Attachment 1

Report: "River Evaluation in the Vicinity of the SSES River Water Intake and River Diffuser and the Proposed BBNPP Intake and Diffuser," Ecology III, Inc., September 12, 2008 (Revised May 6, 2009)

RIVER EVALUATION
IN THE VICINITY OF THE SSES RIVER WATER INTAKE AND RIVER DIFFUSER AND THE PROPOSED BBNPP INTAKE AND DIFFUSER

Prepared by

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Ecology III, Inc.
804 Salem Blvd.
Berwick, PA 18603

12 September 2008
Revised 14 January 2009
Revised 6 May 2009

The Susquehanna Steam Electric Station (SSES) river water intake and discharge diffuser are located on the west bank of the Susquehanna River approximately six miles upriver from Berwick, PA. The proposed Bell Bend Nuclear Power Plant (BBNPP) river water intake will be constructed 300 feet downriver from the SSES intake. The SSES diffuser is located 615 feet downriver from the SSES intake and the proposed BBNPP discharge diffuser will be 380 feet downriver from the SSES diffuser and extend farther out into the river. All four of these structures are located near the middle of a large river pool that begins at a relatively shallow section in front of the Susquehanna SES Environmental Laboratory and extends downriver at least 3,840 feet to the next shallow area (Fig. 1).

The profile of this pool was mapped as part of a more extensive contour mapping survey in 1983 (Ichthyological Associates, Inc. 1984. *Ecological Studies of the Susquehanna River in the Vicinity of the Susquehanna Steam Electric Station*). Although this work was done over 25 years ago, our resident scuba divers agree that there has been no apparent change in the bathymetry of this river pool. This is further substantiated by our aquatic monitoring activities throughout the pool during most months each year from 1983 to the present, which also indicates that the pool has remained about the same. The depth contours in this pool were measured at a river level of 486.2 feet above mean sea level (msl) (Environmental Lab river level of 3.2 feet with a river flow of 1570 cfs). The average width throughout the reach of the pool was 790 feet. If an average depth of 5 feet is assumed at this river level, the volume of the pool can be calculated by the following:

Pool volume = length (3840 ft) X width (790 ft) X depth (5 ft) =15,168,000 ft^3
or 15,168, 000 ft^3 X 7.48 gal/ ft^3 = 113,456,640 gal
or 348.2 acre ft of water

Even if the pool volume was determined at a river level at the Environmental Lab of 2.7 feet msl, which corresponds to a flow at the Environmental Lab of 806 cfs (less than the 820 cfs Q7-10 at Wilkes-Barre 20 miles upriver), the volume is still over 98,000,000 gallons calculated as follows:

Pool volume = 3840 ft X 760 ft (decrease in pool width of 30 ft) X 4.5 ft (decrease of 0.5 ft in depth) = 13,132,800 ft^3
or 13,132,800 ft^3 X 7.48 gal/ft^3 = 98,233,344 gal
or 301.5 acre ft of water

River flow into this pool has been measured at the Environmental Lab since 1973. The relationship of river depth to river flow at the Lab was documented (Soya 1991. *Depth-level-flow relationship of the Susquehanna River at the Susquehanna SES Environmental Laboratory.* Ecology III, Inc., Berwick, PA) with a history of refinements of various regression models to more accurately determine flow from depth. This work resulted in the river depth, level, and flow chart in Attachment 1.

With a river pool volume of 98,000,000 gallons and a river flow into the pool of over 800 cfs or 360,000 gal/min during extreme drought conditions, there will be a negligible effect on the pool level along the 995-foot stretch of this complex. Maximum intake withdrawals at SSES (45,000 gpm) and the proposed BBNPP (27,800 gpm) will result in discharges at SSES (12,500 gpm) and BBNPP (8,700 gpm). This net withdrawal of 52,000 gpm will cause a decrease in river level of approximately 0.08 feet. Little or no loss of aquatic habitat should occur in this area of the pool except during construction of the proposed structures. Overall, the proposed location of the BBNPP intake upstream from the SSES discharge should not be problematic to the aquatic environment within this 67-acre river pool, even during low flow conditions.

The four photographs of the upriver and downriver shallows and the two views of the river pool were done at an Environmental Lab river level of 3.5 feet (486.5 ft above msl) for river flow at the Lab of 2,140 cfs or 960,000 gpm on 8 September 2008. The upriver shallows and the downriver view of the pool were taken from the Lab boat ramp. The downriver shallows and the upriver view of the pool were taken at the PPL Wetlands Cottage, not shown in Fig. 1. Both the upriver and particularly the downriver shallows are much more visible at the lower river levels used in the above calculations of pool volume.

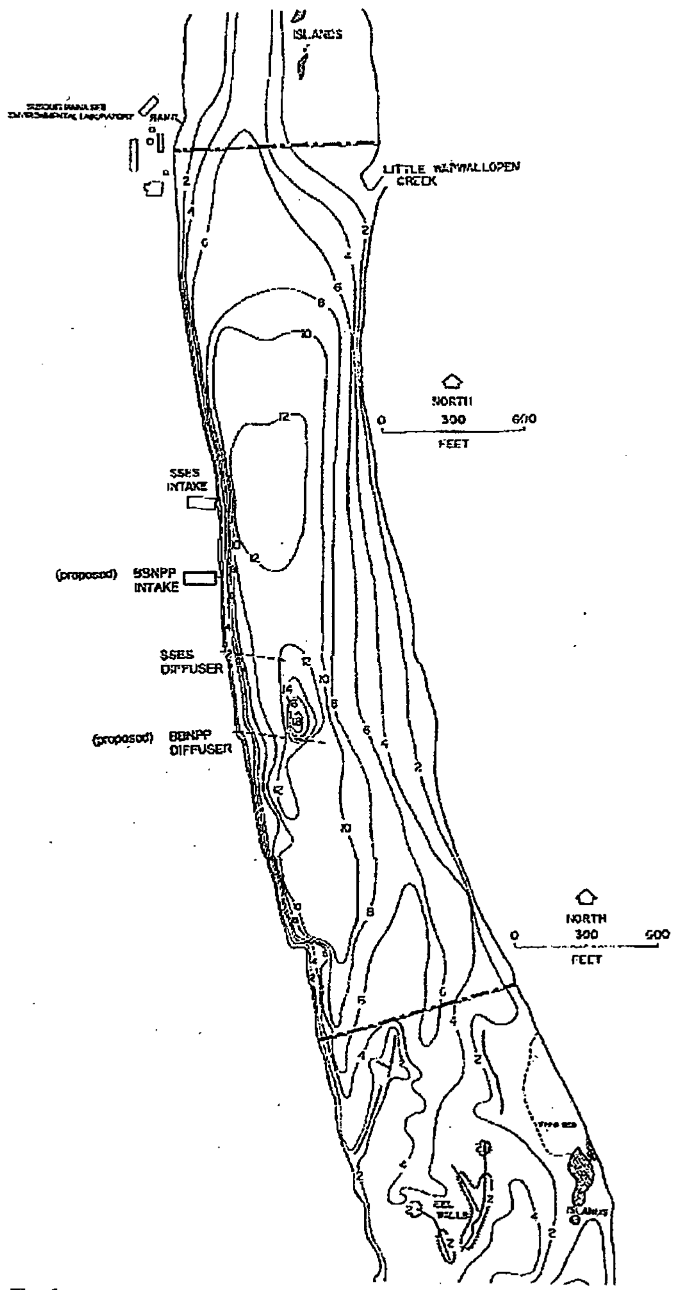


Fig. 1

Location of the Susquehanna Steam Electric Station (SSES) and the proposed Bell Bend Nuclear Power Plant (BBNPP) river water intakes and discharge diffusers along the west bank of a pool in the Susquehanna River, six miles upriver from Berwick, PA, 2008. Depth contours at 2-foot intervals based on a river level at 486.2 foot above mean sea level surveyed in 1983.

ATTACHMENT 1

SEP 1991

DEPTH – LEVEL – FLOW relationship of the Susquehanna River at the Susquehanna SES Environmental Laboratory.

DEPTH (ft)	LEVEL (ft above msl)	FLOW (cfs)	FLOW RANGE (cfs)	DEPTH (ft)	LEVEL (ft above msl)	FLOW (cfs)	FLOW RANGE (cfs)	DEPTH (ft)	LEVEL (ft above msl)	FLOW (cfs)	FLOW RANGE (cfs)
2.1	485.1	403	379–428	6.1	489.1	9540	9358–9726	10.1	493.1	29370	29100–29700
2.2	485.2	455	428–483	6.2	489.2	9910	9726–10100	10.2	493.2	30000	29700–30300
2.3	485.3	513	483–544	6.3	489.3	10290	10100–10500	10.3	493.3	30630	30300–31000
2.4	485.4	576	544–610	6.4	489.4	10670	10500–10900	10.4	493.4	31270	31000–31600
2.5	485.5	646	610–683	6.5	489.5	11060	10900–11300	10.5	493.5	31920	31600–32200
2.6	485.6	723	683–763	6.6	489.6	11460	11300–11700	10.6	493.6	32570	32200–32900
2.7	485.7	806	763–851	6.7	489.7	11860	11700–12100	10.7	493.7	33230	32900–33600
2.8	485.8	897	851–946	6.8	489.8	12270	12100–12500	10.8	493.8	33900	33600–34200
2.9	485.9	1000	946–1050	6.9	489.9	12690	12500–12900	10.9	493.9	34570	34200–34900
3.0	486.0	1210	1050–1300	7.0	490.0	13110	12900–13300	11.0	494.0	35250	34900–35600
3.1	486.1	1390	1300–1480	7.1	490.1	13540	13300–13800	11.1	494.1	35930	35600–36300
3.2	486.2	1570	1480–1660	7.2	490.2	13970	13800–14200	11.2	494.2	36620	36300–37000
3.3	486.3	1750	1660–1850	7.3	490.3	14420	14200–14600	11.3	494.3	37320	37000–37700
3.4	486.4	1940	1850–2040	7.4	490.4	14860	14600–15100	11.4	494.4	38020	37700–38400
3.5	486.5	2140	2040–2240	7.5	490.5	15320	15100–15500	11.5	494.5	38730	38400–39100
3.6	486.6	2350	2240–2450	7.6	490.6	15780	15500–16000	11.6	494.6	39450	39100–39800
3.7	486.7	2560	2450–2660	7.7	490.7	16250	16000–16500	11.7	494.7	40170	39800–40500
3.8	486.8	2770	2660–2880	7.8	490.8	16720	16500–17000	11.8	494.8	40900	40500–41300
3.9	486.9	3000	2880–3110	7.9	490.9	17200	17000–17400	11.9	494.9	41640	41300–42000
4.0	487.0	3230	3110–3350	8.0	491.0	17690	17400–17900	12.0	495.0	42380	42000–42800
4.1	487.1	3460	3350–3580	8.1	491.1	18150	17900–18400	12.1	495.1	43130	42800–43500
4.2	487.2	3710	3580–3830	8.2	491.2	18680	18400–18900	12.2	495.2	43890	43500–44300
4.3	487.3	3960	3830–4080	8.3	491.3	19180	18900–19400	12.3	495.3	44650	44300–45000
4.4	487.4	4210	4080–4340	8.4	491.4	19690	19400–20000	12.4	495.4	45410	45000–45800
4.5	487.5	4480	4340–4610	8.5	491.5	20210	20000–20500	12.5	495.5	46190	45800–46600
4.6	487.6	4740	4610–4880	8.6	491.6	20740	20500–21000	12.6	495.6	46970	46600–47400
4.7	487.7	5020	4880–5160	8.7	491.7	21270	21000–21500	12.7	495.7	47760	47400–48200
4.8	487.8	5300	5160–5440	8.8	491.8	21810	21500–22100	12.8	495.8	48550	48200–48900
4.9	487.9	5590	5440–5740	8.9	491.9	22350	22100–22600	12.9	495.9	49350	48900–49800
5.0	488.0	5880	5740–6030	9.0	492.0	22900	22600–23200	13.0	496.0	50160	49800–50600
5.1	488.1	6180	6030–6340	9.1	492.1	23460	23200–23700	13.1	496.1	50970	50600–51400
5.2	488.2	6490	6340–6650	9.2	492.2	24020	23700–24300	13.2	496.2	51790	51400–52200
5.3	488.3	6800	6650–6960	9.3	492.3	24590	24300–24900	13.3	496.3	52610	52200–53000
5.4	488.4	7120	6960–7290	9.4	492.4	25160	24900–25500	13.4	496.4	53440	53000–53900
5.5	488.5	7450	7290–7620	9.5	492.5	25750	25500–26000	13.5	496.5	54280	53900–54700
5.6	488.6	7780	7620–7950	9.6	492.6	26340	26000–26600	13.6	496.6	55130	54700–55600
5.7	488.7	8120	7950–8290	9.7	492.7	26930	26600–27200	13.7	496.7	55980	55600–56400
5.8	488.8	8470	8290–8640	9.8	492.8	27530	27200–27800	13.8	496.8	56840	56400–57300
5.9	488.9	8820	8640–9000	9.9	492.9	28140	27800–28400	13.9	496.9	57700	57300–58100
6.0	489.0	9180	9000–9360	10.0	493.0	28750	28400–29100	14.0	497.0	58570	58100–59000

(continued).

ATTACHMENT 1 (continued)

DEPTH (ft)	LEVEL (ft above msl)	FLOW (cfs)	FLOW RANGE (cfs)	DEPTH (ft)	LEVEL (ft above msl)	FLOW (cfs)	FLOW RANGE (cfs)	DEPTH (ft)	LEVEL (ft above msl)	FLOW (cfs)	FLOW RANGE (cfs)
14.1	497.1	59450	59000-59900	18.1	501.1	99760	99200-100000	22.1	505.1	150300	150000-151000
14.2	497.2	60330	59900-60800	18.2	501.2	100900	100000-101000	22.2	505.2	151700	151000-152000
14.3	497.3	61220	60800-61700	18.3	501.3	102000	101000-103000	22.3	505.3	153100	152000-154000
14.4	497.4	62110	61700-62600	18.4	501.4	103200	103000-104000	22.4	505.4	154500	154000-155000
14.5	497.5	63020	62600-63500	18.5	501.5	104400	104000-105000	22.5	505.5	155900	155000-157000
14.6	497.6	63920	63500-64400	18.6	501.6	105500	105000-106000	22.6	505.6	157300	157000-158000
14.7	497.7	64840	64400-65300	18.7	501.7	106700	106000-107000	22.7	505.7	158800	158000-159000
14.8	497.8	65760	65300-66200	18.8	501.8	107900	107000-108000	22.8	505.8	160200	159000-161000
14.9	497.9	66690	66200-67200	18.9	501.9	109000	108000-110000	22.9	505.9	161600	161000-162000
15.0	498.0	67620	67200-68100	19.0	502.0	110200	110000-111000	23.0	506.0	163100	162000-164000
15.1	498.1	68560	68100-69000	19.1	502.1	111400	111000-112000	23.1	506.1	164500	164000-165000
15.2	498.2	69510	69000-70000	19.2	502.2	112600	112000-113000	23.2	506.2	166000	165000-167000
15.3	498.3	70460	70000-70900	19.3	502.3	113800	113000-114000	23.3	506.3	167500	167000-168000
15.4	498.4	71420	70900-71900	19.4	502.4	115100	114000-116000	23.4	506.4	168900	168000-170000
15.5	498.5	72390	71900-72900	19.5	502.5	116300	116000-117000	23.5	506.5	170400	170000-171000
15.6	498.6	73360	72900-73900	19.6	502.6	117500	117000-118000	23.6	506.6	171900	171000-173000
15.7	498.7	74340	73900-74800	19.7	502.7	118700	118000-119000	23.7	506.7	173400	173000-174000
15.8	498.8	75330	74800-75800	19.8	502.8	120000	119000-121000	23.8	506.8	174900	174000-176000
15.9	498.9	76320	75800-76800	19.9	502.9	121200	121000-122000	23.9	506.9	176400	176000-177000
16.0	499.0	77320	76800-77800	20.0	503.0	122500	122000-123000	24.0	507.0	177900	177000-179000
16.1	499.1	78320	77800-78800	20.1	503.1	123800	123000-124000	24.1	507.1	179400	179000-180000
16.2	499.2	79330	78800-79800	20.2	503.2	125000	124000-126000	24.2	507.2	180900	180000-182000
16.3	499.3	80350	79800-80900	20.3	503.3	126300	126000-127000	24.3	507.3	182500	182000-183000
16.4	499.4	81370	80900-81900	20.4	503.4	127600	127000-128000	24.4	507.4	184000	183000-185000
16.5	499.5	82400	81900-82900	20.5	503.5	128900	128000-130000	24.5	507.5	185600	185000-186000
16.6	499.6	83440	82900-84000	20.6	503.6	130200	130000-131000	24.6	507.6	187100	186000-188000
16.7	499.7	84480	84000-85000	20.7	503.7	131400	131000-132000	24.7	507.7	188700	188000-189000
16.8	499.8	85530	85000-86100	20.8	503.8	132800	132000-133000	24.8	507.8	190200	189000-191000
16.9	499.9	86590	86100-87100	20.9	503.9	134100	133000-135000	24.9	507.9	191800	191000-193000
17.0	500.0	87650	87100-88200	21.0	504.0	135400	135000-136000	25.0	508.0	193400	193000-194000
17.1	500.1	88720	88200-89300	21.1	504.1	136700	136000-137000	25.1	508.1	194900	194000-196000
17.2	500.2	89790	89300-90300	21.2	504.2	138000	137000-139000	25.2	508.2	196500	196000-197000
17.3	500.3	90880	90300-91400	21.3	504.3	139400	139000-140000	25.3	508.3	198100	197000-199000
17.4	500.4	91960	91400-92500	21.4	504.4	140700	140000-141000	25.4	508.4	199700	199000-201000
17.5	500.5	93060	92500-93600	21.5	504.5	142100	141000-143000	25.5	508.5	201300	201000-202000
17.6	500.6	94160	93600-94700	21.6	504.6	143400	143000-144000	25.6	508.6	202900	202000-204000
17.7	500.7	95260	94700-95800	21.7	504.7	144800	144000-145000	25.7	508.7	204600	204000-205000
17.8	500.8	96380	95800-96900	21.8	504.8	146200	145000-147000	25.8	508.8	206200	205000-207000
17.9	500.9	97500	96900-98100	21.9	504.9	147500	147000-148000	25.9	508.9	207800	207000-209000
18.0	501.0	98620	98100-99200	22.0	505.0	148900	148000-150000	26.0	509.0	209500	209000-210000

DEPTH = reading from gage at the Susquehanna SES Environmental Laboratory

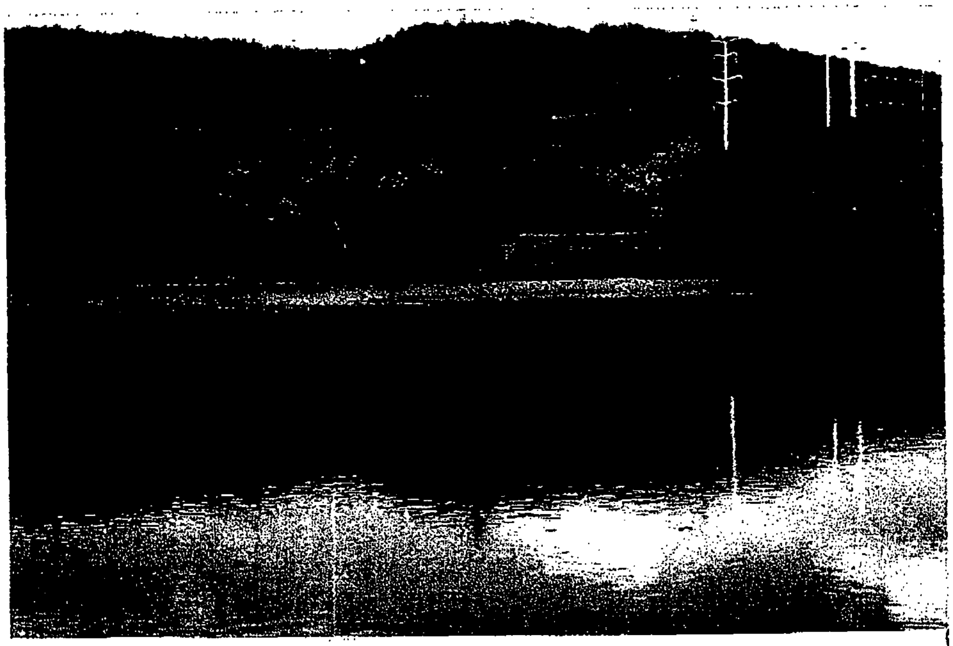
LEVEL = DEPTH + 483.0

when LEVEL ≥ 486.0, $FLOW = 319.96989(LEVEL)^2 - 309316.24395(LEVEL) + 74753300$

when LEVEL < 486.0, $\log FLOW = -0.05251(LEVEL)^2 + 51.478501(LEVEL) - 12612.85672$

FLOW RANGE denotes expected variation at the observed DEPTH.

