,872 (60,076)	15,872 (60,076)	S&L based on 3 cycles of concentration
CWS Cooling Tower Drift	8 (30)	8 (30)	S&L based on 3 cycles of concentration
CWS Cooling Tower Blowdown	7,928 (30,007)	7,928 (30,007)	S&L based on 3 cycles of concentration
Municipal Water Demand (PA American Water)	103 (390)	236 (893)	S&L
Potable and Sanitary Water Distribution System	103 (390)	236 (893)	S&L
Plant Users	93 (352)	216 (818)	Calvert Cliffs RCOLA/Bechtel
Non-Plant Users	10 (38)	20 (76)	S&L
Effluent Discharge to Susquehanna River	8,665 (32,797)	9,367 (35,454)	S&L
Waste Water Retention Basin Discharge	8,654 (32,755)	9,356 (35,412)	S&L

Bell Bend Anticipated Water Use

Water Streams	Average Flow [a] gpm (lpm)	Maximum Flow [b] gpm (lpm)	Source of Information
RWSS Filter Backwash Discharge	91 (344)	208 (787)	S&L
Miscellaneous Low Volume Waste	39 (148)	55 (208)	Calvert Cliffs RCOLA/Bechtel
Demineralizer Feed Reverse Osmosis Reject	27 (102)	27 (102)	S&L
ESWS Cooling Tower Blowdown	569 (2,154)	1,138 (4,307)	S&L
CWS Cooling Tower Blowdown	7,928 (30,007)	7,928 (30,007)	S&L
Start-up Temporary Storage Discharge	—	—	Calvert Cliffs RCOLA/Bechtel
Treated Liquid Radwaste	11 (42)	11 (42)	Calvert Cliffs RCOLA/Bechtel
River Intake Screen Cleaning Water Discharge	—	—	S&L
RWSS Pump Strainer Cleaning Water Discharge	—	—	S&L
Effluent Discharge to Municipal Sewer (Berwick Area Joint Sewer Authority)			
Sanitary Waste	103 (390)	236 (893)	Calvert Cliffs RCOLA/Bechtel + non-plant (S&L)

a. Average flow represents the expected water consumptive rates and returns for normal plant operating conditions.
b. Maximum flow represents water consumptive rates and returns during normal shutdown/cooldown.

R. R. Sgarro
Manager-Nuclear Regulatory Affairs

PPL Bell Bend, LLC
38 Bomboy Lane, Suite 2
Berwick, PA 18603
Tel. 570.802.8102 FAX 570.802.8119
rrsgarro@pplweb.com

April 29, 2009

ATTN: Ms. Amy Elliott
Project Manager
U.S. Army Corps of Engineers
Baltimore District
1631 South Atherton Street
State College, PA 16801

RECEIVED
OCT 15 2009
SRSG

Request for Preliminary Jurisdictional Determination
Bell Bend Nuclear Power Plant
Luzerne County, Pennsylvania
BNP-2009-063

Reference: BNP-2008-002, T. L. Harpster (PPL Bell Bend, LLC) to USNRC, "Application for Combined License for the Bell Bend Nuclear Power Plant," dated October 10, 2008.

Dear Ms. Elliott:

Via the referenced letter, PPL Bell Bend, LLC tendered an application for a combined license for a new nuclear power unit adjacent to the existing site of PPL's Susquehanna Steam Electric Station in Luzerne County, Pennsylvania. The new unit has been designated by PPL as the Bell Bend Nuclear Power Plant.

PPL plans to submit a joint permit application for an individual permit to the Army Corps of Engineers and the Pennsylvania Department of Environmental Protection. In support of these activities, we hereby request a preliminary jurisdictional determination for the Bell Bend project.

The potential jurisdictional wetlands areas and stream features in the area of the project were delineated by Normandeau Associates, Inc. LandStudies, Inc. will be assisting PPL with preparation of the joint permit application. The wetlands delineation report and the map with the wetlands delineation survey are enclosed. PPL owns the land in question and will facilitate U.S. Army Corps of Engineers personnel access to the property as needed.

If you have any questions or need additional information, please contact the undersigned at 570.802.8102 or rrsgarro@pplweb.com.

Respectfully,

Rocco R. Sgarro

Rocco R. Sgarro

Attachment 1: Wetlands Delineation and Exceptional Value Wetlands Analysis Report, February 2009

cc: (w/o attachment)

Mr. Samuel J. Collins
Regional Administrator
U.S. Nuclear Regulatory Commission
Region I
475 Allendale Road
King of Prussia, PA 19406-1415

Mr. Michael Canova
Project Manager
U.S. Nuclear Regulatory Commission
11555 Rockville Pike
Rockville, MD 20852

Ms. Stacey Imboden
Project Manager
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bcc: M. Caverly
T. Harpster
G. Kuczynski
V. Lopiano
J. Freels
J. Fields
V. Kelly
N. Evans
A. Khanwalkar
B. Snapp
D. Lutchenkov
G. Gibson
D. Sullican
M. Gutshall
R. Janati

Attachment 1

Wetlands Delineation and Exceptional Value Wetlands Analysis Report, February 2009

NORMANDEAU ASSOCIATES, INC.
400 Old Reading Pike
Building A, Suite 101
(610) 705-5733
(610)705-5739 (Fax)
www.normandeau.com

AREVA
AREVA NP Inc.,
an AREVA and Siemens company
38-9092360-001

5 February 2009

Barbara Y. Hubbard
AREVA NP, Inc.
Solomon Pond Park
400 Donald Lynch Boulevard
Marlborough, Massachusetts 01752

SUBJECT: Report Transmittal
Revision 1 of the Bell Bend Wetlands Delineation Report

Dear Ms. Hubbard:

Please be advised that we have transmitted Revision 1 of the wetlands report for the Bell Bend NPP site to UniStar's FTP site. The title of this report is: Wetlands Delineation and Exceptional Value Wetlands Analysis Report.Revision 1. This report includes identification and mapping of all wetlands within the present Owner Controlled Area as well as an analysis of the exceptional value wetlands. In addition to supporting the COLA, the report will be very useful for future permitting activities with the PA Department of Environmental Protection and US Army Corps of Engineers.