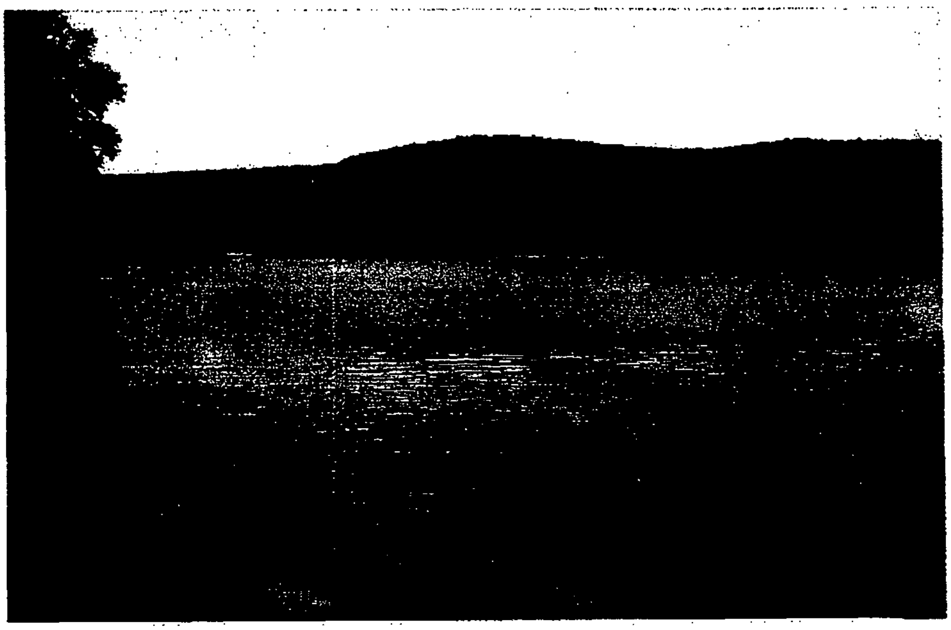
Soya, W. J. 1991. Depth-level-flow relationship of the Susquehanna River at the Susquehanna SES Environmental Laboratory. Ecology III, Inc., Berwick, PA



Upriver shallows looking east across river from Environmental Lab boat ramp, 8 September 2008.

River pool looking downriver from Environmental Lab boat ramp, 8 September 2008.

Downriver shallows looking east across river toward Council Cup Mountain, 8 September 2008.



River pool looking upriver from downriver shallows, 8 September 2008.

Attachment 2

Groundwater Withdrawal Application

Susquehanna River Basin Commission

a water management agency serving the Susquehanna River Watershed

SRBC

Ground-Water Withdrawal Application

General notes by PPL Bell Bend, LLC (Applicant):

- To avoid or minimize confusion, headings and instructions on the original application form are in bold font. Information and data inserted by PPL Bell Bend, LLC are in normal weight font.
- Completion of construction/installation of the dewatering system and initiation of withdrawal of groundwater is expected June 2012.

1. Applicant Information:

Company Name PPL Bell Bend, LLC (hereinafter "PPL BB")

Mailing Address 38 Bomboy Lane, Suite 2

Berwick, PA 18603

Contact Person Nancy Evans **Title** Sr. Environmental Professional

Telephone 610.774.4309 **Fax** 610.774.7136 **E-mail** naevans@pplweb.com

2. a. Location of proposed well(s):

State PA **County** Luzerne

Municipality Salem Township

b. You must attach a copy of a USGS 7 1/2 Minute Quadrangle map indicating location of proposed well(s), all existing project wells, and any nearby wells.

See Attachments GW-1, GW-2 and GW-3. Attachment GW-1 is a topographic map based on the Berwick and Sybertsville quadrangles showing the location of the BBNPP site. Attachment GW-2 shows the location of existing BBNPP site wells; all existing site wells are monitoring wells. Attachment GW-3 shows the locations of all off-site wells within five miles of the center of the BBNPP site.

3. Purpose and description of proposed withdrawal(s):

Groundwater will be withdrawn during construction of BBNPP to depress groundwater levels to facilitate the excavation of overburden and the construction of power block (Nuclear Island) components and the Essential Service Water System Emergency Makeup System (ESWEMS) pumphouse and retention pond. Excavation is expected to reach a depth of 64 ft. A groundwater flow barrier in the form of a vertical soil-bentonite slurry wall of minimum 3-ft thickness extending through the glacial overburden and keyed into competent bedrock will first be constructed on the perimeter of this area. The area enclosed by the slurry wall will be approximately 54 acres. Extensive quality control measures will be taken to ensure that the slurry wall is constructed without gaps or windows.

Approximately 30 dewatering wells will be installed along and inside of the slurry wall. Each dewatering well will extend into competent shale bedrock. The individual well pumps will be rated up to 150 gpm. The slurry wall will minimize both the quantity of water to be withdrawn and the effect of the withdrawal on groundwater levels outside the slurry wall. Groundwater withdrawal is not expected to affect any off-site well.

Drawdown of the groundwater level within the slurry wall enclosure is expected to take two (2) to three (3) months. The average well system withdrawal rate is expected to be 2.6 mgd during this period. Because of uncertainty in the actual hydrology and the construction schedule duration for the drawdown, the drawdown time may need to be compressed. The estimated maximum rates of combined groundwater withdrawal by the dewatering well system are 3.3 mgd as a 30-day average and 3.7 mgd on any day. Following initial drawdown, continuous withdrawal to control steady-state inflow during construction of the component foundations is expected to occur at a nominal rate of 110 gpm (0.16 mgd).

Results of model studies of the groundwater, slurry wall and dewatering well system can be made available to the Commission, if desired.

The majority of the groundwater withdrawn by the dewatering well system will be discharged off-site in accordance with an NPDES permit to be obtained from PA DEP. A relatively small amount of the water withdrawn by the well system is expected to be used during construction for dust control and embankment construction, and possibly for concrete mixing if water quality is adequate. Approval for consumptive use of this water is included in the application for consumptive water use accompanying this application. If the dewatering well system does not supply water sufficient in quality and quantity for construction purposes, additional water will be obtained off-site and, if necessary, will be permitted separately. Potable and sanitary water needed during plant construction and operation is expected to be provided by the local purveyor.

The dewatering well system could be operated for approximately three years during construction. Prior to completion of construction, it is expected that the dewatering well system will be abandoned; the majority of the dewatering wells will be pressure-grouted shut. Some of the wells may be retained to provide a means of controlling groundwater table levels during operation (not anticipated to be necessary at this time).

Other than the withdrawal by the dewatering well system during construction, no other on-site groundwater withdrawal during construction or operation of the plant is anticipated at this time.

4. Requested withdrawal from proposed well(s) (based on a 30-day average):

The dewatering well system will include approximately 30 wells, with a combined requested withdrawal of 3.3 mgd as a 30-day average, as explained in 3, above. The individual wells of the system may have pumping capacities of up to 150 gpm (0.22 mgd), to be determined, but simultaneous pumping by the dewatering system wells will be controlled so as not to exceed the requested system withdrawal. Maximum withdrawal by the system will be temporary, expected not to exceed two (2) to three (3) months in duration.

5. Total combined withdrawal from proposed well(s) (based on a 30-day average):

The requested maximum combined withdrawal from the dewatering well system is 3.3 mgd based on a 30-day average. This is a conservative requested maximum based on an anticipated maximum withdrawal rate of 2.6 mgd during the 2- to 3-month dewatering period. The maximum dewatering system withdrawal rate may be limited by the maximum discharge allowed by the NPDES permit.

6. Existing and projected total water use:

Note [A]: Groundwater withdrawal is expected to occur only during project construction. Accordingly, the table from the application form has been modified, below, and water usage data presented in the table pertain only to the project construction period. Water usage during project operation is addressed in the accompanying surface water withdrawal application.

Water Usage See Note [A] above	Construction Period Quantity/Rate See Note [A] above	Project Design Year Quantity/Rate See Note [A] above
Average Daily Groundwater Withdrawal	0.16 mgd after dewatering period (see 3 above)	Not applicable
Maximum Groundwater Withdrawal	3.7 mgd (peak day) and 3.3 mgd (30-day average) over a two- to three-month dewatering period	Not applicable
Dewatering Well System Capacity	The sum of the individual capacities of the dewatering wells, to be determined, may be as high as approximately 4,500 gpm (6.5 mgd). However, operation of the dewatering system will be controlled so that the aggregate discharge of the dewatering system will not exceed the rate requested.	Not applicable. The dewatering well system will be abandoned prior to the completion of construction.

Explanation

[1] **Project water usage should be on an annual basis, unless the application is for a seasonal operation. For seasonal uses, indicate the duration of the use (the number of months on which the average is based).** (Not applicable to the table as modified)

[2] **For new projects, the existing use should be the proposed use during the first year of operation.** (Not applicable to the table as modified)

[3] **The projected use should be for 25 years in the future (design year). If the project duration is less than 25 years, indicate the year for which projections were made.** (Not applicable to the table as modified)

[4] **The existing system capacity should not include the proposed sources unless the application is for a new project having no prior withdrawal.** (Not applicable to the table as modified)

7. **Existing sources of water:**

a. **Wells** (table deleted)

The project will be a new facility. No wells presently provide water to the site. As described above, a system of dewatering wells will be developed for construction purposes.

b. **Other sources of water (stream intakes, interconnections, reservoirs, springs, etc.):** (table deleted)

The project will be a new facility. No other sources presently provide water to the site. The majority of water during operation will be withdrawn from the Susquehanna River; an application for approval of that withdrawal accompanies this application for groundwater withdrawal. During construction and operation, potable water is expected to be obtained from the Pennsylvania American Water Company (Berwick District) municipal supply system.

8. Well record (proposed well(s)): (data outline deleted)

All new wells will be components of the dewatering system described in 3, above. Information required by the Commission will be provided upon installation, testing and operation of the dewatering system. The discharge from each well will be continuously metered and controlled. The wells will cease to operate prior to completion of project construction.

9. Existing nearby wells:

Attach map identifying all nearby wells owned by others that could be affected by pumpage of the proposed well(s) and complete items below for each well. (data outline deleted)

The locations of existing on-site monitoring wells and well clusters are shown on Attachment GW-2. The on-site wells comprise a system of 41 monitoring wells generally installed and monitored monthly beginning October 2007:

- 14 screened in glacial overburden, 9.2 to 76.0 ft deep
- 19 screened in shallow bedrock, 50 to 181 ft deep
- 8 screened in deeper bedrock, 170 to 400 ft deep

Groundwater withdrawal by the proposed dewatering wells will be from within the area confined by the slurry wall and is not expected to affect any offsite well. Nevertheless, the locations of known existing wells within five miles of the center of the BBNPP site are shown on Attachment GW-3.

10. Driller's log:

Attach separate sheet describing the nature and depth interval of subsurface materials and water-bearing zones penetrated during drilling of each proposed well.

The relevant subsurface materials in the area to be dewatered are glacial sand and gravel overlying shale bedrock. The overburden is up to 65 feet in depth.

The proposed wells will be drilled and tested by one or more licensed well drillers. Logs will be furnished as they become available.

11. Pumping test:

NOTE: Review and approval by the Susquehanna River Basin Commission of the test procedures to be used by the applicant are necessary before the test is started.

Attach copies of basic data sheets and any resultant water level charts, tables, graphs, etc., for the pumped well, monitoring wells, and nearby perennial stream sites. The pumping test shall be of not less than 48 hours pumping duration and at a constant withdrawal rate not less than the proposed rate. A step-drawdown pumping test may precede the 48-hour test, however, water levels should be allowed to essentially recover prior to the constant rate test. The following information from the test is generally required:

a. Date and time of all static, pumping, and recovery water level measurements.

b. Record of pumping rate measured frequently throughout the test.

c. **Sufficient static water level measurements in all wells to determine any trends in water level changes prior to the beginning of pumping. All water levels are to be measured to an accuracy of one-tenth of a foot.**
d. **Pumping and recovery measurements from the pumped well.**
e. **Monitoring data from a sufficient number of wells to determine all possible interference.**
f. **Records of precipitation, measurements or observations of nearby streamflows, and weather conditions throughout the test.**

The proposed dewatering wells will be drilled following construction of the confining slurry wall. Additional monitoring wells will likely be required outside of and along the slurry wall to monitor its effectiveness. The dewatering wells will be tested, with groundwater levels observed in the existing and proposed monitoring wells during the tests. PPL BB will provide the Commission with its plan to test the dewatering well system prior to such testing. At such time as the proposed wells are installed and tested, the information required in this section that is relevant to the system will be provided to the Commission. PPL BB anticipates a piezometric monitoring program that will allow a comparison of withdrawals and drawdown rates to those calculated in advance, in order to determine the existence of discontinuities in the slurry wall and the need for potential remedial measures.

12. Preparer:

Name Jan C. Phillips, P.E.

Title Consulting Engineer

Company NA

Address 2611 Walnut Street, Allentown, PA 18104

Phone 610.821.0160 **Fax** 610.821.0160

Signature Jan C Phillips

Date 5-6-09 **E-mail Address** jcphllps@enter.net

13. Applicant:

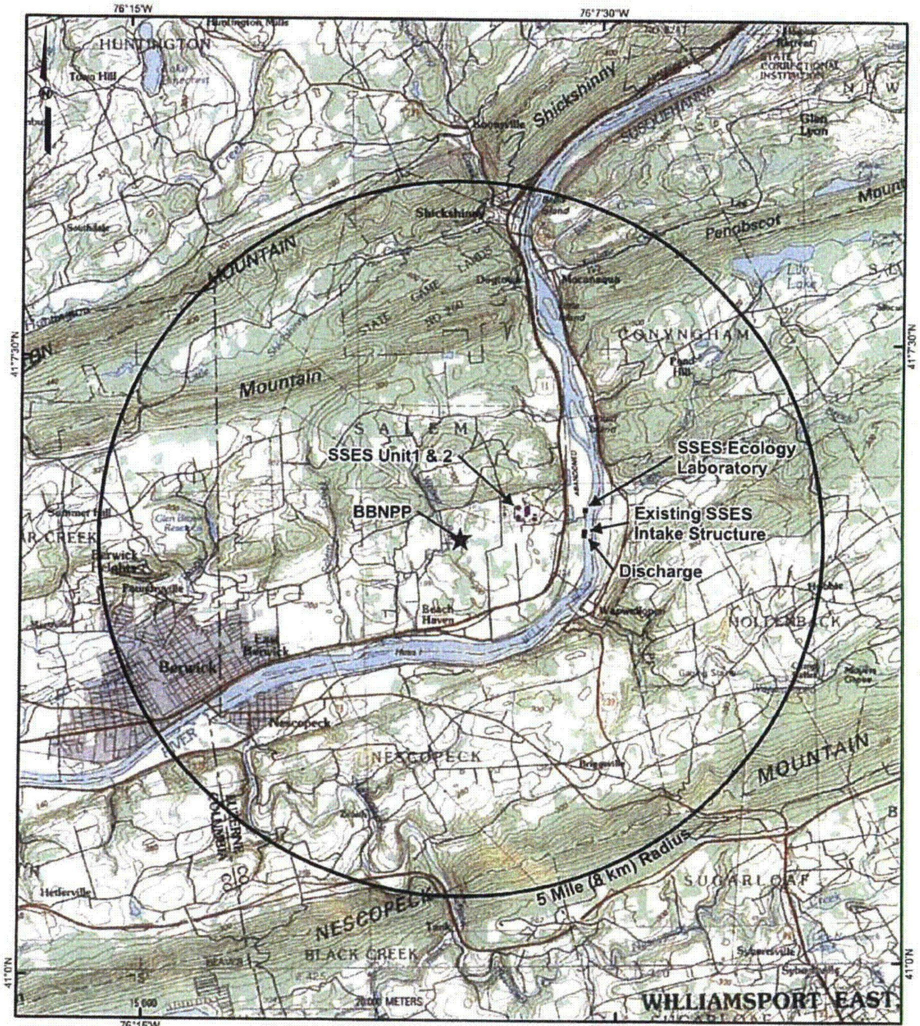
Name (print or type) Terry L. Harpster **Title** ~~Vice~~ President-Bell Bend Project - Development

Signature T Harpster **Date** ______

K:\DATA\JPAIN\WORD\FORMS\SRBC\24G (Ground-Water Instructions and Application).DOC

ATTACHMENT GW-1

Figure 2.3-2 {Site Area Topographic Map 5 Mile (8 km) Radius}



LEGEND

★ Center Point of Proposed Bell Bend NPP (BBNPP)

○ NPP Reactor 5 Mile (8 km) Radius

0 0.5 1 2 Miles

0 0.5 1 2 Kilometers

REFERENCE:
USGS 1:100K Topographic Maps:
Williamsport East and Sunbury.Maps edited 1984.

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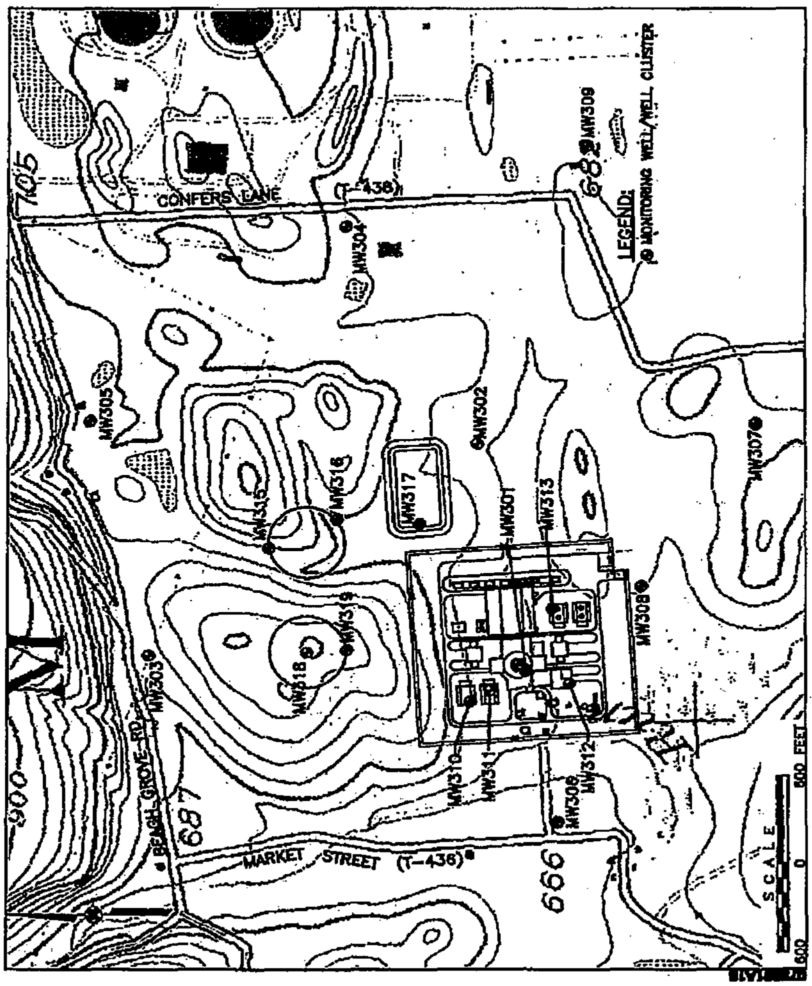
ATTACHMENT GW-2

Figure 2.3-32 {Locations of Groundwater Monitoring Wells}



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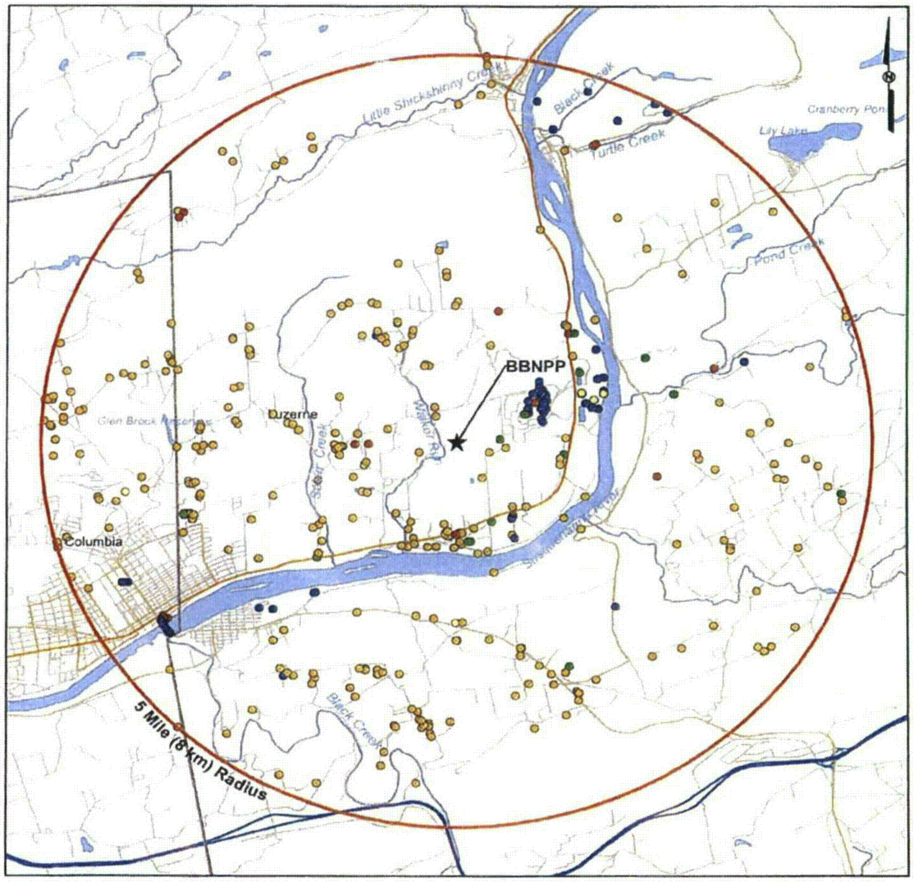
ATTACHMENT GW-3

Figure 2.3-73 {Groundwater Well Locations within a 5-Mile (8-km) Radius}



LEGEND

★ Center Point of Proposed Bell Bend NPP (BBNPP)

Groundwater Well Location (PaGWIS, 2008)
- Public Supply Use
- Commercial Use
- Industrial Use
- Other Use
- Domestic Use

NPP Reactor 5 Mile (8 km) Radius
County Boundary
Interstate
Secondary State and County Highway
Local, Neighborhood, Rural, or City Street
Streams and Rivers
Waterbody

0 0.5 1 2 Miles
0 0.5 1 2 Kilometers

REFERENCE
- ESRI StreetMap Pro [CD-ROM], 2007.rivers, waterbodies, and county boundaries.
- PA Topographic & Geologic Survey, Pa Groundwater Information System (PaGWIS). http://www.dcnr.state.pa.us/topogeo/groundwater/ Database Accesses February 2008.

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Attachment 3

Surface Water Withdrawal Application

Susquehanna River Basin Commission

a water management agency serving the Susquehanna River Watershed

Surface Water Withdrawal Application

General notes by PPL Bell Bend, LLC (Applicant):

- To avoid or minimize confusion, headings and instructions on the original application form are in bold font. Information and data inserted by PPL Bell Bend, LLC are in normal weight font.
- Withdrawal of surface water for purposes of pre-operational testing of BBNPP is expected to begin in January 2017.

1. Applicant Information:

Company Name PPL Bell Bend, LLC (hereinafter "PPL BB")

Mailing Address 38 Bomboy Lane, Suite 2

Berwick, PA 18603

Contact Person Nancy Evans **Title** Sr. Environmental Professional

Telephone 610.774.4309 **Fax** 610. 774.7136 **E-mail** naevans@pplweb.com

2. a. Location of proposed source(s):

State PA **County** Luzerne

Municipality Salem Township

b. You must attach a copy of a USGS 7 1/2 Minute Quadrangle map indicating location of proposed intake(s), all existing project sources, and any water storage facilities.

Attachment SW-1 is a topographic map based on the Berwick and Sybertsville quadrangles showing the location of the BBNPP site. Attachment SW-2 is a plan of BBNPP including the river intake and discharge diffuser and the plant water storage facilities.

3. Purpose of proposed withdrawal(s): The purpose of the proposed withdrawal is to provide water for operation of the proposed Bell Bend Nuclear Power Plant (BBNPP). Except for a small fraction of the required water (potable/sanitary water to be purchased from and delivered by Pennsylvania American Water Company, Berwick Division), all water needed for BBNPP operation will be withdrawn from the Susquehanna River. No water will be withdrawn from the River for construction.

Provide method of computation for the safe yield estimates of all sources of water supply or submit copies of flow or pumping test data. (See Application Sections 4 and 8.) For all run-of-stream sources and sources with limited storage, compute 7-day, 10-year low flow (Q7-10) using low flow statistical data and appropriate hydrologic engineering techniques. Whenever an intake is located on an ungaged stream, the applicant must use an acceptable method for computing the safe yield or Q7-10, such as selecting a reference U.S. Geological Survey gaging station and proportioning the yield based on drainage area. The selected gaging station must be on a watershed having similar geologic and climatic characteristics to those of the ungaged watershed. Other factors to consider are relative size of drainage areas and whether the reference gaging station is influenced by upstream reservoirs or other flow regulation activities. Up-to-date low flow data for specific gaged watersheds may be obtained from the U.S. Geological Survey district offices. Actual flow data collected at the project intake may be used to supplement the use of a reference gaging station. Any data provided should indicate the method used to measure the flow (current meter, weir, etc.), the dates of observation and the flow observed. In application Section 6, show calculation for determining the quantity of withdrawal requested for present and future use (over the next 25 years). Describe alternate sources of supply considered in lieu of requesting a new or increased withdrawal for the sources listed in Application Section 4.

4. Source(s) from which withdrawal is being requested:

Name of Source	Quantity of Withdrawal Requested		Safe Yield or Q7-10 Low Flow[2] at Point of Taking (mgd[1])	Drainage Area (square miles)	Location of Taking Point (latitude/longitude)
	Maximum 30-Day Average (mgd[1])	Maximum Day (mgd[1])			
Susquehanna River	NA	44 mgd[3]	530 mgd[4]	Approx. 10,240 sq mi[5]	N 41° 05′ 13.9″ W 76° 07′ 53.1″
Total	NA	44 mgd[3]	530 mgd[4]		

[1] **mgd = million gallons per day**

[2] **Use acceptable hydrologic practices in determining 7-day, 10-year low flow.**

[3] Quantities shown do not include allowance for measurement error.

[4] A Q7-10 flow of 814 cfs (526 mgd) at the USGS gage at Wilkes-Barre (No. 01536500) has been used by the Commission in determining the need for consumptive use compensation release from Cowanesque Reservoir. The Commission's "Consumptive Use Mitigation Plan" (2008) presents the Q7-10 flow at Wilkes-Barre as 820 cfs (530 mgd). The Wilkes-Barre gage is approximately 20 miles upstream from the proposed BBNPP river intake. At the Wilkes-Barre gage, the 90-percent exceedance flow is 1,670 cfs, the minimum seven-day low flow is 546 cfs (September 1964) and the minimum daily flow is 532 cfs (September 1964).

[5] The drainage area at the Wilkes-Barre gage is 9,960 square miles. The drainage area at the USGS gage at Danville, PA (No. 01540500), approximately 26 miles downstream of the proposed BBNPP river intake, is 11,200 square miles.

5. Prior or pending state or federal permits:

Numerous state and federal permits will ultimately be required for BBNPP; several are related to water use or water resources. The principal approval will be the Combined License (COL) to be issued by the USNRC for plant construction and operation; PPL BB filed its application to the USNRC for the COL on October 10, 2008. Applications for other state and federal permits have not yet been filed.

The table below lists required permits related to water use or water resources, including those listed in the form but not applicable to BBNPP.

Permit Name	Status[1]	Agency	Permit Issue Date	Permit Number
Construction and Operating License	P	U.S. Nuclear Regulatory Commission		
Encroachment or Water Obstruction Permit (Chapter 105: river work, Walker Run relocation) – joint permit with CWA section 404, below	R	PA DEP		
CWA Section 404 Permit(s) (river work, Walker Run relocation, wetlands) – joint permit with Water Obstruction Permit, above	R	U.S. Army Corps of Engineers		
NPDES (discharges to river, Walker Run)	R	PA DEP		
Flood Plain Letter of Map Revision	R	FEMA, Salem Township		
Water Allocation/Appropriation Permit	NA			
Safe Drinking Water Permit	NA			
Dams Permit	NA			

[1] **If not applicable list (NA); if pending, (P); if required but not applied for, (R)**

6. **Show by <u>calculation</u> how the "Quantity of Withdrawal Requested" was determined.**
Approval of a withdrawal of 44 mgd (peak day basis) is requested. The calculation of this quantity is presented as Attachment SW-3.

The allocation requested is considered sufficient to meet the future needs of Bell Bend. At this time, PPL BB does not foresee a need to modify plant design or operation such that an increase in the quantity of withdrawal requested would be required.

No sources other than the Susquehanna River were considered as the primary source of water for operation of Bell Bend, and no other source or combination of sources are adequate.

7. **Existing and projected total water use:**

Note [A]: Surface water withdrawal will occur only during project operation. There is no expectation that water usage will increase during the operating life of the project. Accordingly, the table from the application form has been modified, below, and water usage data presented in the table pertain to the extended project operation period. Water usage during project construction is addressed in the accompanying ground water withdrawal application. Potable and sanitary water needed during operation is expected to be provided by the local purveyor at an average rate during normal operations of approximately 0.15 mgd.

Note [B]: The river intake includes six pumps: three pumps (each rated at 13,100 gpm) will be components of the Circulating Water System Makeup Water System (CWSMWS); and three pumps (each rated at 2,900 gpm) will be components of the Raw Water Supply System (RWSS). The nominal total intake capacity is equivalent to 48,000 gpm (69.1 mgd). However, no scenario is envisioned during which river water withdrawal would exceed 29,100 gpm (41.9 mgd), which is the combined rated capacity of two CWSMWS pumps and one RWSS pump.

Water Usage See Note [A] above	Operation Period Quantity/Rate See Note [A] above
Average Daily Water Demand	38 mgd
Maximum Daily Water Demand	44 mgd
System Capacity	See Note [B] above

[1] **Project water usage should be on an annual basis, unless the application is for a seasonal operation. For seasonal uses, indicate the duration of the use (the number of months on which the average is based).** (Not applicable to the table as modified)

[2] **For new projects, the existing use should be the proposed use during the first year of operation.** (Not applicable to the table as modified)

[3] **The projected use should be for 25 years in the future (design year). If the project duration is less than 25 years, indicate the year for which projections were made.** (Not applicable to the table as modified)

[4] **The existing system capacity should not include the proposed sources unless the application is for a new project having no prior withdrawal.** (Not applicable to the table as modified)

8. Existing sources of water:

a. Wells – None/NA

Well Identification	Frequency of Use[1]	Purpose[2]	Well Depth (ft)	Cased Depth (ft)	Screened Interval (ft to ft)	Existing Pump Capacity (mgd)	Number of Days Used During Calendar Year	Metered (yes/no)	Average Daily Withdrawal (mgd)	Safe Yield[3]
								Total		

[1] Indicate if well is used on Regular (R), Auxiliary (A), or Emergency (E) basis.
[2] Indicate purpose such as potable supply, non-contact cooling, or water quality remediation.
[3] Provide method of computation or submit copies of pumping test data.

b. Other sources of water (stream intakes, interconnections, reservoirs, springs, etc.) – None/NA

Name	Description	Frequency of Use[1]	Purpose[2]	Drainage Area, If Applicable (square miles)	Existing Pump Capacity[3] (mgd)	Number of Days Used During Calendar Year	Metered (yes/no)	Average Daily Withdrawal (mgd)	Safe Yield or Q7-10 Low Flow[4] (mgd)
							Total		

[1] Indicate if source is used on Regular (R), Auxiliary (A), or Emergency (E) basis.
[2] Indicate purpose such as potable supply, process water, non-contact cooling, or irrigation.
[3] If gravity-fed, give maximum hydraulic capacity and label as such.
[4] Provide method of computation for 7-day, 10-year low flow for run-of-stream sources.

9. **Raw water ponds, lakes, intake dams, and storage dams (existing and/or proposed)** – None/NA

Name	Year Constructed	Year of Last Sedimentation Survey	Storage Capacity (mg)	Surface Area (acres)	Drainage Area (sq mi)	Release Works[1]	
						(yes)	(no)

[1] **Does the dam have facilities to provide a release of water to the stream when water is not flowing over the spillway or top of dam? If yes, describe length, diameter, depth, valving, etc.**

10. **Preparer:**

Name Jan C. Phillips, P.E.

Title Consulting Engineer

Company NA

Address 2611 Walnut Street, Allentown, PA 18104

Phone 610.821.0160 **Fax** 610.821.0160

Signature Jan C. Phillips

Date 5-6-09 **E-mail Address** jcphllps@enter.net

11. **Applicant:**

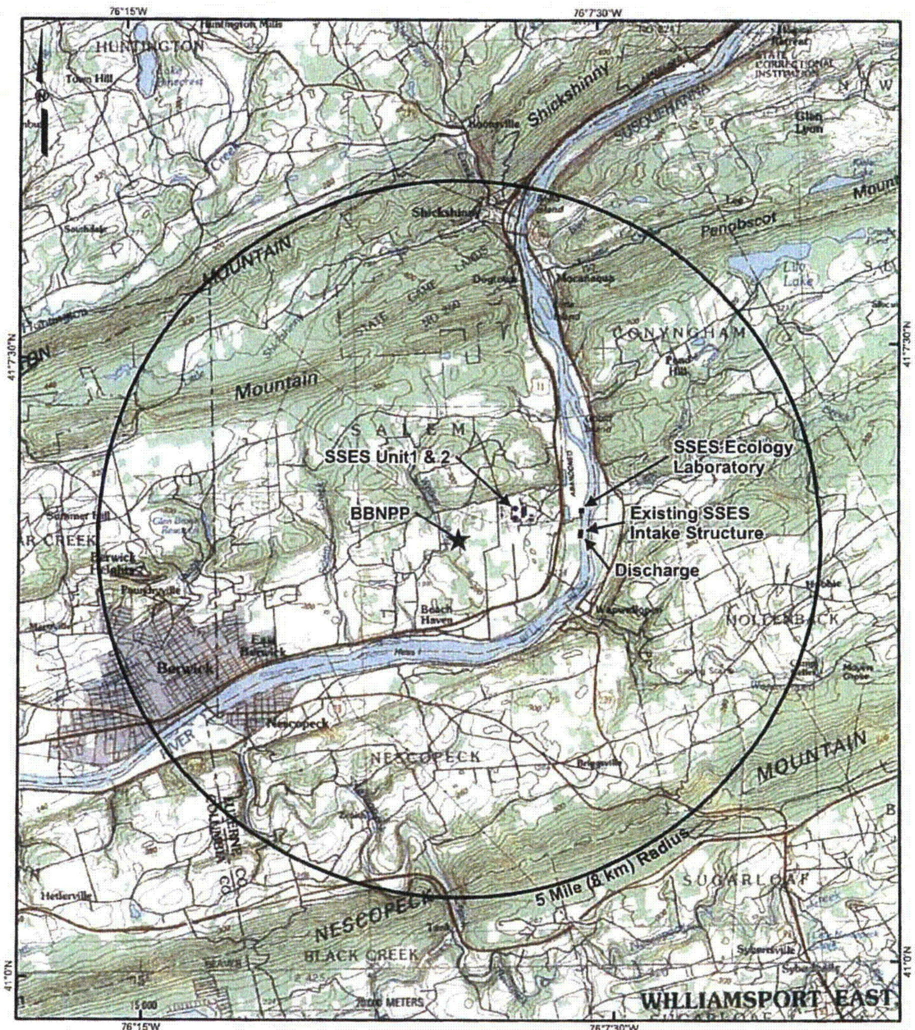
Name (print or type) Terry L. Harpster **Title** Vice President-Bell Bend Project - Development

Signature T. Harpster **Date** ______

K:\DATA\JPAIN\WORD\FORMS\SRBC\24S (Surface-Water Instructions and Application).DOC

ATTACHMENT SW-1

Figure 2.3-2 {Site Area Topographic Map 5 Mile (8 km) Radius}



LEGEND

★ Center Point of Proposed Bell Bend NPP (BBNPP)

○ NPP Reactor 5 Mile (8 km) Radius

0 0.5 1 2 Miles

0 0.5 1 2 Kilometers

REFERENCE:
USGS 1:100K Topographic Maps:
Williamsport East and Sunbury Maps edited 1984.

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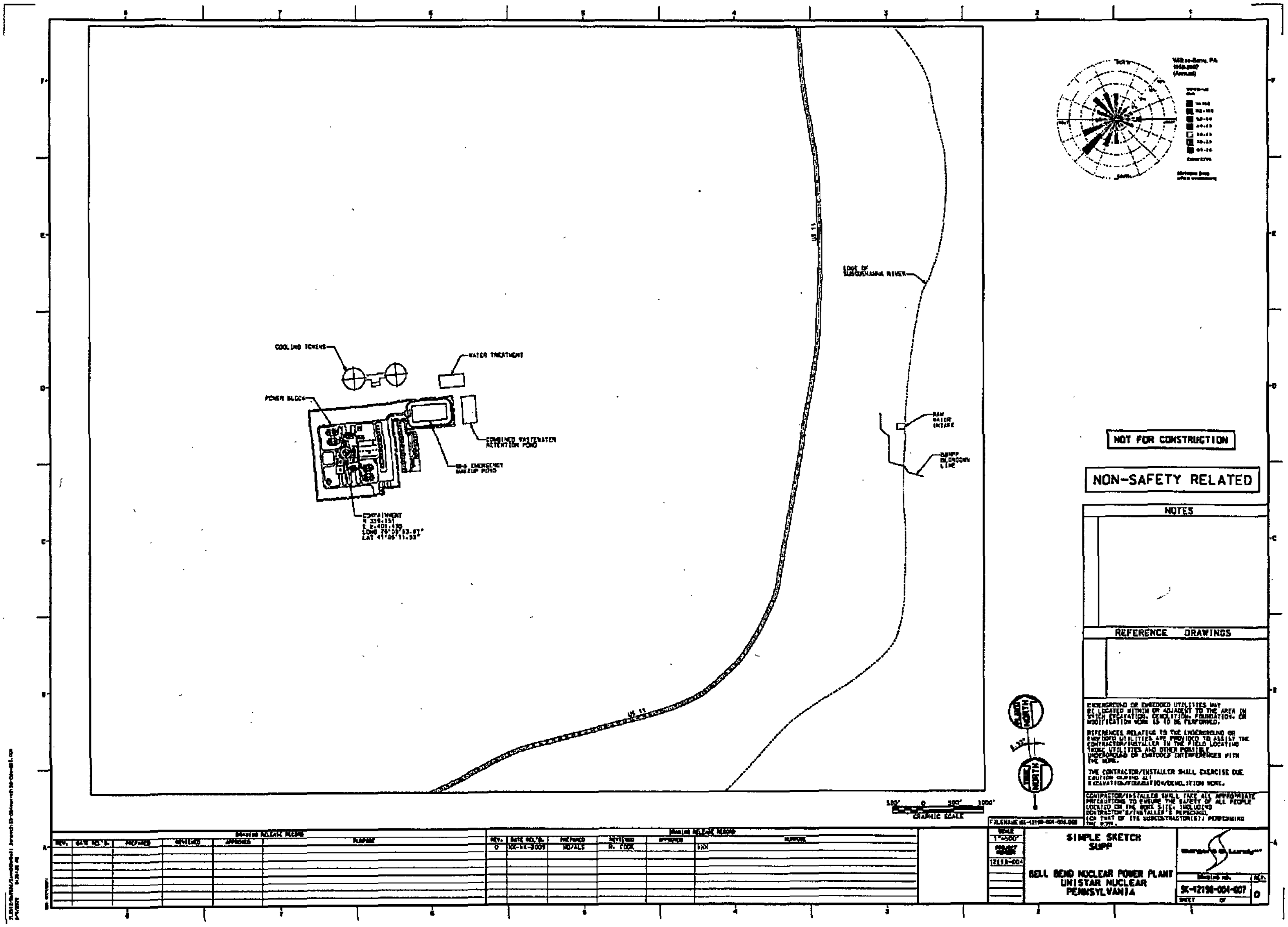
ATTACHMENT SW-2



ATTACHMENT SW-3

CALCULATION OF QUANTITY OF WITHDRAWAL REQUESTED

PPL Bell Bend, LLC is requesting the SRBC to approve withdrawal of up to 44 mgd (peak day) from the Susquehanna River, Salem Township, Luzerne County, PA. This attachment to the application describes how the requested withdrawal quantity was calculated.

Attachment SW-3-A to Attachment SW-3 is the BBNPP "Anticipated Water Use Diagram" showing the main plant water uses and flows coincident with the anticipated peak day withdrawal from the Susquehanna River and peak day consumptive water use. Reference to Attachment SW-3-A is suggested in reviewing this description of the calculation of the withdrawal quantity.

As explained below, the quantity of withdrawal requested includes an allowance to account for variability within the range of monitoring accuracy required by the Commission. However, the anticipated peak day withdrawal and peak day consumptive water use shown on Attachment SW-3-A are the amounts calculated, without such allowance.

Attachment SW-3-A shows two systems that withdraw water from the Susquehanna River for BBNPP use. One is the Circulating Water System Makeup Water System (CWSMWS). The CWSMWS will convey river water into a closed cooling system, which will utilize two natural draft counter-flow cooling towers to remove heat from the water after passing through the plant's steam condenser. Evaporation is lost in the CWS cooling towers and this increases the level of solids in the circulating water. To control solids, a portion of the re-circulated water will be removed through the CWS blowdown and replaced with water through the CWSMWS. In addition, there is a small loss for drift of the cooling tower spray. The CWSMWS provides makeup to account for the cooling tower evaporation, blowdown and drift.

The other system withdrawing water is the Raw Water Supply System (RWSS). The RWSS will supply water to the Demineralized Water System, Fire Water Distribution System, Essential Service Water System (ESWS) and the ESW Emergency Makeup System Retention Pond. The ESWS will feature four, closed cooling systems. Each of the four systems will utilize two mechanical draft cooling towers to dissipate heat from the ESWS. Just as in the case of the main cooling towers, the RWSS provides makeup to ESWS to account for the cooling tower evaporation, blowdown and drift. The RWSS also supplies makeup to the ESW Emergency Makeup System Retention Pond to account for surface evaporative loses from the pond.

The expected maximum withdrawal for CWSMWS would occur with the plant at 100% power, worst-case meteorological conditions and a blowdown flow to maintain 3.0 cycles of concentration. The expected maximum withdrawal for RWSS would occur when the plant is shutting down. Because the maximum withdrawal scenarios for the CWSMWS and the RWSS are mutually exclusive, i.e. 100% power cannot exist during plant shutdown, the maximum withdrawal condition will be based on CWSMWS supporting the plant at 100% power, worst-case meteorological condition and a blowdown flow to maintain 3.0 cycles of concentration, and RWSS supplying loads that are expected for 100% power operation (one ESWS with two cooling towers operating).

With the above information as a basis, the maximum daily (peak day) withdrawal is calculated as described below.

<u>CWSMWS</u>

For CWSMWS assume worst-case meteorology i.e., 77°F wet-bulb temperature and 40% relative humidity conservatively applied for the entire 24-hour period. Information from the cooling tower manufacturer indicates a corresponding evaporation rate of 8,860 gpm and a total evaporation loss for two towers of 8,860 x 2 = 17,720 gpm. Blowdown rates are determined by:

(Blowdown + drift) = (evaporation)/(cycles-1)

A conservative estimate of 3.0 cycles of concentration will be used. Cooling tower drift is estimated as 4 gpm per tower or 8 gpm. Then

(Blowdown + 8 gpm) = 17,720 gpm/(3.0-1) [two towers]
Blowdown = 8,852 gpm [two towers]

CWSMWS Total Withdrawal = Evaporation + Blowdown + Drift
= 17,720 gpm + 8,852 gpm + 8 gpm
= 26,580 gpm (38.3 mgd)

<u>RWSS</u>

For RWSS the maximum withdrawal that would coincide with the maximum CWSMWS withdrawal is 1,921 gpm (2.8 mgd). This value is considered a maximum because of the very conservative makeup flows to ESWS.