If you have any questions regarding this matter, please contact me. We appreciate having the opportunity to perform this work for you.

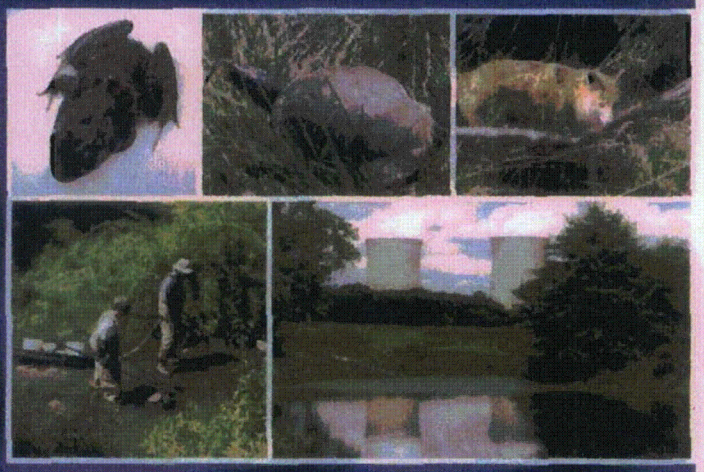
Sincerely yours,

Paul

Paul L. Harmon
Vice President

Rev. 1

Wetlands Delineation and Exceptional Value Wetlands Analysis Report for the Proposed Bell Bend Nuclear Power Plant Site, Luzerne County, Pennsylvania



Submitted to:
AREVA NP, Inc.
Marlborough, MA

February 2009

NORMANDEAU ASSOCIATES
ENVIRONMENTAL CONSULTANTS

Run or south-southeast to the Susquehanna River. As described in Section 2.3.2, the horizontal groundwater flow in the glacial overburden aquifer is generally north to south. As discussed in Section 2.3.1.2.3.2, in the southern trough (where the BBNPP power block is located), ground water in the glacial overburden aquifer flows from east to west and then southwest. The glacial overburden aquifer in this area discharges as springs and seeps into the Farm Pond, the wetlands along the southern border of the BBNPP site, and into Walker Run.

It is also possible that this groundwater could discharge locally at seeps or springs. Any possible impacts on deeper aquifers would also depend on the infiltrating volume and the hydrologic connection with the glacial overburden aquifer.

The composition of possible construction effluents that could infiltrate into the glacial overburden aquifer would depend on several factors related to the physical nature of the effluent material, i.e., solids versus liquids, solubility, vapor pressure, mobility, compound stability, reactivity in the surface and subsurface environments, dilution, and migration distance to groundwater. It is expected that proper housekeeping and spill management practices would minimize potential releases and volumes and physically contain any releases. Pesticides and herbicides are expected to be applied in limited site areas for insect and weed/ brush control.

Several impoundments are planned to catch stormwater and sediment runoff from the various construction areas. Bio-retention ditches are planned to drain the proposed BBNPP power block, cooling tower pads, switchyard, and laydown areas. Modeling of the runoff from the probable maximum flood (PMF) during plant operation bounds the possible runoff amounts, characteristics, and impacts that might occur during construction due to unpaved surfaces during construction allowing for greater stormwater infiltration to ground. The retention ditches will discharge excess runoff into impoundments. The impoundments will be sized so as to prevent fast flowing, sediment laden stormwater from reaching the creeks or the Susquehanna River prior to allowing the sediments to settle out. The flow velocities will be minimized to prevent erosion of stream banks. The allowable flow rates and physical characteristics of stormwater runoff will be specified in state discharge permits.

Maximum runoff for the Walker Run basin during the PMF is estimated at 13,033 cfs (369 m^3/s). The maximum high water level elevation in Walker Run at the BBNPP site is 670.96 ft (204.51 m) NGVD 29, which is below the approximate 674 ft (205 m) msl elevation of the final site grade in the power block, switchyard, and cooling tower area.

4.2.2.6 Baseline Water Quality Data

Baseline water quality data for surface water bodies is provided and discussed in Section 2.3.3. A summary of the water quality data for the onsite surface water bodies is presented in Table 2.3-45. Baseline water quality data for groundwater is provided in Section 2.3.3.

4.2.2.7 Potential Changes to Surface Water and Groundwater Quality

The following section describes the potential water quality impacts resulting from the construction of BBNPP.

The BBNPP site will be provided with water expected to come from the local public water supply once the line is brought to the site. Prior to the availability of the public water supply, water will be trucked in and stored onsite in temporary tanks.

Potential Changes to Surface Water Quality

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Potential surface water quality impacts are associated with the site clearing and grading activities.