The RWSS withdrawal has the following components:
ESWS cooling tower evaporation: 571 gpm per tower = 1,142 gpm [two towers]
ESWS cooling tower drift: 2 gpm per tower = 4 gpm [two towers]
ESWS cooling tower blowdown at 3.0 cycles of concentration:
(Blowdown + 4 gpm) = 1,142 gpm/(3.0-1)
Blowdown = 567 gpm [two towers]
Subtotal: ESWS cooling towers = Evaporation + Blowdown + Drift
= 1,142 gpm + 567 gpm + 4 gpm = 1,713 gpm [two towers]

RWSS Filter Backwash = 91 gpm
Demineralized Water Distribution System = 107 gpm
Fire Water Distribution System = 5 gpm
Floor Wash Drains = 5 gpm

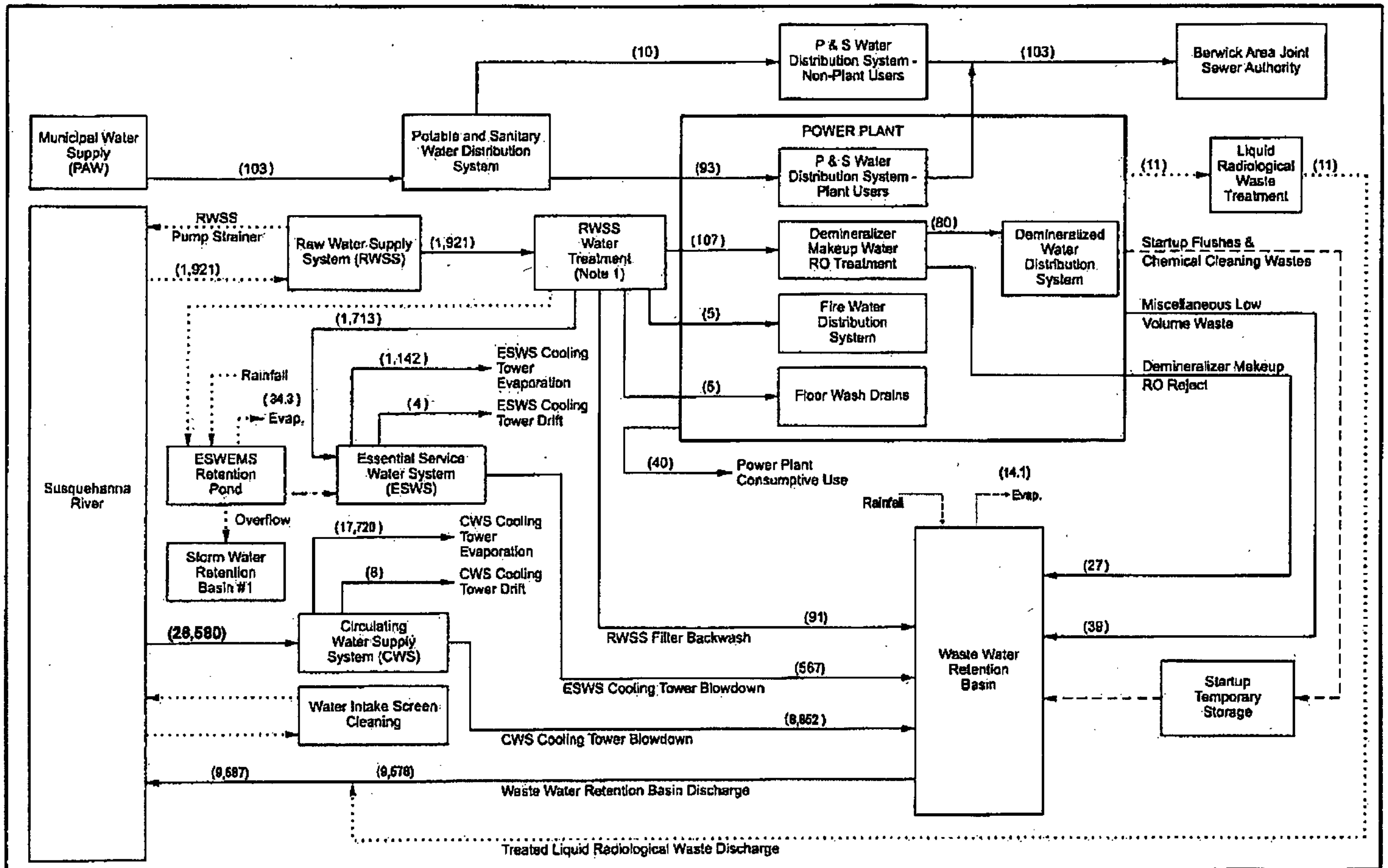
Total RWSS withdrawal
= 1,713 gpm + 91 gpm + 107 gpm + 5 gpm + 5 gpm = 1,921 gpm

Plant (CWSMWS + RWSS)

Max. Daily Withdrawal = Max. Daily Withdrawal (CWSMWS + RWSS)
= 26,580 gpm (38.3 mgd) + 1,921 gpm (2.8 mgd)
= 28,501 gpm (41.1 mgd)

For this application, 41.1 mgd is rounded up to 44 mgd for conservatism and to account for variability within the range of monitoring accuracy required by the Commission.

ATTACHMENT SW-3-A



KEY:

(Flows: Gallons per minute)

NOTES:

1. Dual media filtration.

LEGEND:

- Startup Flows
- Normal Flows
- Flow Varies with Operating Conditions
- DBA Shutdown Flow

BELL BEND NUCLEAR POWER PLANT
ANTICIPATED WATER USE DIAGRAM
PEAK DAY

Attachment 4

Consumptive Water Use Application

SRBC #24C
Rev. 9/99

Susquehanna River Basin Commission

a water management agency serving the Susquehanna River Watershed

Consumptive Water Use Application

General note by PPL Bell Bend, LLC (Applicant):

- To avoid or minimize confusion, headings and instructions on the original application form are in bold font. Information and data inserted by PPL Bell Bend, LLC are in normal weight font.

1. Project Sponsor Information:

Company Name PPL Bell Bend, LLC (hereinafter "PPL BB")

Mailing Address 38 Bomboy Lane, Suite 2
Berwick, PA 18603

Contact Person Nancy Evans Title Sr. Environmental Professional

Telephone 610.774.4309 Fax 610.774.7136 E-mail naevans@pplweb.com

2. Company or Facility Description:

Type of facility Electric generating station

Date operations began or will begin Testing and preparation for commercial operation is expected to begin 2018. Consumptive water use during construction is expected to begin June 2012.

3. a. Location of Facility:

State PA County Luzerne

Municipality Salem Township

c. You must attach a copy of a USGS 7 ½ minute quadrangle map indicating the location of the facility, all water resources, and discharges. Please indicate quadrangle name.

Attachment CU-1 is a topographic map based on the Berwick and Sybertsville quadrangles showing the location of the BBNPP site. Attachment CU-2 is a plan of BBNPP including the river intake and discharge diffuser and the plant water storage facilities.

4. Water Sources (s) (well, spring, stream, public supply, etc.)

Source	Location
Susquehanna River (operation only)	Salem Township, Luzerne County, PA. See Attachment CU-1 for location of proposed river intake.
On-site dewatering wells (construction only)	BBNPP site. Ref. accompanying Ground-Water Withdrawal application. Some water withdrawn from the system of dewatering wells will be used consumptively. The estimated maximum consumptive use of groundwater is 0.12 mgd.
Pennsylvania American Water Company	Extension of existing system (Berwick Division) to site
Trucked-in water (if necessary, construction only)	Source unknown at this time

5. Water Requirements:

Water Use	Prior to January 23, 1971	January 23, 1971, to Present	Future Use (25 years)
	gallons per day		
Maximum Daily Total Withdrawal	NA	NA	44 mgd [Note A]
Maximum Daily Consumptive Use	NA	NA	31 mgd [Note B]
Maximum Average Daily Consumptive Use*	NA	NA	26 mgd [Note C]

*based on maximum consecutive 30-day period

Note A: 41.1 mgd is the calculated amount. PPL BB is applying for 44 mgd.
Note B: 27.3 mgd is the calculated amount. PPL BB is applying for 31 mgd.
Note C: 25.9 mgd is the calculated amount. PPL BB delineates the value as 26 mgd.

6. Metering:

Inflow to the facility √ yes _____ no Effluent √ yes _____ no

7. Provide method of computing consumptive use.
See Attachment CU-3 for computation of both the estimated maximum daily consumptive use and the estimated maximum 30-day average consumptive use.

8. **Provide flow chart showing the movement of water through the facility, including location and amount of any losses.** Attachment CU-4 is the BBNPP "Anticipated Water Use Diagram" showing the main plant water uses and flows coincident with the anticipated peak day withdrawal from the Susquehanna River and peak day consumptive water use. As explained in Attachment CU-3, the quantity of consumptive use requested includes an allowance to account for variability within the range of monitoring accuracy required by the Commission. However, the anticipated peak day withdrawal and peak day consumptive water use shown on Attachment CU-4 are the amounts calculated, without such allowance.

9. Consumptive Use Compensation Options (please choose one):

Discontinue consumptive water use NA
Provide water storage See letter transmitting application
Reimburse Commission for water storage See letter transmitting application
Other (explain) NA

10. Preparer:

Name Jan C. Phillips, P.E.

Title Consulting Engineer

Company NA

Address 2611 Walnut Street, Allentown, PA 18104

Phone 610.821.0160 Fax 610. 821.0160

Signature Jan C Phillips

Date 5-6-09 E-mail Address jcphilps@enter.net

11. Project Sponsor:

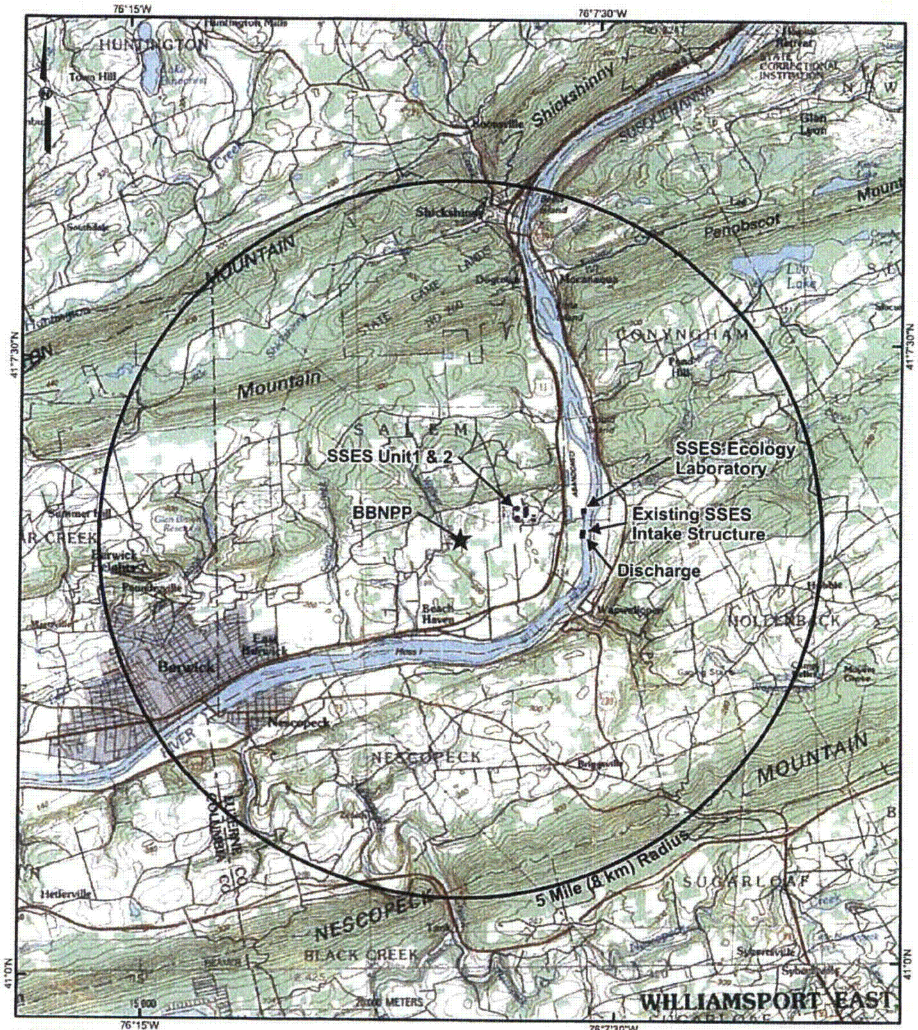
Name (print or type) Terry L. Harpster Title Vice President-Bell Bend Project - Development

Signature T L Harpster Date

K:\DATA\JPAIN\WORD\FORMS\SRBC\24C (Consumptive Use Instructions and Application).DOC

ATTACHMENT CU-1

Figure 2.3-2 {Site Area Topographic Map 5 Mile (8 km) Radius}



LEGEND

★ Center Point of Proposed Bell Bend NPP (BBNPP)

○ NPP Reactor 5 Mile (8 km) Radius

0 0.5 1 2 Miles

0 0.5 1 2 Kilometers

REFERENCE:
USGS 1:100K Topographic Maps:
Williamsport East and Sunbury Maps edited 1984.

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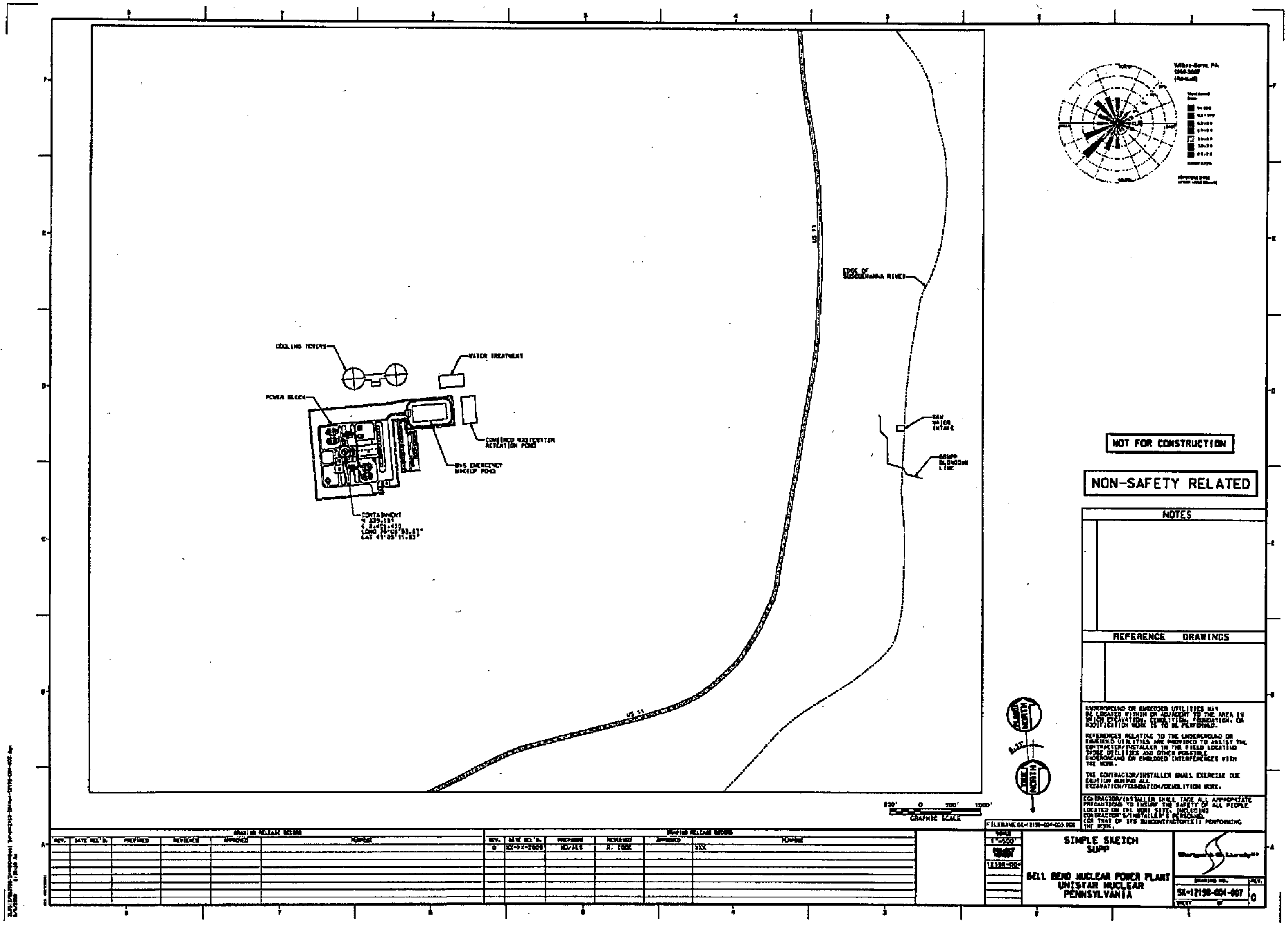
ATTACHMENT CU-2



ATTACHMENT CU-3

METHOD OF CALCULATION OF CONSUMPTIVE USE

Maximum Daily (Peak Day) Consumptive Use:

There are seven (7) paths that consume water during normal plant operation. These are:

- Main (Circulating Water System) Cooling Towers Evaporation
- Main Cooling Towers Drift
- Essential Services Water Emergency Makeup System (ESWEMS) Cooling Towers Evaporation
- ESWEMS Cooling Towers Drift
- ESWEMS Retention Pond Evaporation
- Waste Water Retention Basin Evaporation and
- Power Plant Consumptive Use

The maximum daily value for each path is provided below either by reference or calculation, and then the values are summed to provide maximum daily consumptive use.

The derivations of values noted with an asterisk [*] are presented in Attachment SW-3 of the accompanying Surface Water Withdrawal Application.

Main (CWS) Cooling Towers Evaporation *

Maximum daily evaporation based on worst-case weather conditions is 17,720 gpm. [two towers]

Main (CWS) Cooling Towers Drift *

Drift loss is 8 gpm. [two towers]

ESWEMS Cooling Towers Evaporation *

Maximum anticipated evaporation coincident with maximum Main cooling tower evaporation is 1,142 gpm. [two towers]

ESWEMS Cooling Towers Drift *

Drift loss is 4 gpm. [two towers]

ESWEMS Retention Pond Evaporation

The calculated estimate of water evaporation from the ESWEMS Retention Pond for very conservative meteorological conditions over a 30-day period is 198,300 ft^3. This is converted to gpm by

$(198,300\ ft^3/30\ days) \times (7.48\ gal/\ ft^3) \times (1\ gpm/1440\ gal/day) = 34.3\ gpm$

Note: The area of the ESWEMS Retention Pond is 247,900 ft^2. The very conservative 30-day evaporation rate is equivalent to

$$((198,300\ ft^3/30\ days)\ /\ 247,900\ ft^2) \times 12\ in/ft = 9.6\ inches.$$

Waste Water Retention Basin Evaporation

Evaporation for this basin can be determined from the estimate for the ESWEMS Retention Pond (34.3 gpm, above) based on the ratio of surface areas. The surface area for the Waste Water Retention Basin will be 102,000 ft^2

Thus,

$$(102,000\ ft^2/247,900\ ft^2) \times 34.3\ gpm = 14.1\ gpm$$

Power Plant Consumptive Use

The maximum daily value is 40 gpm.

Thus, the maximum daily consumptive use

= 17,720 gpm + 8 gpm + 1,142 gpm + 4 gpm + 34.3 gpm + 14.1 gpm + 40 gpm

= 18,962.4 gpm (27.3 mgd rounded up to 28 mgd for conservatism).

<u>Maximum 30-day Average Consumptive Use</u>:

This value is calculated based on 10 days at the maximum daily CWS cooling tower evaporation from above, 20 days at the CWS cooling tower design point evaporation shown below, and addition of the other consumptive use daily values from above.

The design point evaporation is calculated to be 8,100 gpm and the total for two towers will be 8,100 x 2 = 16,200 gpm. The corresponding blowdown rate assuming 3.0 cycles of concentration is

(Blowdown + drift) = (evaporation)/(cycles-1)

Then,

(Blowdown + 8 gpm) = 16,200 gpm/(3-1)

Blowdown = 8,092 gpm (design point) [two towers]

CWSMWS Total = Evaporation + Blowdown + Drift

= 16,200 gpm + 8,092 gpm + 8 gpm

= 24,300 gpm (35.0 mgd) (design point)

Thus:

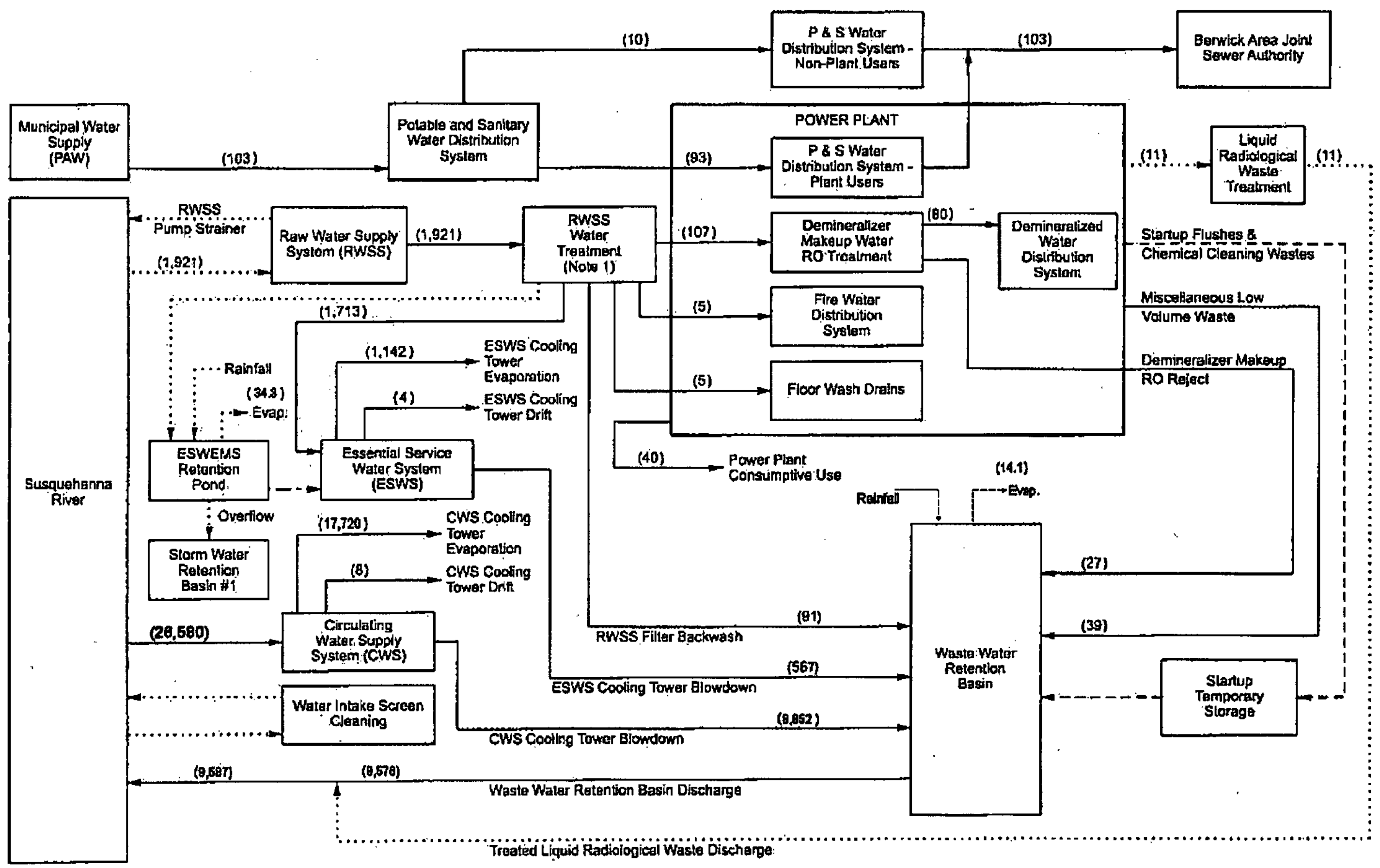
Average of 10 days @ CWSMWS Maximum Evaporation + 20 days @ CWSMWS Design Point Evaporation + other daily consumptive use values

= ((17,720 gpm x 60 minutes/hr x 24 hr/day x 10 days)
+ (16,200 gpm x 60 minutes/hr x 24 hr/day x 20 days))/30 days

+ (8 gpm + 1,142 gpm + 4 gpm + 34.3 gpm + 14.1 gpm + 40 gpm)
x 60 minutes/hr x 24 hr/day

= 24.1 mgd + 1.8 mgd =
= 25.9 mgd (rounded up to 28 mgd for conservatism and to account for variability within the range of monitoring accuracy required by the Commission).

ATTACHMENT CU-4



KEY:

(Flows: Gallons per minute)

NOTES:

1. Dual media filtration.

LEGEND:

- - - - - Startup Flows
——— Normal Flows
········ Flow Varies with Operating Conditions
–·–·– DBA Shutdown Flow

BELL BEND NUCLEAR POWER PLANT
ANTICIPATED WATER USE DIAGRAM
PEAK DAY

T. L. Harpster
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October 9, 2009

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 cc: (w/o attachment)

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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

Attachment 1

Supplemental Application Documents

806.14(c)

Refer to attached reports associated with the project:

Walker Run Survey: Wild Trout Habitat Assessment, LandStudies, May, 2009.

Walker Run Geomorphic Assessment, LandStudies, April, 2009.

A Field Survey of Terrestrial Fauna at the Proposed Bell Bend Nuclear Power Plant, Site, Luzerne County, Pennsylvania, Normandeau Associates, September, 2008.

A Field Survey of Plant Communities at the Proposed Bell Bend Nuclear Power Plant Site, Luzerne County, Pennsylvania, September, 2008.

A Field Survey of Fish and Aquatic Macroinvertebrates at the Proposed Bell Bend Nuclear Power Plant Site, Luzerne County, Pennsylvania, Normandeau Associates, September, 2008.

Preliminary Mussel Survey in the Susquehanna River in the Vicinity of the Proposed Bell Bend Nuclear Power Plant Site, Luzerne County, Pennsylvania, Normandeau Associates, September, 2008.

Impingement and Entrainment Sampling for the Proposed Bell Bend Nuclear Power Plant at the SSES Circulating water Supply System Intake Structure, Luzerne County, Pennsylvania, Normandeau Associates, September, 2008.

806.14(a)(1) Identification of project sponsor

Refer to attached BBNPP Combined Construction and Operating License Application Sections:

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

806.14(a)(2)(i) Project location

Refer to attached BBNPP Combined Construction and Operating License Application Sections:

2.0 Environmental Description

2.1 Station Location – includes location coordinates

Figure 2.1-2
Figure 2.1-3
Figure 2.1-4

Note: Cooling water intake structure coordinates:

North 339563.04 (Latitude 41 05 13.91276)
East 2414655.16 (Longitude 76 07 53.11175)

806.14(a)(2)(ii) Project purpose

Refer to attached BBNPP Combined Construction and Operating License Application Sections:

8.0 Need for Power

- 8.1 Description of Power System
- 8.2 Power Demand
- 8.3 Power Supply
- 8.4 Assessment of Need for Power

806.14(a)(2)(iii) Proposed quantity of water to be withdrawn

See surface water withdrawal application form.

806.14(a)(2)(iv) Proposed quantity of water to be consumed

See consumptive use application form.

806.14((a)(2)(ix) – Plans for avoiding or mitigating for consumptive use.

Attached BBNPP Environmental Report Section 9.4.1.1, Evaluation of Alternative Heat Dissipation Systems, provides a summary of heat dissipation system alternatives and their evaluation.

806.14(a)(2)(v) Constant-rate aquifer tests

Not applicable to surface water withdrawal and consumptive use applications.

806.14(a)(2)(vi) Water use and availability:

From Environmental Report Section 9.2.3.3.1
"The BBNPP will operate as a baseload, merchant independent power producer. The power produced will be sold on the wholesale market without specific consideration to supplying a traditional service area or satisfying a reserve margin objective. The ability to generate baseload power in a consistent, predictable manner meets the business objectives for the BBNPP."

From Environmental Report Section 3.4.1.3.1
"The U.S. EPR is designed to operate with a capacity factor of 95% (annualized), considering scheduled outages and other plant maintenance."

From Environmental Report Section 5.2.1.2
"… refueling outages occur approximately every eighteen months and last approximately 1 month …"

806.14(a)(2)(vii) All water sources

The Susquehanna River will be the source of water for the project. Testing and preparation for commercial operation is expected to begin in 2018. This would be the initiation of surface water use.

806.14(a)(2)(viii) – Supporting Studies, reports, and other information upon which assumptions and assertions have been based.

See attached reports:

1. Report Documenting the Withdrawal and Consumptive Use values in the Bell Bend Nuclear Power Plant Combined Application to the Susquehanna River Basin Commission, Revision 0
2. S&L Report No. 009655, Construction Dewatering Design, Revision 1
3. Evaporation Curve from SPX Cooling Tower Co.
4. S&L Calculation 2008-08550, Bell Bend Water Balance Calculation, Revision 2
5. S&L Report No. SL-009498, Conceptual Design of the Circulating Water System, Revision 3
6. S&L Calculation No. 2008-07916, RWSS Pump and Piping Sizing, Revision 1
7. B&V Calculation 161642.51.2001, ESWEMS Retention pond Sizing, Revision 0
8. S&L Calculation No. SL-009446, Conceptual Design of Storm water management system, Revision 2

806.14(a)(2)(x) Copies of correspondence with member jurisdiction agencies

- November 20, 2008 letter from the Federal Emergency Management Agency to US Nuclear Regulatory Commission concerning the Radiological Emergency Preparedness Program.
- August 27, 2008 letter from the Pennsylvania Emergency Management Agency to UniStar on the proposed emergency plans for the project.
- January 27, 2009 letter from New Jersey Department of Environmental Protection to Us Nuclear Regulatory commission concerning alternative site.
- July 9, 2008 letter from the Luzerne County, Pennsylvania to UniStar concerning the proposed project.
- Six (6) letters to Michael Canova, US Nuclear Regulatory Commission in support of the PPL Bell Bend project.
- October 8, 2008 letter from Congressman Paul Kanjorski to US Nuclear Regulatory Commission in support of the project.
- January 29, 2009 statement from Pennsylvania Energy Alliance in support of the project.
- February 19, 2009 letter from Governor Edward G. Rendell to Department of Energy in support of the project.
- February 12, 2009 letter from the Pennsylvania Department of Conservation and Natural Resources to US Nuclear Regulatory Commission on the Pennsylvania Natural Diversity Inventory Review for the Bell Bend Site.
- March 5, 2009 letter from the Pennsylvania Fish & Boat Commission to US Nuclear Regulatory Commission concerning Pennsylvania Natural Diversity Inventory for the Bell Bend site.

- March 2, 2009 letter from the PA Historical and Museum Commission to UniStar approving the Phase Ib Cultural Resources Investigation report and recommendations.

- March 23, 2009 letter from the PA Historical and Museum Commission to PPL Bell Bend approving the Supplemental Phase Ib Cultural Resources Investigation report.

- May 26, 2009 letter from PPL Bell Bend to Pennsylvania Historic and Museum Commission submitting the work scope for Phase II National Register Evaluations of Archaeological Sites.

- June 11, 2009 letter from the PA Historical and Museum Commission to PPL Bell Bend approving the scope of work proposal for Phase II Archaeological Evaluations and Assessment of Effects to Historic Resources.

- March 13, 2009 letter from the US Department of the Interior to US Nuclear Regulatory Commission with comments on an alternative site.

- July 10, 2009 letter from the US Department of the Interior to US Nuclear Regulatory Commission concerning their input to the environmental impact statement for the project.

- April 9, 2009 letter from US Army Corps of Engineers to US Nuclear Regulatory Commission

- April 29, 2009 letter from PPL Bell Bend to US Army Corps of Engineers requesting Preliminary Jurisdictional Determination and transmitting the Wetlands Delineation and Exceptional Value Wetlands Analysis Report, dated February 2009.

- All NRC correspondence can be found at:

http://www.nrc.gov/reactors/new-reactors/col/bell-bend/documents/app-2008.html

806.14(a)(2)(xi): Evidence of compliance with applicable water registration requirements of the member jurisdiction in which the project is located.

The Water Resources Planning Act, Act 220, requires the Department of Environmental Protection (DEP) to conduct a statewide water withdrawal and use registration and reporting program. The regulation, which establishes water withdrawal and use registration, monitoring, record-keeping and reporting requirements at 25 Pa. Code Chapter 110, became effective upon its publication in the Pennsylvania Bulletin on November 15, 2008.

Chapter 110 applies to public water supply agencies (defined as community water systems) and hydropower facilities, irrespective of the amount of withdrawal, and any person whose total withdrawal from one or more points of withdrawal within a watershed operated as a system either concurrently or sequentially exceeds an average rate of 10,000 gallons per day (gpd) of water in any 30-day period. Those persons who obtain their water through an interconnection with another person in an amount that exceeds an average rate of 100,000 gpd in any 30-day period also must register. Registrants must annually report their water usage and other information and retain records for at least 5 years.

Specifically, §110.202, Submission of registrations, states, "Registration shall be submitted to the Department by March 16, 2004, or 30 days following initiation of a water withdrawal or withdrawal use subject to §110.201 (relating to the registration requirement), whichever is later."

The registration of water withdrawal for the Bell Bend project will be made by submitting the proper registration forms to the Pennsylvania Department of Environmental Protection no later than 30 days following initiation of water withdrawal for the facility.

806.14(a)(3)(i) Surface water characteristics (quality, quantity, flow regimen, other hydrological characteristics).

Refer to attached BBNPP Environmental Report Sections:

4.2	Water-related Impacts
4.3.2.2	Impacts to the Susquehanna River and Offsite Streams
5.2	Water Related Impacts
5.3.3	Heat Discharge System

Report: Susquehanna River Thermal Plume and Dilution Modeling BBNPP, ERM, June, 2008.

806.14(a)(3)(ii) Threatened or endangered species and their habitats.

Refer to attached BBNPP Environmental Report Sections:

4.3 Ecological Impacts
5.4.4 Impacts to Biota Other Than Members of the Public

See also: 806.14(a)(2)(x) Copies of correspondence with member jurisdiction agencies.

806.14(a)(3)(iii) – Existing water withdrawals.

Refer to attached BBNPP Environmental Report Sections:

2.3.2.1.2 Consumptive Surface Water Use
4.2 Water-related Impacts
5.2 Water Related Impacts
5.3 Cooling System Impacts

806.14(a)(4) Project estimated completion date and estimated construction schedule

Refer to attached PPL Bell Bend NPP Level 2 Schedule

806.14(b)(1)(i) Engineering feasibility

This project is a single-unit US Evolutionary Power Reactor (EPR).

Refer to attached Bell Bend Nuclear Power Plant-Specific System Design parameters.

Refer to the Final Safety Analysis Report (FSAR) in Part 02 of the Combined Construction and Operating License Application (COLA) for a detailed explanation of the project.

806.14(b)(1)(ii) Ability of project sponsor to fund the project or action

Refer to the attached BBNPP Combined Construction and Operating License Applications Sections:

1.5 Financial Qualifications
1.6 Decommissioning Funding Assurance
    1.6.1 Decommissioning Cost Estimate
    1.6.2 Decommissioning Funding Mechanism
    1.6.3 Decommissioning Costs and Funding – Status Reporting
    1.6.4 Recordkeeping Plans Related to Decommissioning Funding
1.7 Foreign Ownership, Control, or Domination
1.8 Restricted Data and classified National Security Information
1.9 References

Tables 1.9-1 through 1.9-10
Appendix A

806.14(b)(1)(iii) Identification and description of reasonable alternatives

Refer to attached Bell Bend Nuclear Power Plant, Alternative Site Evaluation, Revision 0, September 2009, Luzerne County, Pennsylvania

806.14(b)(1)(iv) Compatibility of proposed project with existing and anticipated uses

Refer to the attached BBNPP Combined Construction and Operating License Applications Sections:

Part 2: Final Safety Analysis Report
    2.2 Nearby Industrial, Transportation and Military Facilities

This project is a single-unit US Evolutionary Power Reactor (EPR) that will be located adjacent to the existing Susquehanna Steam Electric Station nuclear plant.

806.14(b)(1)(v)(A) Flood damage potential considering the location of the project with respect to the flood plain and flood hazard zones.

Refer to attached BBNPP Final Safety Analysis Report Sections:

2.4 Hydrologic Engineering
3.4 Water Level (Flood) Design

A FEMA flood analysis of the project site is being performed as part of the actions needed for the Joint Permit Application, US Army Corps of Engineers/Pennsylvania Department of Environmental Protection. (See 806.14(b)(2)(iii))

806.14(b)(1)(v)(B) – Recreational potential.

Refer to attached BBNPP Environmental Report Sections:

2.2	Land
2.2.2.1.3	Non-Consumptive Surface Water Use
2.5.2.6	Area Recreational Opportunities
4.2.2.7	Potential Changes to Surface Water and Groundwater Quality
4.2.2.10	Measures to Control Construction Related Impacts
4.4.1	Physical Impacts
4.4.2.9	Public Facilities
5.8.1.2	Distribution of Community Populations, Buildings, Roads and Recreational Facilities
5.8.2.6.2	Area-Wide and Recreational Aesthetics

806.14(b)(1)(v)(C) Fish and wildlife (habitat quality, kind and number of species).

Refer to attached BBNPP Environmental Report Sections:

2.4.1.2	Important Terrestrial Species and Habitats
2.4.1.3	Habitat Importance
4.3	Ecological Impact
5.3.1.2	Aquatic Ecosystems
5.3.2.2	Aquatic Ecosystems
5.3.3.2	Terrestrial Ecosystems

Note: On October 6, 2009, the Pennsylvania Fish & Boat Commission designated Walker Run as a Wild Trout Stream.

806.14(b)(1)(v)(D) – Natural environmental uses (scenic vistas, natural and manmade corridors, wild and wilderness areas, wild, scenic and recreation rivers.

Refer to BBNPP Environmental Report Sections identified for 806.14(b)(1)(v)(B).

806.14(b)(1)(v)(E) – Site development considerations (geology, topography, soil characteristics, adjoining and nearby land uses, adequacy of site facilities).

Refer to attached BBNPP Environmental Report Sections:

2.2 Land
4.1.1 The Site and Vicinity
5.1.1 The Site and Vicinity

806.14(b)(1)(v)(F) Historical, cultural and archaeological impacts.

Refer to attached BBNPP Environmental Report Sections:

2.5.3 Historical Properties
4.1.3 Historical Properties
5.1.3 Historical Properties and Cultural Resources

See also: 806.14(a)(2)(x) Copies of correspondence with member jurisdiction agencies.

806.14(b)(2)(i) Need for government services or finances

and

806.14(b)(2)(ii) Commitment of government to provide services or finances

The Federal Energy Policy Act of 2005 provides two important government incentives, which may be perceived as "services or finances." This Act clearly demonstrates the federal government's commitment to provide such services or finances.

The first incentive under the Act is the eligibility of new nuclear plants for Production Tax Credits, as long as the following schedule milestones are achieved:

COLA filed with NRC by 12/31/2008
First "safety related" concrete pour by 12/31/13
Commercial operations by 12/31/2020

The Production Tax Credits can amount to as much as $125 million per 1,000 megawatts (MW) of production, for each of the first eight years of operation. The Production Tax Credits are more fully described immediately below.

Production Tax Credits For New Plants
The legislation provides a production tax credit of 1.8 cents per kilowatt-hour for 6,000 MW of capacity from new nuclear power plants for the first eight years of operation.

A qualifying advanced nuclear facility is a nuclear facility for which a company (or companies) has received an allocation of megawatt capacity and which is placed in service before 2021.

The 6,000 MW of capacity eligible for the credit is allocated by the Secretary of the Treasury (in consultation with the Secretary of Energy). If more than 6,000 MW of new nuclear generating capacity is operating in any given year and is eligible for the production tax credit, the Treasury Secretary will presumably apportion the 6,000-MW allocation on a pro rata basis among the nuclear plants in operation.

The aggregate amount of credit that a taxpayer may claim in any year during the eight-year period is subject to two limitations, based on allocated capacity and an annual limitation:

(1) The company may claim credit only for production of electricity equal to the ratio of the allocated capacity that the taxpayer receives from the Secretary to the rated nameplate capacity of the company's facility. For example, if the company receives an allocation of 750 MW of capacity from the 6,000 MW, and the company's facility has a rated nameplate capacity of 1,000 MW, then the company may claim three-quarters of the allowable credit, or 1.35 cents per kilowatt-hour, for each kilowatt-hour of electricity produced at the facility (subject to the annual limitation described below).

(2) A company operating a qualified facility may claim no more than $125 million in tax credits per 1,000 MW of allocated capacity in any one year of the eight-year credit period. If the company operates a 1,350-MW plant and has received an allocation for 1,350 MW of capacity eligible for the credit, the company's annual limitation on credits that may be claimed is equal to 1.35 times $125 million, or $168.75 million.

If the company operates a facility with a nameplate rated capacity of 1,000 MW but has received an allocation from the Secretary for 750 MW of credit-eligible capacity, then the two limitations apply such that the company may claim a credit equal to 1.35 cents per kilowatt-hour of electricity produced (as described above), subject to an annual credit limitation of $93.75 million in credits (three-quarters of $125 million).

The production tax credit places nuclear energy on equal footing with other sources of emission-free power, including wind and closed-loop biomass. These other sources have received a production tax credit since 1992.

The Energy Policy Act of 2005 also provides access to Department of Energy (DOE) Loan Guarantees that can cover up to 80% of the construction costs of a project. The DOE Loan Guarantees are described immediately below, followed by an explanation of the need for such incentives.

Loan Guarantees for New Nuclear Plants
The bill authorizes the Energy Secretary to provide loan guarantees to support the development of innovative energy technologies "that avoid, reduce or sequester air pollutants or anthropogenic emissions of greenhouse gases."

These technologies include nuclear energy facilities, renewable energy, coal gasification and hydrogen fuel-cell technology. The loan guarantee can be up to 80 percent of the project cost. The Secretary sets the rate, and full payment must be made within 30 years or 90 percent of the project's life.

The legislation creates a self-financing Energy Loan Guarantee Fund that minimizes the potential costs to the federal government. The legislation provides two alternatives to finance the cost of a loan guarantee:

- The project developer can pay the cost of the loan guarantee into the fund.
- The Secretary of Energy can request an appropriation for that amount, and the project developer pays back that amount over time.

The cost of a loan guarantee is a small percentage of the face value of the amount being guaranteed, much like the loan origination fee charged by a bank when it provides a home mortgage.

The incentives provided pursuant to the Energy Policy Act of 2005, particularly the DOE Loan Guarantees, are absolutely essential to the success of a new nuclear project. Financing of new nuclear power plants poses unique challenges for projects and their sponsors. PPL, in consultation with its financial advisors, believes that, absent a long-term, guaranteed loan similar to the DOE Loan Guarantee, a project financing market for the project would not exist.