The addition of sediment and organic debris to the local streams resulting from clearing, grubbing, and grading could decrease water quality. Organic debris could dam or clog existing streams, increase sediment deposition, and increase potential for future flooding. Organic debris decomposing in streams can cause dissolved oxygen and pH imbalances and subsequent releases of other organic and inorganic compounds from the stream sediments. Sediment laden waters are prone to reduced oxygen levels, algal growth, and increases in pathogens. If heavy metals or chemical compounds spill and/or wash into surface waters, there could be a direct toxicity to aquatic organisms. These potential pollutant releases could impact aquatic species and in turn affect the recreational aspects associated with fishing.

The water bodies downstream of the proposed construction areas could be directly and indirectly affected by construction activities onsite. Construction debris residing on the pads and temporary staging areas could mix with construction wash-down water or stormwater, exit the site via untreated runoff and produce chemical reactions adverse to downstream ecology. Possible contaminants include: sediment, alkaline byproducts from concrete production, concrete sealants, acidic byproducts, heavy metals, nutrients, solvents, and hydrocarbons (fuels, oils, and greases). There could be a high potential for contaminants to mix with site wash-down water or rainwater/precipitation runoff and be washed downstream into surface water bodies existing on the BBNPP site due to the persistent nature of local precipitation. There could also be the potential for spills within the construction areas consisting of fuels, solvents, sealants, paints, or glues. Construction dusts not suppressed could drift outside of the construction zones and contaminate nearby water supplies. If these contaminants enter the surface water bodies unchecked there could be a potential for infiltration and subsequent groundwater contamination.

The impacts to surface water quality downstream of the construction site are small due to the use of BMPs to control dust, runoff, and spills.

Potential Changes to Groundwater Quality

Dewatering for the foundation excavations may increase the oxidation of some sedimentary constituents by placing them in direct contact with the atmosphere. The oxides might have an increased solubility and could migrate down gradient when the potentiometric head is reestablished following construction completion. Possible impacts to the glacial overburden aquifer water quality would be small and decrease with migration and dilution.

4.2.2.8 Surface Water and Groundwater Users

Surface water users downstream of the site may experience impacts from potential water quality changes if construction effluent concentrations and volumes are large enough and the release enters directly into a surface water body bypassing the overflow catch basins and retention ponds. The surface water users that could be impacted in the event of a release are those downstream of the BBNPP site along the tributaries flowing to the Susquehanna River. Any impacts to the Susquehanna River receiving the discharge are expected to be small.

Groundwater users in vicinity of the BBNPP site are identified in Section 2.3.2.

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4.2.2.9 Predicted Impacts on Water Users

The impact of potential increased sediment loads in site runoff during construction would result in small or no impacts to surface water users and affected areas.

Potential construction effluent impacts on aquifer groundwater quality would first be manifested in the glacial overburden aquifer. Construction activities are only expected to produce limited and temporary impacts in the Surficial aquifer. As described in Section 2.3.1, the glacial overburden aquifer is not used as a potable water source in the vicinity of the BBNPP site. Therefore, potential groundwater quality changes would not be expected to have any impact on possible users. Potential impacts to the deeper aquifers are dependant on the nature of the hydraulic connection between aquifers described in Section 4.2.1.1. Groundwater quality impacts on users of the deeper aquifer users are small due to dilution and other contaminant attenuation effects that could occur along any effluent plume migration path.

The BBNPP site is located in U.S. EPA Region 3 (the District of Columbia, Delaware, Maryland, Pennsylvania, Virginia, and West Virginia). Six sole-source aquifers are identified in U.S. EPA Region 3 (Figure 2.3-70). None of these are located in the region of BBNPP (USEPA, 1996). Thus, the addition of BBNPP is not an impact to any sole source aquifer.

4.2.2.10 Measures to Control Construction Related Impacts

The following measures will be taken to avoid runoff from the construction areas entering and potentially impacting downstream surface water bodies and groundwater, as applicable:

- Implementation of a Erosion and Sediment control Plan;
- Controlling runoff and potential spills using dikes, earthen berms, seeded ditches, and impoundments;
- Monitoring for contaminants within construction area impoundments and impoundments downstream of disturbed areas;
- Implementation of BMPs to protect against accidental discharge of contaminants (fuel spills, other fluids and solids that could degrade groundwater and surface water resources); and
- Performing additional onsite surface and groundwater monitoring compared to established water quality benchmarks and historical site data.

Bio-retention ditches are planned for the periphery of the power block, laydown, cooling tower and switchyard areas. The ditches are constructed of base materials that promote infiltration of runoff from low intensity rainfall events. However, for large storms the infiltration capacity of the base materials would be exceeded and the overflow pipes are provided to direct the runoff to the stormwater basins. The stormwater basins are unlined impoundments with simple earth-fill closure on the down stream end and include discharge piping to the adjacent watercourses.

As discussed in Section 2.3.2.2.9, during construction, dewatering of the glacial overburden aquifer will be required in the power block and the ESWEMS pumphouse areas in order to excavate down to bedrock. Groundwater flow barriers will be installed around these areas in order to minimize impacts to the aquifer. Because a groundwater barrier will be installed prior to excavation, the amount of groundwater that needs to be pumped and resulting impacts to the shallow aquifer will be minimal.

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During operation of the BBNPP, groundwater will not be pumped and will not be used in the plant. Therefore, the long term impacts on groundwater levels, flow direction, and resources resulting from construction and operation of the BBNPP will be localized and will be minimal.

Following the acquisition of the required permits and authorizations, site preparation activities include the installation or establishment of environmental controls to assist in controlling construction impacts to groundwater. These environmental controls include:

- Coffer Dams;
- Stormwater management systems;
- Spill containment controls;
- Silt screens;
- Settling basins; and
- Dust suppression systems.

These controls assist in protecting the glacial aquifer by minimizing the potential for construction effluents to infiltrate directly into the subsurface or to carry possible contaminants to aquifer recharge areas.

Mitigation measures for construction activities in the area of the CWS Intake Structure and discharge outfall include:

- Installing a sheet pile cofferdam and dewatering system to facilitate construction of the BBNPP CWS Intake Structure and discharge outfall structure; and
- Carrying out water-quality monitoring in accordance with any permit requirements.

Additional measures to minimize or contain accidental releases of contaminants will be the establishment, maintenance, and monitoring of:

- Solid waste storage areas;
- Backfill borrow, spoils, and topsoil storage areas; and
- Site drainage patterns.

Groundwater monitor wells will be installed to assess gradient changes toward the excavation dewatering areas and potential groundwater quantity and quality changes.

As explained in Section 4.2.2.7, any contamination that might be introduced into the glacial overburden aquifer would be attenuated by the time it might reach deeper aquifers.

4.2.2.11 Consultation with Federal, State and Local Environmental Organizations

The regulations guiding the implementation of Best Management Practices (BMPs) are provided by the Pennsylvania Department of Environmental Protection (PADEP) for water quality, and the Susquehanna River Basin Commission (SRBC) for water use. (PADEP, 2006). These regulations contain BMP installation instructions and typical construction activities which require BMPs. Monitoring of construction effluents and stormwater runoff would be performed as required in the stormwater management plan, NPDES permit, and other applicable permits obtained for the construction. The integrated permitting process for the *applicable environmental permits will proceed concurrently with NRC review of the combined* license application.

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4.4 SOCIOECONOMIC IMPACTS

4.4.1 PHYSICAL IMPACTS

Construction activities at the BBNPP site will cause temporary and generally localized physical impacts such as increased noise, vehicle exhaust, and dust. This section addresses these potential impacts as they might affect people (the local public and workers), buildings, transportation routes, and the aesthetics of areas located near the plant site.

A description of the BBNPP site, location and surrounding community characteristics is provided in Section 2.1, Section 2.2, and Section 2.5. Chapter 3 describes the proposed facility including its external appearance.

As discussed below, the BBNPP site is located in a rural area, relatively remote from nearby population centers and communities. As a result, the potential for direct physical impacts to the surrounding communities from plant construction is expected to be SMALL.

4.4.1.1 The Public and Workers

People who work at or live near the BBNPPsite will be subject to physical impacts resulting from construction activities. Onsite construction workers will be impacted the most, with workers at the existing adjacent operating units subject to slightly reduced, similar impacts. People living or working adjacent to the site will be impacted significantly less due to site access controls and distance from the construction site where most activities will occur. Transient populations and recreational visitors will be impacted the least for similar reasons and the limited exposure to any impacts of construction.

4.4.1.2 Noise

Section 2.7 provides information and data related to the background noise levels that exist at the construction site.

Noise levels in the site area will increase during construction primarily due to the operation of vehicles; earth moving, materials-handling, and impact equipment; and other tools. Pile driving will occur during some construction activities.

Typical noise levels from equipment that is likely to be used during construction are provided in Table 4.4-1 (Beranek, 1971). Onsite noise levels that workers will be exposed to are controlled through appropriate training, personnel protective equipment, periodic health and safety monitoring, and industry good practices. Good practices such as maintenance of noise limiting devices on vehicles and equipment, and controlling access to high noise areas, duration of emission, or shielding high noise sources near their origin will limit the adverse effects of noise on workers. Non-routine activities with potential to adversely impact noise levels such as blasting will be conducted during weekday business hours and will utilize good industry practices that further limit adverse effects.

The exposure of the public to adverse effects of noise from construction activities will be reduced at the source by many of the same measures described above and the additional distance, interposing terrain, and vegetation which provide noise attenuation. Typically, noise generated by construction equipment decreases by approximately 6 dBA for each doubling of distance (Harris, 1979). For instance, if the maximum noise levels produced by construction are 90 dBA at a reference distance of 50 ft (15 m), then at 100 ft (30 m) that noise level will be reduced to 84 dBA. Because the nearest residence is 1,400 ft (427 m) away, noise effects from construction are expected to be SMALL.

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Traffic noise in the local area will increase as additional workers commute, and materials and waste are transported to and from the construction site. Noise impacts will occur primarily during shift changes and will not be extraordinary given the source and nature of vehicle noise and the normally varying nature of transient vehicle noise levels. Additionally, localized impacts will be reduced as distance from the construction site increases and traffic diverges outward.

In summary, good noise control practices on the construction site, and the additional attenuation provided by the distance between the public and the site, will limit noise effects to the public and workers during construction so that its impact will be small and temporary. Construction noise generation is directly linked with the conduct of construction activities which will end as the facility enters operation.

4.4.1.3 Dust and Other Air Emissions

Construction activities will result in increased air emissions. Fugitive dust and fine particulate matter will be generated during earth moving and material handling activities. Vehicles and engine-driven equipment (e.g., generators and compressors) will generate combustion product emissions such as carbon monoxide, oxides of nitrogen, and to a lesser extent, sulfur dioxides. Painting, coating and similar operations will also generate emissions from the use of volatile organic compounds (VOCs).