Several factors negatively affect the ability to raise non-recourse, project debt financing for a new nuclear facility, namely:

- Long lead-time construction with no interim cash flows available for debt service;

- New technology risk involved in building the superior technology of Generation III+ nuclear plants;
- Complexity in the construction of nuclear power plants and the financing risks associated with potential delays and cost overruns;
- Potential regulatory delays despite an overhauled and streamlined licensing process;
- Limited domestic construction experience in building new nuclear power plants given the hiatus of several decades since last build-out;
- Magnitude of costs associated with these large projects relative to the size of U.S. power/utility companies and to the depth of the project financing markets;
- Absence of a power contracting market with flexibility and depth necessary to support adequate long term financing on commercially reasonable terms.
- 20+ year tenor to secure adequate financing on commercially reasonable terms.

The alternative to financing with the DOE Loan Guarantee Program would be to finance in the commercial markets on terms and conditions that would likely be challenging for power and utility companies to accept – shorter term debt, higher equity component, incremental on balance sheet debt attribution, and higher asset concentration. For these reasons, the DOE Loan Guarantee Program provides benefits to the applicants in the following key areas:

1. Debt tenor: DOE provides for 30-year financing. Given the high capital costs of a new nuclear facility, the longer debt maturity is required to ensure adequate debt serviceability and reduce refinancing risk. A 30-year debt maturity is not excessive given the 60-year expected lives of the assets.

2. Absolute leverage: The DOE Loan Guarantee is available for up to 80% of the Eligible Project Costs. The increase in leverage makes the required cost of electricity on a cost per kilowatt basis more affordable to the end customer. If a loan were financed with the project sponsor's capital structure of approximately 56% debt and 44% equity, the costs would be less economic for customers. The DOE Loan Guarantee ensures that the policy objectives are met with the least cost alternative.

3. Preservation of Corporate Credit: The absolute leverage necessary to make the project economic to both the project sponsor and the consumer would severely challenge the creditworthiness of the project sponsor. Structured correctly, the guaranteed and nonrecourse nature of a project's financing will afford off-credit treatment of a significant portion of the debt and would preserve the creditworthiness and credit rating of the sponsor. Such risk segregation would enable the project sponsor to undertake the project without risking the entire enterprise.

4. Reduces Asset Concentration Risk: In the absence of a guarantee and resulting off-credit treatment, the project would constitute 61% of the current property, plant and equipment, and 45% of the total asset balances of the project sponsor. PPL believes that investors would be challenged with that level of asset concentration without the risk sharing mechanism of the DOE Loan Guarantee. PPL believes that with the DOE Loan Guarantee, the project would be able to raise adequate debt financing from the Federal Financing Bank (FFB) and other sources of credit (such as export credit agencies), so long as such other credit providers can be secured by the assets on a *pari passu* basis with the FFB/DOE Loan.

806.14(b)(2)(iii) Status of application with other governmental regulatory bodies.

Refer to attached Bell Bend Permit matrix, Rev. 0, 7/6/2009

Status of applications to date:

- Joint Permit Application, US Army Corps of Engineers/Pennsylvania Department of Environmental Protection

    PPL Bell Bend is working with the US ACOE and PADEP in preparation of the JPA for submission in October, 2010.

- Loan Application, US Department of Energy

    Part I and Part II of the application have been submitted. The application is being updated with current information quarterly.

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

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January 14, 2011

Mr. James Richenderfer, Ph.D., P.G.
Director, Technical Programs
Susquehanna River Basin Commission
1721 N. Front Street
Harrisburg, PA 17102-2391

BELL BEND NUCLEAR POWER PLANT
APPLICATION FOR SURFACE WATER WITHDRAWAL
APPLICATION FOR CONSUMPTIVE WATER USE
BNP-2011-005 Docket No. 52-039

By letter of May 13, 2009, PPL Bell Bend LLC (PPL) submitted applications to the Susquehanna River Basin Commission (Commission) for groundwater withdrawal, surface water withdrawal, and consumptive water use at the proposed Bell Bend Nuclear Power Plant (BBNPP). On March 1, 2010 the Commission requested additional information on the applications. Since then, the application for groundwater withdrawal has been withdrawn, and the applications for surface water withdrawal and for consumptive water use have been supplemented.

The May 2009 application for surface water withdrawal requested the Commission's approval to withdraw up to a maximum of 44 million gallons per day (mgd) (peak day) from the Susquehanna River. Based on information that has become available since the initial application, PPL wishes to reduce the requested maximum (peak day) withdrawal to 42 mgd. Enclosure 1 to this letter documents the determination of the 42 mgd in accordance with Commission requirements under 18 CFR 806.14(a)(2) (iii) and (viii) and in response to the Commission's March 1, 210 letter.

The May 2009 application for consumptive water use requested the Commission's approval to consume up to a maximum of 31 mgd (peak day). Based on information that has become available since the initial application, PPL wishes to reduce the requested maximum (peak day) consumptive water use to 28 mgd. Enclosure 2 to this letter documents the determination of the 28 mgd in accordance with Commission requirements under 18 CFR 806.14(a)(2)(iv) and in response to the Commission's March 1, 210 letter. Enclosure 2 accounts for thermal-induced in-river evaporation as required by the Commission. Please note that the previously defined stormwater ponds are no longer a project component.

Final BBNPP system designs are not complete and the procurement of equipment has not begun; consequently, there are no certified cooling tower or pump performance curves. The requested maximum (peak day) 42 mgd surface water withdrawal and requested maximum (peak day) 28 mgd consumptive water use values are based on best available information and believed to be conservative, as explained in Enclosures 1 and 2, respectively. While PPL does not envision a need to do so, it is possible that one or both of the requested values will need to be revised as plant system designs are completed.

Actual water use at BBNPP will be monitored in accordance with an approved Water Monitoring Plan, in compliance with the Commission's regulations. PPL submitted a proposed Water Monitoring Plan to the Commission by letter dated July 8, 2010.

Should you or your staff have any questions, please contact Bradley Wise at 610.774.6508 or bawise@pplweb.com or Gary Petrewski at 610.774.5996 or gpetrewski@pplweb.com.

Respectfully,

TL Harpster

Terry L Harpster

TLH/kw

Enclosures: 1) Determination of Surface Water Withdrawal

2) Determination of Consumptive Water Use

cc: w/ Enclosures

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Enclosure 1

Determination of Surface Water Withdrawal

Contents

PPL Bell Bend, LLC
Bell Bend Nuclear Power Plant
Determination of Surface Water Withdrawal

1 Introduction

The initial applications to SRBC (May 2009) requested approval for surface water withdrawal up to a maximum (peak day) of 44 mgd and for consumptive water use up to a maximum (peak day) of 31 mgd. Based on currently available information, PPL Bell Bend has re-determined the surface water withdrawal and consumptive water use values. Consequently, PPL Bell Bend is revising the respective applications to request approval for surface water withdrawal up to a maximum (peak day) of 42 mgd and for consumptive water use up to a maximum (peak day) of 28 mgd.

Enclosure 1 documents determination of the requested maximum (peak day) surface water withdrawal of 42 mgd, as well as other water use values required in the application for surface water withdrawal. With respect to the required water use values, Enclosure 1 supersedes Attachment SW-3 to the initial application.

Abbreviations relating to plant systems used herein are:

- CWS – Circulating Water System
- CWSMWS – Circulating Water System Makeup Water System
- ESWS – Essential Service Water System
- ESWEMS – Essential Service Water Emergency Makeup System
- RWSS – Raw Water Supply System

2 General Information

All water necessary for normal and emergency use at BBNPP will be withdrawn from the Susquehanna River except for a relatively minor amount of potable and sanitary water that is expected to be supplied by the local purveyor and not addressed herein. The water withdrawn from the Susquehanna River for emergency use consists of on-site stored capacity, no water is required to be withdrawn from the Susquehanna River during an emergency.

BBNPP will have two systems that withdraw water from the Susquehanna River for BBNPP use, namely the CWSMWS and the RWSS, as depicted on Attachment A.

The CWSMWS will convey river water into a closed cooling system, which will utilize two natural draft counter-flow cooling towers (Main Cooling Towers) to remove heat from the circulating cooling water after passing through the plant's steam condenser. Evaporation is lost in the Main Cooling Towers; this loss increases the level of solids in the circulating water. To control dissolved solids, a portion of the re-circulated water will be removed (blowdown) and discharged to the river. In addition, there is a small loss for drift of the cooling tower spray. The CWSMWS provides makeup to replenish water lost by the Main Cooling Towers through evaporation, blowdown and drift.

The RWSS will supply water to the ESWS, the Demineralized Water Distribution System, the Fire Water Distribution System, Floor Wash Drains, and the RWSS filter backwash. The ESWS will feature four, closed cooling water systems. Each system will utilize a mechanical draft cooling tower with two cells to dissipate heat from the ESWS. Just as in the case of the Main

Cooling Towers, the RWSS provides makeup to ESWS to account for the cooling tower evaporation, blowdown and drift. The RWSS also supplies makeup to the ESWEMS Retention Pond to account for surface evaporative losses from the pond as needed.

In the determinations described below, consideration was given to adding an allowance for monitoring instrument accuracy, as was done in the initial applications. Allowance for monitoring instrument accuracy was intended to result in values of surface water withdrawal or consumptive water use that would not be exceeded, so long as the accuracy of the monitoring instruments remained within the required tolerance required by the Commission. However, PPL is confident that the maximum (peak day) surface water withdrawal of 42 mgd for which approval is being requested amply compensates for monitoring instrument accuracy. Accordingly, specific allowances for instrument accuracy are not included in the determinations below.

Because the amount of surface water withdrawal depends upon some plant consumptive water use, the determination of the relevant consumptive water use values is included below, for convenience. (Determinations of these and other consumptive water use values are presented in Enclosure 2.)

3 Determination of Consumptive Water Use Values Relevant to Determination of Surface Water Withdrawal

Three values of plant consumptive water use are required:
- Maximum (peak day) consumptive water use, required to determine maximum (peak day) surface water withdrawal;
- Maximum 30-day average consumptive water use, required to determine maximum 30-day average surface water withdrawal; and
- Average consumptive water use, required to determine average surface water withdrawal.

The maximum values will occur during normal (i.e., non-emergency) plant operation, at full power, during adverse climatic conditions.

There are a total of five (5) paths that consume water during normal plant operation and are relevant to the determination of surface water withdrawal. See Attachment A. These are:
- Main (CWS) Cooling Towers Evaporation
- Main (CWS) Cooling Towers Drift
- ESWS Cooling Towers Evaporation
- ESWS Cooling Towers Drift and
- ESWEMS Retention Pond Evaporation

3.1 Maximum (Peak Day) Consumptive Water Use

3.1.1 Main Cooling Towers Evaporation

The maximum (peak day) value determined from a 61-year historical meteorological record is 16,723 gallons per minute (gpm) for two towers combined. See Attachment B.

3.1.2 Main Cooling Towers Drift

The maximum daily value is 8 gpm. [Reference 5.1, Section 5.0] This value will be assumed in all cases for which consumptive water use is determined herein.

3.1.3 ESWS Cooling Towers Evaporation

The ESWS Cooling Towers evaporation that coincides with the maximum (peak day) Main Cooling Towers evaporation determined from 61 years of daily meteorological data is 480 gpm for two towers combined. See Attachment B.

3.1.4 ESWS Cooling Towers Drift

The maximum daily value is 2 gpm. [Reference 5.1, Section 5.0] This value will be assumed in all cases for which consumptive water use is determined herein.

3.1.5 ESWEMS Retention Pond Evaporation

Reference 5.4, Section 7.4 provides a calculation for water evaporation from the ESWEMS Retention Pond for worst-case meteorological conditions over a 30-day period. The result, 198,300 ft^3 is converted to gpm by

198,300 ft^3/30 days) x (7.48 gal/ft^3) x (1 gpm/1,440 gal/day) = 34.3 gpm

This value will be assumed in all cases for which consumptive water use is determined herein.

NOTE: The area of the ESWEMS Retention Pond is 247,900 ft^2. [Reference 5.4, Section 7.4] The worst-case 30-day evaporation rate is equivalent to

((198,300 ft^3/30 days) /247,900 ft^2) x 12 in/ft = 9.6 inches in 30 days.

3.2 Maximum 30-Day Average Consumptive Water Use

3.2.1 Main Cooling Towers Evaporation

The maximum 30-day average value determined from a 61-year historical meteorological record is 16,026 gpm for two towers combined. See Attachment B.

3.2.2 Main Cooling Towers Drift

The maximum value of 8 gpm is assumed. [3.1.2]

3.2.3 ESWS Cooling Towers Evaporation

The 30-day average value that coincides with the maximum 30-day average Main Cooling Towers evaporation determined from 61 years of daily meteorological data is 448 gpm. See Attachment B.

3.2.4 ESWS Cooling Towers Drift

The maximum value of 2 gpm is assumed. [3.1.4]

3.2.5 ESWEMS Retention Pond Evaporation

The maximum value of 34.3 gpm is assumed. [3.1.5]

3.3 Average Consumptive Water Use

3.3.1 Main Cooling Towers Evaporation

The average value determined from a 61-year historical meteorological record is 13,360 gpm for two towers combined. See Attachment B.

3.3.2 Main Cooling Towers Drift

The maximum value of 8 gpm is assumed. [3.1.2]

3.3.3 ESWS Cooling Towers Evaporation

The average value that coincides with the average Main Cooling Towers evaporation determined from 61 years of daily meteorological data is 324 gpm. See Attachment B.

3.3.4 ESWS Cooling Towers Drift

The maximum value of 2 gpm is assumed. [3.1.4]

3.3.5 ESWEMS Retention Pond Evaporation

The maximum value of 34.3 gpm is assumed. [3.1.5]

4 Determination of Surface Water Withdrawal

Attachment A is a schematic diagram of the water flow into, within, and from the plant, and shows the flows corresponding to the maximum (peak day) surface water withdrawal.

Four values relating to surface water withdrawal are required:
- Maximum (peak day) surface water withdrawal;
- Maximum 30-day average surface water withdrawal;
- Average surface water withdrawal (demand); and
- Withdrawal systems capability.

The maximum withdrawal for CWSMWS occurs with the plant at 100% power, worst-case meteorological conditions and a blowdown flow to maintain 3.0 cycles of dissolved solids concentration. The maximum withdrawal for RWSS occurs when the plant is shutting down. Because the maximum withdrawal scenarios for each system are mutually exclusive, i.e. 100% power cannot exist during plant shutdown, the maximum surface water withdrawal will be based on CWSMWS supporting the plant at 100% power, worst-case meteorological conditions, a blowdown flow to maintain 3.0 cycles of dissolved solids concentration (Cycles = 3.0), and the RWSS supplying loads that are expected for 100% power operation. The average surface water withdrawal is also calculated assuming continuous normal, non-emergency operation, and 3.0 cycles of dissolved solids concentration.

Blowdown from an evaporative cooling tower is calculated as:

Blowdown = Evaporation/(Cycles-1) - Drift [Reference 5.1, Section 5.0]

The total plant withdrawal is the sum of the respective CSWMWS and RWSS withdrawal values. The CSWMWS Withdrawal is equal to

Main Cooling Tower (Evaporation + Drift + Blowdown)

The RWSS Withdrawal is equal to

ESWS Cooling Tower (Evaporation + Drift + Blowdown) + the following miscellaneous uses shown on Attachment A:

Use	gpm
Makeup to ESWEMS Pond	24
RWSS Filter Backwash	91
Demineralizer Makeup	107
Fire Water Distribution System	5
Floor Wash Drains	5
Total of Miscellaneous Uses	232

Miscellaneous uses equal to 232 gpm will be assumed in all cases for which surface water withdrawal is determined herein.

4.1 Maximum (Peak Day) Surface Water Withdrawal

4.1.1 CWSMWS Withdrawal

The maximum (peak day) Main Cooling Towers evaporation is 16,723 gpm. [3.1.1]

The Main Cooling Towers drift is 8 gpm. [3.1.2]

Then, Main Cooling Towers blowdown = 16,723/(3-1) - 8 = 8,354 gpm

CWSMWS Withdrawal = Main Cooling Towers (Evaporation + Blowdown + Drift)
= 16,723 gpm + 8,354 gpm + 8 gpm
= 25,085 gpm

4.1.2 RWSS Withdrawal

The ESWS Cooling Towers evaporation that coincides with the maximum (peak day) Main Cooling Towers evaporation is 480 gpm. [3.1.3]

The ESWS Cooling Towers drift is 2 gpm. [3.1.4]

Then, ESWS Cooling Towers blowdown = 480/(3-1) -2 = 238 gpm

RWSS Withdrawal = ESWS Cooling Towers (Evaporation + Blowdown + Drift) + Miscellaneous Uses
= 480 gpm + 238 gpm + 2 gpm + 232 gpm = 952 gpm
The maximum (peak day) surface water withdrawal is then
25,085 gpm + 952 gpm =26,037 gpm = 37.5 mgd.

4.2 Maximum 30-Day Average Surface Water Withdrawal

4.2.1 CWSMWS Withdrawal

The maximum 30-day average Main Cooling Towers evaporation is 16,026 gpm. [3.2.1]

The Main Cooling Towers drift is 8 gpm. [3.1.2]

Then, Main Cooling Towers blowdown = 16,026/(3-1) - 8 = 8,005 gpm

CWSMWS Withdrawal = Main Cooling Towers (Evaporation + Blowdown + Drift)
= 16,026 gpm + 8,005 gpm + 8 gpm = 24,039 gpm

4.2.2 RWSS Withdrawal

The ESWS Cooling Towers evaporation that coincides with the maximum 30-day average Main Cooling Towers evaporation is 448 gpm. [3.2.3]

The ESWS Cooling Towers drift is 2 gpm. [3.1.4]

Then, ESWS Cooling Towers blowdown = 448/(3-1) -2 = 222 gpm

RWSS Withdrawal = ESWS Cooling Towers (Evaporation + Blowdown + Drift) + Miscellaneous Uses
= 448 gpm + 222 gpm + 2 gpm + 232 gpm = 904 gpm

The maximum 30-day average surface water withdrawal is then:
24,039 gpm + 904 gpm = 24,943 gpm = 35.9 mgd.

4.3 Average Surface Water Withdrawal

4.3.1 CWSMWS Withdrawal

The average Main Cooling Tower evaporation value determined from a 61-year historical meteorological record is 13,360 gpm for two towers combined. [3.3.1]

The Main Cooling Towers drift is 8 gpm. [3.1.2]

Then, Main Cooling Towers blowdown = 13,360/(3-1) - 8 = 6,672 gpm

CWSMWS Withdrawal = Main Cooling Towers (Evaporation + Blowdown + Drift)
= 13,360 gpm + 6,672 gpm + 8 gpm
= 20,040 gpm

4.3.2 RWSS Withdrawal

The average ESWS Cooling Towers evaporation value determined from a 61-year historical meteorological record is 324 gpm for two towers combined. [3.3.3]

The ESWS Cooling Towers drift is 2 gpm. [3.1.4]

Then, ESWS Cooling Towers blowdown = 324/(3-1) -2 = 160 gpm

RWSS Withdrawal = ESWS Cooling Towers (Evaporation + Blowdown + Drift) + Miscellaneous Uses
= 324 gpm + 160 gpm + 2 gpm + 232 gpm = 718 gpm

The average surface water withdrawal is then:
20,040 gpm + 718 gpm =20,758 gpm = 29.9 mgd.

4.4 Withdrawal Systems Capability

The CWSMWS has three (3) 50% capacity vertical pumps each rated 13,100 gpm @ 182 psi. [Reference 5.2, Section 4.3.2] Expected normal operation is two pumps in service.

The RWSS has three (3) pumps each rated 2,900 gpm @ 552 ft TDH. [Reference 5.3, Section 6] The number of pumps in service will be dependent on the mode of the plant. During normal operation one pump in service will be sufficient to handle the load.

No scenario is envisioned during which simultaneous pump operation would exceed the combined capacity of two CWSMWS pumps and one RWSS pump. Thus, the maximum instantaneous surface water withdrawal is equal to:

2 x 13,100 gpm + 2,900 gpm = 29,100 gpm = 41.9 mgd

Since the maximum instantaneous surface water withdrawal based on maximum pump operation (41.9 mgd) exceeds the calculated maximum (peak day) surface water withdrawal (37.5 mgd), approval for the maximum instantaneous surface water withdrawal rounded up to 42 mgd from 41.9 mgd is being requested.