To limit and mitigate releases, emission-specific strategies, plans and measures will be developed and implemented to ensure compliance within the applicable regulatory limits defined by the primary and secondary National Ambient Air Quality Standards in 40 CFR 50 (CFR, 2007a) and the National Emission Standards for Hazardous Air Pollutants in 40 CFR 61 (CFR, 2007b). For example, a dust control program will be incorporated into the Storm Water Pollution Prevention Plan. A routine vehicle and equipment inspection and maintenance program will be established to minimize air pollution emissions. Emissions will be monitored in locations where air emissions could exceed limits (e.g. the concrete batch plant). Air quality and release permits and operating certificates will be secured where required.

The Pennsylvania Department of Labor and Industry (PADOLI) implements occupational health and safety regulations that set limits to protect workers from adverse conditions including emissions of airborne contaminants (PADOLI, 1953). If localized emissions result in limits being exceeded, corrective and protective measures will be implemented to reduce emissions (or otherwise protect workers in some cases) in accordance with the applicable regulations.

Implementation of controls and limits at the source of emissions on the construction site will result in reduction of impacts offsite. For example, the dust control program will limit dust due to construction activities to the extent that it is not expected to reach site boundaries.

Transportation and other offsite activities will result in emissions due largely to use of vehicles. Activities will generally be conducted on improved surfaces and any related fugitive dust emissions will be minimized. As with noise, impacts will be reduced as distance from the site increases.

In summary, air emission impacts from construction are expected to be SMALL because emissions will be controlled at the sources where practicable, maintained within established regulatory limits that were designed to minimize impacts, and distance between the construction site and the public will limit offsite exposures. Construction air emissions impacts are temporary because they will only occur during the actual use of the specific construction

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equipment or conduct of specific construction activities, and surfaces will be stabilized upon completion of construction activities.

4.4.1.4 Buildings

The primary buildings in the immediate area with the potential for impact from construction are the residences located 1,400 ft (427 m) or more to the west and south of the site and those associated with SSES, which is located approximately 5,000 ft (1,524 m) to the east. Related information about historic properties and the impacts of construction on them is provided in Section 2.5.3 and Section 4.1.3.

Many existing SSES onsite buildings related to safety of the existing facility were constructed to meet seismic qualification criteria which make them resistant to the effects of vibration and shock similar to that which could occur during construction. Other SSES onsite facilities were constructed to the appropriate building codes and standards which include consideration of seismic loads. Regardless of the applicable design standard, construction activities will be planned, reviewed, and conducted in a manner that ensures no adverse effect on the operating nuclear units and that SSES buildings are adequately protected from adverse impact.

Construction activities are not expected to affect other offsite buildings due to their distance from the construction site.

The impact of construction activities on nearby buildings will be SMALL and temporary because of the design of SSES buildings and the administrative programs that will ensure no adverse interaction with the operating units, while offsite buildings are located at distances that isolate them from potential interaction.

4.4.1.5 Transportation Routes

The major transportation routes in the area are described in Section 2.5.1.

The current Luzerne County highway system contains the major Interstates 80 and 81. Interstate 80, the closest to the proposed plant, runs east-west along the southern end of Luzerne County and is a four-lane divided road built to accommodate large volumes of passenger vehicles and freight transport. These highways provide access to traffic and shipping routes for BBNPP via their intersection with U.S. Highway 11. U.S. Highway 11 is a well maintained two-lane paved road oriented northeast-southwest. Traffic will increase substantially on U.S. Highway 11 during peak construction periods and will be at its greatest during shift changes. Construction workers will use U.S. Highway 11 and Interstates 80 and 81 in the area around the site to commute to work. Additionally, public roadways will be used to transport construction materials and equipment to the site, although most heavy equipment and plant components will be brought in by rail. Impact on area transportation resources will generally decrease with increased distance from the site as various routes are taken by individual vehicles.

A transportation study was performed to identify potential routes, both highway and rail, that could support the shipment of materials for the BBNPP. This study found that significant improvements made to the rail and roadway networks since the 1970's and early 80's are sufficient to ship the necessary construction material(s) to the site. An access road will be built to connect BBNPP with U.S. Highway 11. The existing rail spur will be extended from the existing SSES plant to BBNPP. Use of rail spur during construction is not expected to directly impact traffic flow on U.S. Highway 11 as there are no at-grade rail crossings along this route in the vicinity of BBNPP and SSES. However, rail deliveries would have the potential to create

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temporary congestion during SSES shift changes because the rail spur crosses access ways that serve SSES. Measures suggested to avoid these impacts included scheduling shipments over the rail spur to avoid shift changes.

An additional study of traffic related to construction activities (KLD, 2008) was performed to assess the impacts on capacity and level of service (LOS) and to identify potential mitigation actions, if needed. The study found that mitigation will be required to maintain an acceptable level of service on U.S. Highway 11 and at nearby intersections. Table 4.4-2 provides the projected levels of service at key intersections (Figure 4.4-1) during construction of BBNPP as compared to the future no-build traffic condition. Measures suggested to mitigate excess construction traffic impacts included installation of signals at the entrance to the BBNPP access road and nearby cross roads, realignment of lanes on U.S. Highway 11 to facilitate entrance to the site, and the provision of additional entrance and exit lanes on the access road at the intersection of U.S. Highway 11.

A water intake pump house along with discharge piping will be constructed for BBNPP. The Circulating Water System (CWS) Makeup Water Intake Structure will be located south of the existing SSES plant intake on the west bank of the Susquehanna River. Construction of the intake and discharge will occupy a portion of the river due to construction of sheetpile cofferdams, but these structures are sufficiently small such that access to upstream and downstream areas by boaters should not be impeded. Furthermore, the cofferdams will be removed prior to operations.

Thus, the potential impacts to the surrounding communities from construction related traffic are expected to be SMALL.

4.4.1.6 Aesthetics

The BBNPP will be separated from the currently operating SSES facilities by a distance of approximately 5,000 ft (1,524 m). Construction activities that might affect visual aesthetics will largely be limited to those seen from the new construction access road and from Market Street and Beach Grove Road, which pass to the west and north along the perimeter of the site. Some residential properties located west of the site are expected to experience the most direct aesthetic impacts.

As detailed and illustrated in Section 3.1, the proposed building structures that might impact the aesthetic qualities of the area as they reach the tree line during construction are the reactor building, turbine hall, and the two natural draft cooling towers. Of the buildings listed, the two cooling towers, at approximately 475 ft (145 m) above grade, and the reactor building at 204 ft (62 m) above grade, will be the highest structures. Most other new buildings will not be visible because they will be obscured by the taller structures and will generally exist below the tree line.

Visual impacts of construction are expected to be SMALL, because of the topography that includes forests and rolling terrain, and since the BBNPP site is about a 1 mi (1.6 km) from U.S. Highway 11 to the east and south. However, to limit and mitigate aesthetic impacts, the following design and layout concepts will be included:

- Locating the new intake structure, pump house, and discharge piping near the existing facilities on the river shoreline.
- Minimizing tree or natural vegetation removal by placing concrete and grassy areas in already cleared areas of the site.

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- Minimizing the amount of new road construction.
- Creating an exterior for new structures that is compatible with the color and texture of the surrounding area.
- Where feasible, replanting and reseeding of cleared areas with native trees and vegetation.

The existing 500 kV transmission system and the PJM Interconnection, LLC, planned upgrades being installed independent of BBNPP construction will serve the offsite needs of BBNPP, requiring no new construction of offsite transmission towers. New transmission towers and transmission lines will be constructed onsite to connect BBNPP to the existing SSES 500 kV switchyard and a new 500 kV switchyard to the north of the site. These new lines will be built on land currently owned by SSES and will be consistent with existing onsite facilities.

In summary, aesthetic impacts are expected to be SMALL and temporary, because the BBNPP site is set back from, and only limited portions of the construction will be visible from, publicly accessible areas. Most construction activities will be shielded from public view and construction activities are by nature temporary.

4.4.1.7 Reference

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CFR, 2007a. Title 40, Code of Federal Regulations, Part 50, National Primary and Secondary Ambient Air Quality Standards, 2007.

CFR, 2007b. Title 40, Code of Federal Regulations, Part 61, Standards for Performance for New Stationary Sources, 2007.

Harris, 1979. Handbook of Noise Control, 2nd edition, McGraw Hill, 1979.

KLD, 2008. Traffic Impact Study Related to the Proposed Expansion at Susquehanna Steam Electric Station, KLD Associates, Inc, July 2008.

PADOLI, 1953. General Safety Law, Act Number 174 (May 18, 1937), P.L. 654, Pennsylvania Department of Labor and Industry, as amended June 28, 1951 and July 13, 1953.

4.4.2 *SOCIAL AND ECONOMIC IMPACTS*

This analysis presents information about the potential impacts to key social and economic characteristics that could arise from the construction of the power plant at the BBNPP site. The analysis was conducted for the 50 mi (80 km) comparative geographic area and for the region of influence (ROI), Luzerne County and Columbia County, Pennsylvania, where appropriate and as described in Section 2.5.2. The discussion focuses on potential impacts to population settlement patterns, housing, employment and income, tax revenue generation, and public services and facilities.

4.4.2.1 Study Methods

Changes in regional employment can result in impacts to the region's social and economic systems. An estimate of direct full-time equivalent (FTE) personnel that would be needed to construct the new unit was determined and is provided in Table 4.4-3. "Direct" jobs are those new construction employment positions that would be located on the BBNPP site. "Indirect jobs" are positions created off of the BBNPP site as a result of the purchases of construction

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Educational System

As described above, an estimated 469 to 821 new households would in-migrate into Luzerne County for construction of BBNPP. It is estimated that these new households would have a maximum of 259 to 453 children, assuming in-migration of the entire indirect workforce, with most of them likely to be school aged (assuming 0.48 children per household). This would represent an increase of 1.1% to 2.0% in the 42,000 students enrolled in the county during 2005-2006. The increased annual real estate taxes (Section 4.4.2.6.2) that would be paid to Luzerne County and the Berwick Area School district during construction of BBNPP would provide additional funds to meet the educational needs of children for the in-migrating construction workforce. If enrollment levels were to increase as a result of constructing the power plant, the district might seek assistance in recruiting additional teachers and could install modular classrooms. A representative of the Berwick Area School District confirmed that capital investments related to infrastructure might not be needed. Because the percentage increase is not great and additional tax revenues would provide funding to meet new project-related impacts to the school system and the Berwick Area School District, it is estimated that the impacts would be SMALL, and would not require additional mitigation.