5 References

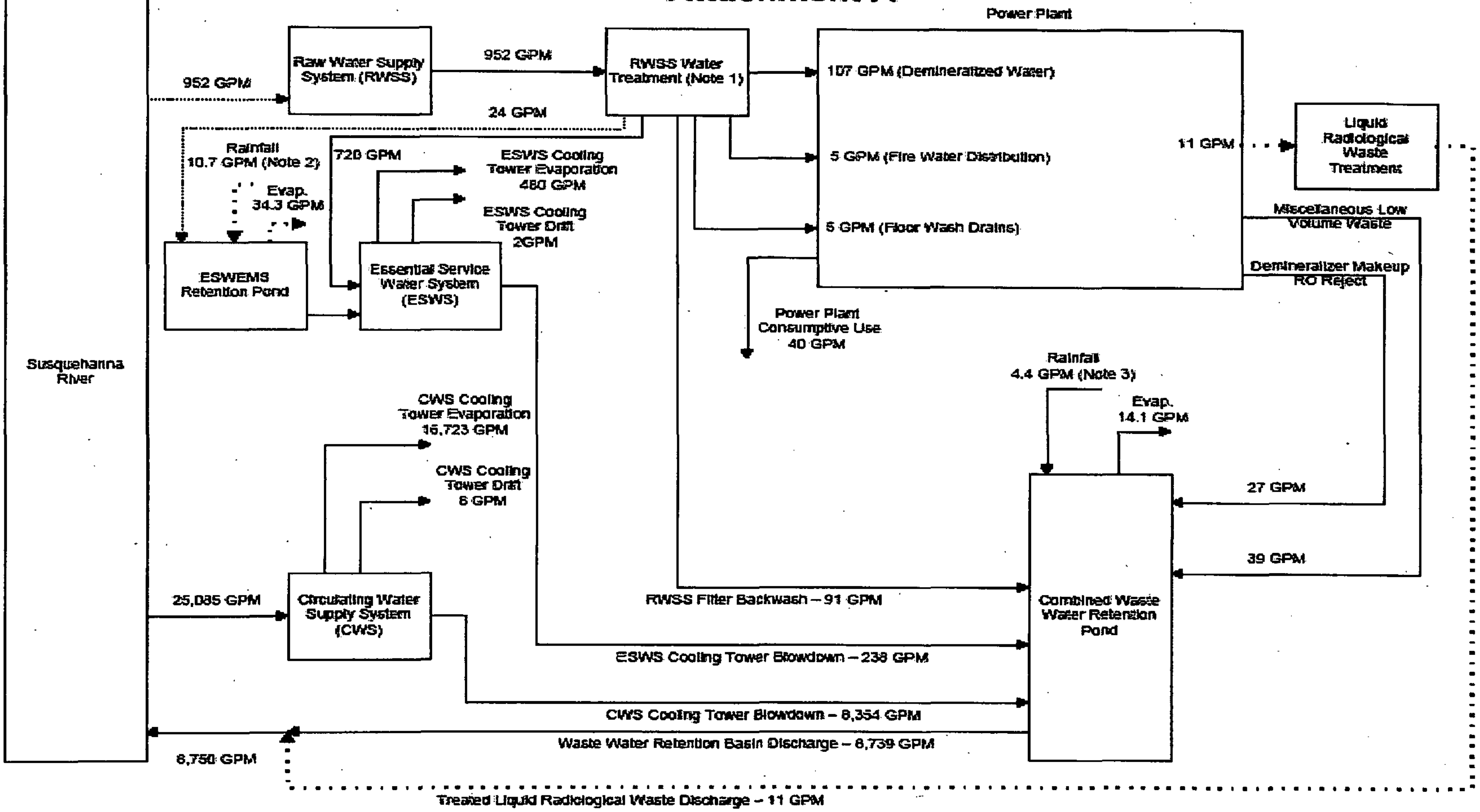
5.1 Sargent & Lundy Calculation 2008-08550, Rev. 3, Bell Bend Water Balance Calculation

5.2 Sargent & Lundy Report No. SL-009498, Rev. 6, Conceptual Design of the CWS Pump and Pipe Sizing Calculation

5.3 Sargent & Lundy Calculation No. 2008-07916, Rev. 6, RWSS Pump and Pipe Sizing

5.4 Black & Veatch Calculation 161642.51.2001, Rev. 1, ESWEMS Retention Pond Sizing

Attachment A



NOTES:
1. Dual media filtration.
2. Based on an annual precipitation of 36.25 inches (BBNPP ER Table 2.7-50) and pond surface area 248,533 sq.ft. (B&V Calculation 161642.51.2001 Rev. 1, Section 6.3)
3. Base on an annual precipitation of 36.25 inches (BBNPP ER Table 2.7-50) and pond surface area 101,500 sq.ft. (S&L Report SL-009498 Bell Bend Nuclear Power Plant Rev.6)
4. Process flow values are rounded to the nearest whole value.

LEGEND:

Normal Flows
Flow Varies
DBA Shutdown Flow

BELL BEND NUCLEAR POWER PLANT
PEAK DAY WATER USE DIAGRAM

Attachment B

Determination of BBNPP Cooling Tower Evaporation Rates

BBNPP will have two types of evaporative cooling towers. There will be two Circulating Water System (Main) cooling towers and four Essential Service Water System (ESWS) cooling towers. During normal plant operation, both Main cooling towers and two ESWS cooling towers will be in service.

The Main cooling towers will be natural draft towers, each with a design water flow of 360,000 gpm and a design cooling range of 27.56 F degrees. A cooling tower manufacturer has provided a diagram relating expected evaporation rate (per tower) to relative humidity (RH) and wet-bulb temperature (WBT) corresponding to the design water flow and cooling range. The diagram depicts four curves of evaporation rate; the four curves represent RH values of 25, 50, 75 and 100 percent respectively, and each curve spans WBT values ranging from 30 to 90 degrees F.

The ESWS cooling towers will be mechanical draft towers, each with a design water flow of 19,200 gpm and a cooling range of 13.4 F degrees during normal operation. A cooling tower manufacturer has provided several diagrams relating expected evaporation rate (per tower) to cooling range, RH and WBT corresponding to a water flow of 19,000 gpm. (The evaporation rates determined as described below were adjusted to represent the design water flow of 19,200 gpm.) The several diagrams each represent a selected RH value from 28 to 72 percent; each diagram depicts two curves, one for each of two selected cooling ranges, and each curve spans WBT values ranging from 30 to 70 degrees F.

Daily average RH and WBT values for the meteorological station at Wilkes-Barre were obtained for the 61-year period January 1949 through December 2009. (The daily record is approximately 99 percent complete for this period.) Daily in-plant consumptive water use was simulated by an Excel spreadsheet prepared for this purpose; normal, full-load plant operation each day during the simulation period was assumed. The spreadsheet includes algorithms to determine daily Main cooling tower evaporation and daily ESWS cooling tower evaporation as a function of daily average RH and WBT; the algorithms were derived by interpolation and extrapolation from the respective cooling tower evaporation curves provided by the manufacturers.

Table A-1 on the following page presents the cooling tower evaporation rates cited in the Main Report, as determined by the spreadsheet simulation, along with the corresponding dates and average RH and WBT values. It is important to note that the maximum evaporation rates for the Main and the ESWS cooling towers do not occur at the same RH and WBT conditions. Maximum in-plant consumptive use coincides with maximum Main cooling tower evaporation; accordingly, the ESWS cooling tower evaporation rates for the peak day and maximum 30-day average as presented in Table A-1 are slightly less than the corresponding maximum rates for the ESWS cooling towers alone.

Table A-1. BBNPP Cooling Tower Evaporation Rates Cited in Enclosure 1

Condition		Date(s)	RH (%)	WBT (deg F)	Cooling Tower	Evaporation Rate (gpm, total two towers)
1	Peak Day	July 15, 1995	66.2	77.8	Main	16,723
					ESWS	480
2	Maximum 30-day average	July 8 through August 6, 1955	62.2 [1]	67.1 [1]	Main	16,026
					ESWS	448
3	Daily Average	January 1949 through December 2009	69.3 [1]	44.4 [1]	Main	13,360
					ESWS	324

[Note 1] The average RH and WBT values for the maximum 30-day average and 61-year average conditions are presented for reference. The evaporation rates presented in the table are the averages of the simulated daily evaporation rates during the respective periods rather than the evaporation rates corresponding to the average RH and WBT values during the period.

Enclosure 2

Determination of Consumptive Water Use

Contents

PPL Bell Bend, LLC
Bell Bend Nuclear Power Plant
Determination of Consumptive Water Use

1 Introduction

The initial applications to SRBC (May 2009) requested approval for surface water withdrawal up to a maximum (peak day) of 44 mgd and for consumptive water use up to a maximum (peak day) of 31 mgd. Based on currently available information, PPL Bell Bend has re-determined the surface water withdrawal and consumptive water use values. Consequently, PPL Bell Bend is revising the respective applications to request approval for surface water withdrawal up to a maximum (peak day) of 42 mgd and for consumptive water use up to a maximum (peak day) of 28 mgd.

Enclosure 2 documents determination of the requested maximum (peak day) consumptive water use of 28 mgd, as well as other water use values required in the application for consumptive water use. With respect to the required water use values, Enclosure 2 supersedes Attachment CU-3 to the initial application.

Abbreviations relating to plant systems used herein are:

- CWS – Circulating Water System
- CWSMWS – Circulating Water System Makeup Water System
- ESWS – Essential Service Water System
- ESWEMS – Essential Service Water Emergency Makeup System
- RWSS – Raw Water Supply System

2 General Information

All water necessary for normal and emergency use at BBNPP will be withdrawn from the Susquehanna River except for a relatively minor amount of potable and sanitary water that is expected to be supplied by the local purveyor and not addressed herein. The water withdrawn from the Susquehanna River for emergency use consists of on-site stored capacity, no water is required to be withdrawn from the Susquehanna River during an emergency.

BBNPP will have two systems that withdraw water from the Susquehanna River for BBNPP use, namely the CWSMWS and the RWSS, as depicted on Attachment A.

The CWSMWS will convey river water into a closed cooling system, which will utilize two natural draft counter-flow cooling towers (Main Cooling Towers) to remove heat from the circulating cooling water after passing through the plant's steam condenser. Evaporation is lost in the Main Cooling Towers; this loss increases the level of solids in the circulating water. To control dissolved solids, a portion of the re-circulated water will be removed (blowdown) and discharged to the river. In addition, there is a small loss for drift of the cooling tower spray. The CWSMWS provides makeup to replenish water lost by the Main Cooling Towers through evaporation, blowdown and drift.

The RWSS will supply water to the ESWS, the Demineralized Water Distribution System, the Fire Water Distribution System, Floor Wash Drains, and the RWSS filter backwash. The ESWS will feature four, closed cooling water systems. Each system will utilize a mechanical draft cooling tower with two cells to dissipate heat from the ESWS. Just as in the case of the Main

Cooling Towers, the RWSS provides makeup to ESWS to account for the cooling tower evaporation, blowdown and drift. The RWSS also supplies makeup to the ESWEMS Retention Pond to account for surface evaporative losses from the pond as needed.

In the determinations described below, consideration was given to adding an allowance for monitoring instrument accuracy, as was done in the initial applications. Allowance for monitoring instrument accuracy was intended to result in values of surface water withdrawal or consumptive water use that would not be exceeded, so long as the accuracy of the monitoring instruments remained within the required tolerance required by the Commission. However, PPL is confident that the maximum (peak day) consumptive water use of 28 mgd for which approval is being requested amply compensate for monitoring instrument accuracy. Accordingly, specific allowances for instrument accuracy are not included in the determinations below.

3 Determination of Consumptive Water Use

Two values of plant consumptive water use are required: maximum (peak day) consumptive water use; and maximum 30-day average consumptive water use. These maximum values will occur during normal (i.e., non-emergency) plant operation, at full power, during adverse climatic conditions.

There are a total of seven (7) paths that consume water during normal plant operation. See Attachment A. These are:

- Main (CWS) Cooling Towers Evaporation
- Main (CWS) Cooling Towers Drift
- ESWS Cooling Towers Evaporation
- ESWS Cooling Towers Drift
- ESWEMS Retention Pond Evaporation
- Combined Waste Water Retention Basin Evaporation and
- Power Plant Consumptive Use

In addition to the above values an allowance will be added for in-river evaporation from the BBNPP blowdown discharge at the river diffuser.

The maximum daily value for each path and allowance for in-river evaporation are provided below either by reference or by calculation, and then the values are summed to determine a maximum daily consumptive use.

3.1 Maximum (Peak Day) Consumptive Water Use

3.1.1 Main Cooling Towers Evaporation

The maximum (peak day) value determined from a 61-year historical meteorological record is 16,723 gallons per minute (gpm) for two towers combined. See Attachment B.

3.1.2 Main Cooling Towers Drift

The maximum daily value is 8 gpm. [Reference 5.2, Section 5.0] This value will be assumed in all cases for which consumptive water use is determined herein.

3.1.3 ESWS Cooling Towers Evaporation

The ESWS Cooling Towers evaporation that coincides with the maximum (peak day) Main Cooling Towers evaporation determined from 61 years of daily meteorological data is 480 gpm for two towers combined. See Attachment B.

3.1.4 ESWS Cooling Towers Drift

The maximum daily value is 2 gpm. [Reference 5.2, Section 5.0] This value will be assumed in all cases for which consumptive water use is determined herein.

3.1.5 ESWEMS Retention Pond Evaporation

Reference 5.5, Section 7.4 provides a calculation for water evaporation from the ESWEMS Retention Pond for worst-case meteorological conditions over a 30-day period. The result, 198,300 ft^3 is converted to gpm by

$$198{,}300\ ft^3/30\ days) \times (7.48\ gal/ft^3) \times (1\ gpm/1440\ gal/day) = 34.3\ gpm$$

This value will be assumed in all cases for which consumptive water use is determined herein.

NOTE: The area of the ESWEMS Retention Pond is 247,900 ft^2. [Reference 5.5, Section 7.4] The worst-case 30-day evaporation rate is equivalent to

$$((198{,}300\ ft^3/30\ days)\ /247{,}900\ ft^2) \times 12\ in/ft = 9.6\ inches\ in\ 30\ days.$$

3.1.6 Combined Waste Water Retention Basin Evaporation

Evaporation for this basin can be determined from the ESWEMS Retention Pond evaporation rate above based on the ratio of surface areas. The surface area for the Combined Waste Water Retention Basin is 102,000 ft^2. [Reference 5.3, Section 4.7] The evaporative loss from the Combined Waste Water Retention Basin is then

$$(102{,}000\ ft^2/247{,}900\ ft^2) \times 34.3\ gpm = 14.1\ gpm$$

This value will be assumed in all cases for which consumptive water use is determined herein.

3.1.7 Power Plant Consumptive Use

Maximum daily value is 40 gpm. [Reference 5.1, Figure 3.3-1] This value will be assumed in all cases for which consumptive water use is determined herein.

3.1.8 Allowance for In-River Evaporation

Attachment D [replicated from Reference 5.6] presents the calculation of in-river evaporation at BBNPP; the methodology used is explained in Attachment C [replicated from Reference 5.6]. The calculated maximum monthly in-river evaporation in Attachment D is 88,000 gallons per day, or 61.1 gpm. Although in-river evaporation at a rate of 61.1 gpm is unlikely to coincide with maximum plant consumptive water use, this value will be assumed in all cases for which consumptive water use is determined herein.

The calculated maximum (peak day) consumptive water use is thus 17,363 gpm without allowance for monitoring instrument accuracy, as follows:

Path/Allowance	gpm
Main Cooling Tower Evaporation	16,723
Main Cooling Tower Drift	8
ESWS Cooling Towers Evaporation	480
ESWS Cooling Towers Drift	2
ESWEMS Retention Pond Evaporation	34.3
Combined Waste Water Retention Pond Evaporation	14.1
Power Plant Consumptive Use	40
In-River Evaporation	61.1
TOTAL	17, 363

The calculated maximum consumptive water use of 17,363 gpm is equal to 25.0 mgd. PPL is applying for approval of consumptive water use up to 28 mgd to provide an adequate margin for monitoring instrument accuracy or any other unforeseen condition that could result in monitored consumptive water use exceeding the calculated maximum of 25.0 mgd.

3.2 Maximum 30-Day Average Consumptive Water Use

3.2.1 Main Cooling Towers Evaporation

The maximum 30-day average value determined from a 61-year historical meteorological record is 16,026 gpm for two towers combined. See Attachment B.

3.2.2 Main Cooling Towers Drift

The maximum value of 8 gpm is assumed. [3.1.2]

3.2.3 ESWS Cooling Towers Evaporation

The 30-day average value that coincides with the maximum 30-day average Main Cooling Towers evaporation determined from 61 years of daily meteorological data is 448 gpm. See Attachment B.

3.2.4 ESWS Cooling Towers Drift

The maximum value of 2 gpm is assumed. [3.1.4]

3.2.5 ESWEMS Retention Pond Evaporation

The maximum value of 34.3 gpm is assumed. [3.1.5]

3.2.6 Combined Waste Water Retention Basin Evaporation

The maximum value of 14.1 gpm is assumed. [3.1.6]

3.2.7 Power Plant Consumptive Use

The maximum value of 40 gpm is assumed. [3.1.7]

3.2.8 Allowance for In-River Evaporation

The maximum value of 61.1 gpm is assumed. [3.1.8]

The calculated maximum 30-day average consumptive water use is thus 16,634 gpm without allowance for monitoring instrument accuracy, as follows:

Path/Allowance	gpm
Main Cooling Tower Evaporation	16,026
Main Cooling Tower Drift	8
ESWS Cooling Towers Evaporation	448
ESWS Cooling Towers Drift	2
ESWEMS Retention Pond Evaporation	34.3
Combined Waste Water Retention Pond Evaporation	14.1
Power Plant Consumptive Use	40
In-river Evaporation	61.1
TOTAL	16,634

The calculated maximum 30-day average consumptive water use of 16,634 gpm is equal to 24.0 mgd.

4 Maximum Daily Total Withdrawal

The maximum surface water withdrawal being requested is based upon the capability of the withdrawal systems. CWSMWS has three (3) 50% capacity vertical pumps each rated 13,100 gpm @ 182 psi. [Reference 5.2, Section 4.3.2] Expected normal operation is two pumps in service.

The RWSS has three (3) pumps each rated 2,900 gpm @ 552 ft TDH. [Reference 5.3, Section 6] The number of pumps in service will be dependent on the mode of the plant. During normal operation one pump in service will be sufficient to handle the load.

No scenario is envisioned during which simultaneous pump operation would exceed the combined capacity of two CWSMWS pumps and one RWSS pump. Thus, the maximum daily surface water withdrawal is equal to:

$$2 \times 13{,}100 \text{ gpm} + 2{,}900 \text{ gpm} = 29{,}100 \text{ gpm} = 41.9 \text{ mgd}$$

Approval for a maximum instantaneous surface water withdrawal rounded up to 42 mgd from 41.9 mgd is being requested.

5 References

5.1 BBNPP Environmental Report, Revision 2

5.2 Sargent & Lundy Calculation 2008-08550, Rev. 3, Bell Bend Water Balance Calculation

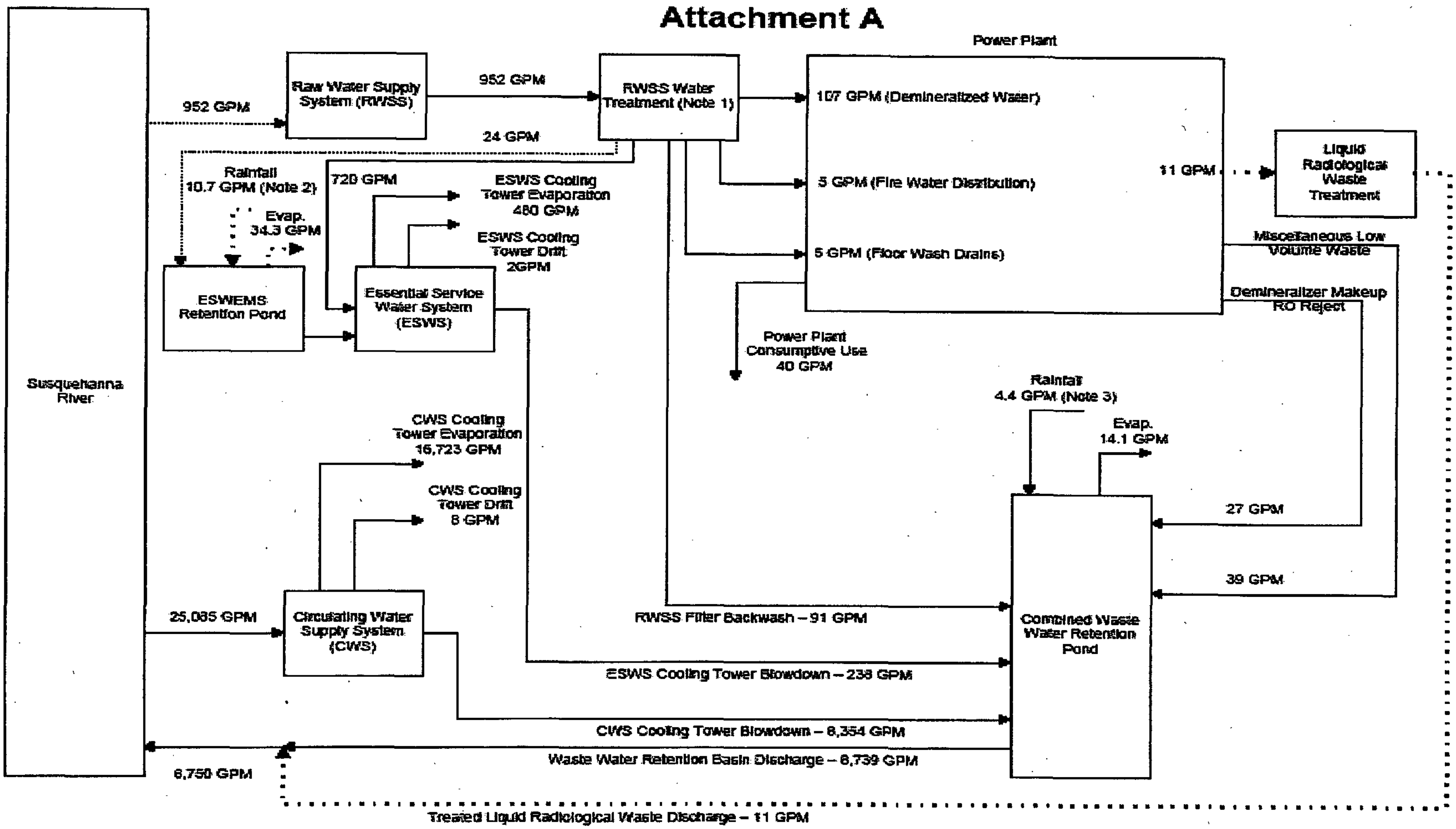
5.3 Sargent & Lundy Report No. SL-009498, Rev. 6, Conceptual Design of the CWS Pump and Pipe Sizing Calculation

5.4 Sargent & Lundy Calculation No. 2008-07916, Rev. 6, RWSS Pump and Pipe Sizing

5.5 Black & Veatch Calculation 161642.51.2001, Rev. 1, ESWEMS Retention Pond Sizing

5.6 Water Monitoring Plan for Bell Bend Nuclear Power Plant submitted by letter BNP-2010-164 to the SRBC July 8, 2010.

Attachment A



NOTES:
1. Dual media filtration.
2. Based on an annual precipitation of 36.25 inches (BBNPP ER Table 2.7-50) and pond surface area 248,533 sq.ft. (B&V Calculation 161642.51.2001 Rev. 1, Section 6.3)
3. Base on an annual precipitation of 36.25 inches (BBNPP ER Table 2.7-50) and pond surface area 101,500 sq.ft. (S&L Report SL-009498 Bell Bend Nuclear Power Plant Rev.6)
4. Process flow values are rounded to the nearest whole value.