The in-migration of an estimated 497 to 869 new households into the Columbia County from construction of the BBNPP could place greater demands on the Columbia County public school system. It is estimated that these new households would have a maximum of 274 to 480 children, assuming in-migration of the entire indirect workforce, with most of them likely to be school aged (assuming 0.48 children per household). This would represent an increase of 4.6% to 8.0% in the 10,800 students enrolled in the county during 2005-2006. Although the school district would receive some additional funding from real estate taxes generated by these new households (likely to be minimal because adequate housing units are already available in the county and those units are already being taxed), it would not receive additional funding directly from the power plant because BBNPP does not pay property taxes to Columbia County. Because there would be some additional demands placed on the Columbia County Public School System, the impacts of the power plant would be MODERATE and some additional mitigation might be required.

4.4.2.9 Public Facilities

As discussed above, there is a sufficient quantity of vacant housing units in Luzerne County and Columbia County to meet the housing needs of the in-migrating direct construction workforce for BBNPP, so no new housing units would likely be required. The excess capacity in the water and sewage services and the lack of new construction resulting from the power plant would result in no effects to those services. Although an increase in the population would likely place additional demands on area recreational facilities, the facilities appear to have enough capacity to accommodate the increased demand and impacts would likely be SMALL. Area highways, roads, and schools would have increased use levels resulting in MODERATE impacts. These impacts are described in Section 4.4.1.

4.4.2.10 References

BEA, 2008. Regional Input-Output Modeling System (RIMS II) Economic Multipliers (1997/2005), U.S. Bureau of Economic Analysis, Regional Economic Analysis Division, Website: www.bea.gov/regional/gsp/action.cfm, Date accessed: July 2008.

Blinder, 1979. The Effect of High Voltage Overhead Transmission Lines on Residential Property Values, presented to the Second Symposium on Environmental Concerns in Rights-of-Way, Ann Arbor, Michigan, C. Blinder, October 1979.

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5.8 SOCIOECONOMIC IMPACTS

5.8.1 PHYSICAL IMPACTS OF STATION OPERATION

This section addresses the direct physical impacts of plant operation on the surrounding community. The impacts evaluated include the effects from noise, odors, exhausts, thermal emissions, and visual intrusion. The discussion evaluates how these impacts should be treated and whether mitigation is needed. As a result of regulatory permits and controls and the remoteness of the site, direct physical impacts from plant operation on the surrounding community are expected to be SMALL.

5.8.1.1 Plant Layout

Potential physical impacts will be controlled through compliance with applicable regulations and woodland screening. The plant layout is provided in Figure 2.2-1. As described in Section 2.1, the area of the proposed facility is largely deciduous woodlands, interspersed with grasslands and orchards. It is a rural area, relatively remote from population and community centers. Its location is approximately 5 mi (8 km) from Berwick, the nearest population center.

The plant layout is provided in Figure 3.1-1 and its structures are described in Section 3.1. The BBNPP site boundary would encompass approximately 424 ac (172 ha) within the Owner Controlled Area of 882 ac (357 ha) adjacent to the existing Susquehanna Steam Electric Station (SSES) Units 1 and 2.

5.8.1.2 Distribution of Community Population, Buildings, Roads and Recreational Facilities

The total residential population within 1 mi (1.6 km) is an estimated 280 persons based on the 2000 U.S. Census (Table 2.5-6). The number of residents within the 3 mi (4.8 km) Low Population Zone (LPZ) was estimated to be 2,733 persons (Section 2.5.1). No residential properties are located within the BBNPP site boundary. Furthermore, there are no nursing homes, hospitals, prisons, or schools within the LPZ.

Table 2.5-6 presents population distributions, by residential population and transient population in 2000, within each of the sixteen geographic directional sectors at radii of 0 to 1 mi (0 to 2 km), 1 to 2 mi (2 to 3 km), 2 to 3 mi (3 to 5 km), 3 to 4 mi (5 to 6 km), 4 to 5 mi (6 to 8 km) and 5 to 10 mi (8 to 16 km) from the BBNPP site.

Besides the residential or farm buildings to the west and south, Berwick is located southwest of the BBNPP site and has commercial buildings in the town center. Figure 2.2-7 shows roads/highways that are in the vicinity of the BBNPP site.

The major recreational facility in the immediate area near the BBNPP site is the 401 ac (162 ha) Riverlands Recreational Area, which is part of the land owned by SSES. This recreational area is located east of the BBNPP and SSES sites along the Susquehanna River, as denoted in Figure 2.1-3. Three additional Commonwealth owned game lands are located within the 6 mi (10 km) radius of the BBNPP site. The two largest game lands total approximately 5,557 ac (2,249 ha). Two smaller privately owned land trust conservancy lands are also located within the 6 mi (10 km) radius.

5.8.1.3 Noise

The principal noise sources associated with operation of the new plant are the switchyard, transformers, and CWS and ESWS cooling towers. As noted in Section 2.7.7, a recent baseline ambient noise survey documents that there was no observed, offsite, audible noise from the

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highways and roads would have increased traffic levels, particularly during shift changes at the BBNPP, resulting in a SMALL traffic impact.

5.8.2.6.1 Transportation

As indicated for the construction phase of BBNPP, any replacement heavy equipment and reactor components could be taken by railroad during plant operation and maintenance activities, thereby reducing potential regional highway/road impacts. These materials would then be transported from the railroad, on the BBNPP access road, to the site (Section 4.1.1).

As shown in Table 5.8-3, under the future without construction of BBNPP scenario, levels of service (LOS) would be "A" (i.e., the best level of service on a scale of A to F) for the intersection of Route 11 and Main Street and for the intersection of Route 11 and LaSalle Street. All other intersections analyzed would have LOS levels of "B." Under the future build scenario with the BBNPP projected 363 operational workers, these service levels could be maintained by implementing mitigation that would only entail optimizing the signal timing plan at the Route 11 and Orange Street intersection (KLD, 2008). If this improvement was made prior to operation of the power plant, it would accommodate the commuting patterns of the BBNPP operational workforce. Thus, it is concluded that the impacts to transportation would be SMALL, and no additional mitigation would be required.

5.8.2.6.2 Area-Wide and Recreational Aesthetics

The BBNPP site is currently partly forested and partly cleared land. The BBNPP would be located primarily in the cleared area where many of the facilities, and particularly the tallest structures (e.g., the Reactor Building, vent stack, and the CWS cooling towers) would be visible from three adjacent residential properties about 1,400 feet (426 m) or more to the west and south at ground level. The tallest structures associated with construction of BBNPP include the Reactor Building that would rise about 204 ft (62 m) above grade, the vent stack that would rise 211 ft (64 m), and the two natural draft CWS cooling towers that would rise 475 ft (145 m) above grade.

BBNPP would be built west of SSES Units 1 and 2, at least 1,400 ft (426 m) from the nearest residential properties and 1.5 mi (2.5 km) west of the Susquehanna River shoreline. The tallest structures would include the Reactor Building that would rise about 204 ft (62 m) above grade, the vent stack that would rise 211 ft (64 m), and the two natural draft CWS cooling towers that would rise 475 ft (145 m) above grade. Thus, these structures would be visible from some locations, but the exterior finishes of the new plant buildings would be compatible in color and texture to those of the existing plant buildings. This would provide a consistent, overall appearance, architecturally integrating the two plants. Thus, the visual impacts of these structures to area residents and transportation facilities (e.g., U.S. Highway 11 providing access to the site and the elevated State Route 93 North located south/southwest of the site and across the Susquehanna River) would be SMALL, to the extent that those offsite facilities are used.

SSES Units 1 and 2 have cooling towers, so visible water vapor plumes are currently created. The plume generated by the BBNPP cooling towers would be visible to area residents, recreational users in the surrounding area, travelers along U.S. Highway 11, and to travelers along State Route 93 North, an elevated roadway located south/southwest of the BBNPP site across the Susquehanna River. It is estimated that the average plume length would range from 0.274 mi (0.440 km) in the summer to 0.615 mi (0.990 km) in the winter, and its average height would range from 776 ft (236 m) in the summer to 961 ft (293 m) in the winter. Thus, the plumes

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would not introduce a new element to the visual landscape, so the additional visual impacts from BBNPP would be SMALL.

Because only existing off-site transmission corridors, or proposed transmission corridors that are unrelated to the project's construction, would be used to accommodate the increased generation from BBNPP, no new off-site transmission lines would be built to service the plant and only new, short on-site interconnections or line relocations would be required.

Because no new housing units or developments would likely be built to meet BBNPP operational workforce needs, there would be no visual impacts to existing residents or users in the ROI from these facilities.

Because of the minimal visual impacts of the BBNPP structures, access roads, water intake, outfall, transmission lines, and the water vapor plumes, it is concluded that the impacts to area-wide and recreational aesthetics would be SMALL, and would not require mitigation.

5.8.2.7 Public Services

An increase in population levels from the BBNPP operational workforces would not likely place additional demands on area doctors and hospitals, police services, fire suppression and EMS services, and schools because the area has experienced a 1.4% population decline from 2000 to 2006. As shown in Section 2.5.1, population levels in the ROI without the BBNPP project are estimated to decline by 11,928 people from 2000 to 2010, and another 6,727 people from 2010 to 2020, thus somewhat reducing the need for public services. This loss of population would be offset somewhat by the potential total direct and indirect in-migration of 1,366 people into the ROI for operation of BBNPP. Also, because the addition of BBNPP-related population is so much less than the general projected out-migration of population, there should still be an overall reduced need for public services. Thus, these services should have enough capacity to accommodate the increased demand and impacts would likely be SMALL.

5.8.2.7.1 Police, EMS, and Fire Suppression Services

As described in Section 2.5.2 and Section 4.4.2, Luzerne County and Columbia County have large volunteer fire departments that are meeting the needs of their respective residents. Because additional needs would be met during the construction phase of the power plant, no additional police, EMS or fire suppression services would likely be required for the operational phase, the impact would be SMALL, and no mitigation would be required.

A Salem Township Volunteer Fire Company representative suggested that an increased number of calls would be anticipated, but additional equipment and personnel are needed regardless of the operation of the new facility. In addition, a Berwick Fire Department representative suggested the need for specialized equipment for the rescue operations, such as confined space entry or high rope rescue materials. However, these fire and emergency response departments would be supplemented by a BBNPP onsite emergency response team, which would include a fire brigade. The BBNPP staff would also include an onsite emergency response team and emergency medical technician (EMT) responders. An emergency management plan would be developed for BBNPP, similar to that which already existing for SSES Units 1 and 2. The plan would address PPL Bell Bend, LLC and agency responsibilities, reporting procedures, actions to be taken, and other items should an emergency occur at BBNPP.

For additional unforeseen service needs that might arise, as described in Section 5.8.2.4 above, the significant new tax revenues generated in Luzerne County by operation of BBNPP would

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