LEGEND:
Normal Flows
Flow Varies
DBA Shutdown Flow

BELL BEND NUCLEAR POWER PLANT
PEAK DAY WATER USE DIAGRAM

Attachment B

Determination of BBNPP Cooling Tower Evaporation Rates

BBNPP will have two types of evaporative cooling towers. There will be two Circulating Water System (Main) cooling towers and four Essential Service Water System (ESWS) cooling towers. During normal plant operation, both Main cooling towers and two ESWS cooling towers will be in service.

The Main cooling towers will be natural draft towers, each with a design water flow of 360,000 gpm and a design cooling range of 27.56 F degrees. A cooling tower manufacturer has provided a diagram relating expected evaporation rate (per tower) to relative humidity (RH) and wet-bulb temperature (WBT) corresponding to the design water flow and cooling range. The diagram depicts four curves of evaporation rate; the four curves represent RH values of 25, 50, 75 and 100 percent respectively, and each curve spans WBT values ranging from 30 to 90 degrees F.

The ESWS cooling towers will be mechanical draft towers, each with a design water flow of 19,200 gpm and a cooling range of 13.4 F degrees during normal operation. A cooling tower manufacturer has provided several diagrams relating expected evaporation rate (per tower) to cooling range, RH and WBT corresponding to a water flow of 19,000 gpm. (The evaporation rates determined as described below were adjusted to represent the design water flow of 19,200 gpm.) The several diagrams each represent a selected RH value from 28 to 72 percent; each diagram depicts two curves, one for each of two selected cooling ranges, and each curve spans WBT values ranging from 30 to 70 degrees F.

Daily average RH and WBT values for the meteorological station at Wilkes-Barre were obtained for the 61-year period January 1949 through December 2009. (The daily record is approximately 99 percent complete for this period.) Daily in-plant consumptive water use was simulated by an Excel spreadsheet prepared for this purpose; normal, full-load plant operation each day during the simulation period was assumed. The spreadsheet includes algorithms to determine daily Main cooling tower evaporation and daily ESWS cooling tower evaporation as a function of daily average RH and WBT; the algorithms were derived by interpolation and extrapolation from the respective cooling tower evaporation curves provided by the manufacturers.

Table A-1 on the following page presents the cooling tower evaporation rates cited in the Main Report, as determined by the spreadsheet simulation, along with the corresponding dates and average RH and WBT values. It is important to note that the maximum evaporation rates for the Main and the ESWS cooling towers do not occur at the same RH and WBT conditions. Maximum in-plant consumptive use coincides with maximum Main cooling tower evaporation; accordingly, the ESWS cooling tower evaporation rates for the peak day and maximum 30-day average as presented in Table A-1 are slightly less than the corresponding maximum rates for the ESWS cooling towers alone.

Table A-1. BBNPP Cooling Tower Evaporation Rates Cited in Enclosure 1

Condition		Date(s)	RH (%)	WBT (deg F)	Cooling Tower	Evaporation Rate (gpm, total two towers)
1	Peak Day	July 15, 1995	66.2	77.8	Main	16,723
					ESWS	480
2	Maximum 30-day average	July 8 through August 6, 1955	62.2 [1]	67.1 [1]	Main	16,026
					ESWS	448
3	Daily Average	January 1949 through December 2009	69.3 [1]	44.4 [1]	Main	13,360
					ESWS	324

[Note 1] The average RH and WBT values for the maximum 30-day average and 61-year average conditions are presented for reference. The evaporation rates presented in the table are the averages of the simulated daily evaporation rates during the respective periods rather than the evaporation rates corresponding to the average RH and WBT values during the period.

Attachment C

Methodology to Calculate In-River Evaporation

[Attachment C replicates Attachment 3 to the Water Monitoring Plan for Bell Bend Nuclear Power Plant submitted to the Commission on July 8, 2010]

The owners of electric generating facilities in the Delaware and Susquehanna river basins have estimated in-stream evaporation induced by thermal discharge using a method developed in the 1960s by Edinger and Geyer. [1 2 3] The "Edinger-Geyer Method" is employed to determine a coefficient of evaporation ("C") in cfs (alternatively, MGD) per billion Btu/hr of heat rejected by the plant or unit. The ambient parameters used in the method are the temperature of the receiving water body, the dew point temperature and the wind speed. Typically, long-term average monthly values for these parameters are used to determine a value of "C" for each month of the year. The average evaporation for each month is determined as the product of the plant/unit full-load heat rejection rate, the plant/unit capacity factor for the month, and the monthly "C" value.

The method is as follows, where:

C - consumptive water use (cfs per 10^9 Btu/hr)

T_d - dew point temperature (°F)

T_s - background temperature of receiving stream (°F, assumed surface)

U - wind speed (miles per hr)

L - latent heat of vaporization of water at T_s (Btu per lb)

B - slope of saturated water vapor pressure curve between T_d and T_s (mmHg per °F)

K - surface heat exchange coefficient (Btu ft $^{-2}$ day $^{-1}$ °F $^{-1}$)

Monthly average values of T_d, T_s and U are obtained from long-term data.

L depends upon T_s and may be determined from a table of water properties or approximated as

$L = 1093.9 - 0.566T_s$

B, K and C are calculated as:

$B = 0.255 - 0.0085T + 0.000204T^2$ (mmHg per °F)

where $T = (T_s + T_d)/2$ (°F)

[1] Edinger, J.E. and J.C. Geyer, "Heat Exchange in the Environment," Edison Electric Institute, Publication NO. 65-902, 1965

[2] Helwig, D.R., "An Overview of Heat Rejection from Electric Generating Facilities," presentation to the SRBC on behalf of Susquehanna River Basin Electric Utilities Group, 1975

[3] Technical Support Document - Calculation of Evaporative Water Loss from Steam Electric Plants Located in the Delaware River Basin," Delaware River Basin Electric Utilities Group, 1986

$K = 15.7 + (B+0.26) \times f(W)$ (Btu ft $^{-2}$ day $^{-1}$ °F $^{-1}$)

where $f(W) = 70 + 0.7U^2$ (Btu ft $^{-2}$ day $^{-1}$ mmHg $^{-1}$)

$C = (4450/L) \times B \times (K-15.7)/((0.26 + B) \times K)$ (cfs per 10^9 Btu/hr)

Alternatively, $C = (2880/L) \times B \times (K-15.7)/((0.26 + B) \times K)$ (MGD per 10^9 Btu/hr)

Attachment D

Calculation of In-River Evaporation at BBNPP

[Attachment D replicates Attachment 4 to the Water Monitoring Plan for Bell Bend Nuclear Power Plant submitted to the Commission on July 8, 2010]

Ambient Data

Available monthly average ambient meteorological and river water temperature data tabulated below were used in the calculation.

Parameter	Available each month during 1977 through 2007 except as noted	Data site
Wet-bulb temperature	excludes Jul-Sep 1988	Wilkes-Barre weather station
Relative humidity	excludes Jul-Sep 1988	Wilkes-Barre weather station
River water temperature	excludes Aug 2003-Jan 2004 and Aug 2007-Dec 2007	Susquehanna SES
Dew point temperature	excludes Oct-Dec 2007	Wilkes-Barre weather station
Wind speed	excludes Oct-Dec 2007	Wilkes-Barre weather station

These data allowed estimated in-river evaporation to be calculated for ambient conditions during each month of the following periods: January 1977 through June 1988; October 1988 through July 2003; and February 2004 through July 2007.

Circulating Water System (CWS) Cooling Tower Blowdown Flow Rate (gpm)

The monthly average CWS full-power cooling tower blowdown flow was estimated as follows:

1. CWS cooling tower evaporation rate (gpm) was derived from manufacturer evaporation curves[4] according to monthly average wet-bulb temperature (WBT) and relative humidity (RH). The evaporation curves were replicated mathematically in a spreadsheet to facilitate derivation of the evaporation rates.
2. Blowdown flow rate (gpm) was calculated as evaporation rate divided by the difference between assumed cycles of concentration (CC) and unity. CC was assumed in all months to be 3.0. The result for each month:

   Monthly average blowdown flow rate = monthly average evaporation rate / 2

Total Plant Blowdown Flow Rate (gpm)

The total plant blowdown flow rate (gpm) was considered to be the estimated CWS cooling tower blowdown flow rate plus a constant additional flow rate of 724 gpm. The 724 gpm is the estimated normal operations peak day flow rate from other plant systems:

- Essential Service Water System cooling tower blowdown (567 gpm)
- Raw Water Supply System water treatment filter backwash (91 gpm)
- Miscellaneous Low Volume Waste flow (39 gpm)
- Demineralizer Makeup Reverse Osmosis reject flow (27 gpm)

Intermittent water treatment flow (11 gpm) is not included.

CWS Cooling Tower Blowdown Temperature (deg F)

[4] SPX Cooling Tower Co., "TRACS Version 18-SEP-08, Cooling Tower Model 8500 202-5.3-324," 100% design flow rate, April 2, 2010.

1. CWS cold-water temperature was derived from manufacturer cold-water temperature curves[5] according to monthly average WBT and RH. The cold-water temperature curves were replicated mathematically in a spreadsheet to facilitate derivation of the cold-water temperatures. The curves are linear and correspond to WBT ranging from 60 deg F to 80 deg F; the curves were assumed to extend linearly in both directions outside that WBT range.
2. CWS blowdown temperature was assumed to be equal to the cold-water temperature.

Total Plant Blowdown Temperature (deg F)
The CWS cooling tower blowdown temperature was assumed to be the temperature of the total plant blowdown to the river.

Heat Rejection Rate (billion Btu per hour)
The heat rejection rate to the river (HRR, 10^9 Btu/hr) was calculated as the product of (a) the total plant blowdown flow rate and (b) the difference between the total plant blowdown temperature and the river water temperature, adjusted for units:

HRR (10^9 Btu/hr) = 8.34 x blowdown flow rate (gpm) x 60
x (blowdown temperature – river water temperature) (deg F) / 10^9, or
HRR (10^9 Btu/hr) = 0.0000005 x blowdown flow rate (gpm)
x (blowdown temperature – river water temperature) (deg F)

HRR was assumed equal to zero when river water temperature exceeded blowdown temperature.

In-River Evaporation Rate (gpd)
The estimated monthly average in-river evaporation rate was calculated in accordance with the methodology in Attachment 3, corresponding to monthly average ambient river water temperature, dew point temperature and wind speed.

Back-up In-River Evaporation Rates (gpd)
The estimated in-river evaporation rates corresponding to full-power operation for ambient conditions of 1977 through 2007 are tabulated on the following page. The back-up in-river evaporation rates in Attachment 2 are the maximum monthly rates shown in the table, for each month.

Conservatism of Estimated Amounts
The estimated in-river evaporation rates are considered to be conservative (high) for the following reasons:

- 3.0 cycles of concentration (CC) were assumed in calculating the CWS cooling tower blowdown flow rate. Average CC values over periods as long as one month are always expected to exceed 3.0, resulting in reduced blowdown flow rates compared to the calculated rates.
- The assumed additional blowdown flow from non-CWS systems is a peak-day flow.
- The small effect of CWS cooling tower drift in reducing derived blowdown flow was disregarded.
- The effect of river water make-up temperature in reducing CWS cooling tower blowdown temperature was disregarded.
- The loss of heat in the blowdown flow in transit from the plant via the Waste Water Retention Pond to the river was disregarded.

[5] SPX Cooling Tower Co., "TRACS Version 18-SEP-08, Cooling Tower Model 8500 202-5.3-324," 100% design flow rate, November 24, 2008.

Table to Attachment 4. Estimated monthly maximum, average and minimum in-river evaporation (gpd) for ambient meteorological data and river water temperatures from 1977 through 2007.

Month	Maximum Month	Average Month	Minimum Month	Years	Notes
Jan	69,000	47,000	26,000	30	excludes 2004
Feb	70,000	50,000	28,000	31	
Mar	68,000	60,000	48,000	31	
Apr	88,000	64,000	44,000	31	
May	75,000	52,000	33,000	31	
Jun	66,000	32,000	0	31	
Jul	42,000	17,000	0	30	excludes 1988
Aug	42,000	16,000	0	28	excludes 1988, 2003, 2007
Sep	44,000	31,000	14,000	28	excludes 1988, 2003, 2007
Oct	60,000	48,000	28,000	29	excludes 2003, 2007
Nov	67,000	57,000	46,000	29	excludes 2003, 2007
Dec	62,000	51,000	32,000	29	excludes 2003, 2007

T.L. Harpster
VP-Bell Bend Project Development

PPL Nuclear Development, LLC
Two North Ninth Street
Allentown, PA 18101-1179
Tel. 610.774.5996 Fax 610.774.2618
tlharpster@pplweb.com

June 28, 2011

Mr. James Richenderfer, Ph.D., P.G.
Director, Technical Programs
Susquehanna River Basin Commission
1721 North Front Street
Harrisburg, PA 17102-2391

BELL BEND NUCLEAR POWER PLANT
APPLICATION FOR AQUIFER TEST PLAN WAIVER
BNP-2011-125 Docket No. 52-039

PPL Bell Bend, LLC (PPL) anticipates the submission of a groundwater withdrawal application by December 31, 2011 associated with the planned installation of temporary dewatering wells to facilitate the construction of an Essential Service Water Emergency Make-up Supply (ESWEMS) pond as part of the above referenced project. In accordance with Commission regulations, PPL respectfully requests Commission consideration of the attached Application for Aquifer Test Plan Waiver. An application fee in the amount of $3,380.00 is also enclosed.

As described in the attached application, the ESWEMS pond is a safety related project feature that requires founding on competent bedrock. Pond construction is expected to take approximately two years and will require excavation to bedrock and subsequent backfilling of the excavation with structural fill. This work must be accomplished in the dry, and as a result will require the installation of temporary dewatering wells. Due to the proximity of the pond to on-site wetlands, PPL is proposing to construct a slurry wall around the excavation zone in order to limit the potential effects of planned well pumping. The anticipated pumping rate for the initial dewatering of the excavation area is estimated to be 715 gpm (1.0 mgd). After initial dewatering, the steady state pumping rate is estimated to be 350 gpm (0.5 mgd)

PPL has completed extensive on-site investigations and a modeling analysis that has determined that drawdown associated with the proposed pumping will be limited to within the PPL project boundary. PPL has also developed a construction dewatering mitigation plan to minimize potential impacts to on-site wetlands. This plan includes an extensive monitoring and irrigation plan during the planned period of construction.

For reasons as stated in the attached application PPL believes that a waiver of Commission aquifer test requirements is justified. Commission consideration of this application is requested on a timely basis. Should you have any questions regarding the attached request please contact Gary Petrewski of my staff at 610-774-5996, or by e-mail at gpetrewski@pplweb.com.

Sincerely,

Terry L. Harpster

TH/cw

Enclosures
1) Application for Aquifer Test Plan Waiver
2) Application Fee

cc: (w/ Enclosure 1 only)

Ms. Stacey Imboden
Senior Project Manager
U.S. Nuclear Regulatory Commission
11545 Rockville Pike
Rockville, MD 20852

Ms. Jamie Davis
Office of Environmental Programs (3EA30)
U.S. Environmental Protection Agency
1650 Arch Street
Philadelphia, PA 19103-2029

Mr. Tom Shervinskie
Pa Fish & Boat Commission
450 Robinson Lane
Bellefonte, PA 16823

Ms. Jennifer Kagel
United States Fish & Wildlife Service
Pennsylvania Field Office
315 S. Allen St. #322
State College, PA 16801

Mr. Eugene Trowbridge
Pa Dept Environmental Resources
Northeast Regional Office
2 Public Square
Wilkes-Barre, PA 18711

Ms. Amy Elliott
U.S. Army Corps of Engineers - Baltimore District
State College Field Office
1631 South Atherton Street, Suite 102
State College, PA 16801

Ms. Paula B. Ballaron
Susquehanna River Basin Commission
1721 North Front Street
Harrisburg, PA 17102-0425

Mr. Thomas W. Beauduy
Susquehanna River Basin Commission
1721 North Front Street
Harrisburg, PA 17102-0425

Enclosure 1

Application for Aquifer Test Plan Waiver

PPL NUCLEAR DEVELOPMENT

PPL Bell Bend Nuclear Power Plant

Luzerne County, Salem Township, Pennsylvania

Application for Aquifer Test Plan Waiver

For

ESWEMS Pond Construction Dewatering Well

Submitted to SRBC

June 2011

Table of Contents

SRBC #72
06/12/02

ATTACHMENT 1

Susquehanna River Basin Commission

a water management agency serving the Susquehanna River Watershed

PROJECT INFORMATION

1. Applicant Information:

Applicant Name or Registered Fictitious Name: PPL Bell Bend, LLC

Parent Corporation Name, if different: ____________

Mailing Address: 38 Bomboy Lane
Suite 2

City: Berwick State: PA Zip: 18603

Contact Person: Terry Harpster Title: VP- Bell Bend Project Development

Telephone (570)802-8111 Fax (570)502-8119 E-Mail tlharpster@pplweb.com

2. Preparer (Hydrogeologist/Engineer):

Name: Benjamin Ehrhart, PE

Title: Water Resources Engineer

Company: LandStudies, Inc.

Address: 315 North Street
Lititz, PA 17543

Phone (717)627-4440 Fax (717)627-4660

Signature: [signature]

Date: 6-24-11 E-Mail Address: ben1@landstudies.com

3. Project Engineer:

Name ____________

Title ____________

Company ____________

Address ____________

Phone ( ) Fax ( )

Signature ____________

Date ____________ E-Mail Address ____________

4. Location of proposed source(s), if applicable:

State Pennsylvania County Luzerne
Municipality Salem Township
Latitude 41° 05' 21.19" Longitude -76° 09' 57.34"

5. State, county, or other regulatory/permitting contacts:

Agency PA DEP **Department** Northeast Regional Office
Name Gene Trowbridge **Position**
Permit/Area of Concern: Water Obstruction and Encroachment
Address 2 Public Square
Wilkes-Barre, PA 18711
Phone (570) 820-4919 **E-Mail** etrowbridg@state.pa.us

Agency US ACOE **Department** State College Field Office
Name Amy Elliot **Position**
Permit/Area of Concern: 404 Permit
Address 1631 South Atherton Street, Suite 102
State College, PA 16801
Phone (814) 235-0573 **E-Mail** amy.h.elliott@usace.army.mil

Agency Salem Township **Department** Code Enforcement
Name Karen Karchner **Position** Zoning Officer/ Building Code Official
Permit/Area of Concern: Township Planning and Zoning
Address P.O. Box 45
38 Bomboy Lane
Berwick, PA 18603
Phone 570-752-4399 **E-Mail** salemcodes@pa.metrocast.net

Application for Aquifer Test Plan Waiver

PPL Bell Bend Nuclear Power Plant
Salem Township, Luzerne County, PA

1. Background Information

PPL Bell Bend, LLC (the Applicant) proposes to construct a new nuclear power plant, the Bell Bend Nuclear Power Plant ("BBNPP" or "the Project"), at a site adjacent to the existing Susquehanna Steam Electric Station (SSES) in Salem Township, Luzerne County, Pennsylvania. The purpose of the BBNPP is to generate 1,600 MWe of nuclear baseload electrical supply to address the growing demand for electricity in the PJM Interconnection, LLC market area. The Applicant is in the process of designing, siting and licensing the new nuclear facility. The intent of this application is to request a waiver of aquifer testing for the dewatering wells necessary to construct the essential service water emergency makeup system (ESWEMS) pond. Extensive hydrogeologic evaluations have already been conducted on the site, as presented in this application. The applicant asserts that no additional testing is necessary, given the justifications provided in sections 4 and 5 of this application.

Dewatering is needed during excavation and fill placement for the ESWEMS pond. This facility is a safety-related plant feature and must have a foundation placed on competent bedrock. The excavation to bedrock and placement of structural fill to design elevations must be done in a dry condition, therefore, dewatering wells, sumps, and sump pumps will be used during foundation construction, which may extend up to two years. PPL Bell Bend, LLC will be the owner and operator for the duration of these temporary pumping activities.

The anticipated pumping rate for the initial dewatering of the excavation area is estimated to be 715 gpm (1.0 mgd). After initial dewatering, the steady state pumping rate is estimated to be 350 gpm (0.5 mgd) (Sargent and Lundy 2010). To minimize the area of influence of the groundwater drawdown to the excavation and the immediately adjacent area, a bentonite slurry flow barrier is proposed. This flow barrier will also reduce the required pumping rate. Actual pumping rates may be less than the estimated 0.5 mgd depending on hydrologic conditions and the effectiveness of the flow barrier. Pumped groundwater from the construction dewatering operation will be discharged into the first cell of a two-cell holding pond. Each cell has the capacity to hold twenty-four hours of pumped water at the anticipated pumping rate, or 0.5 million gallons. The total pond capacity is equal to two days of pumping volume, or one million gallons. Overflow from the pond will be returned to Tributary 2 to Walker Run located immediately west of the proposed ESWEMS pond via a temporary swale. A temporary irrigation system, using the holding pond for source water, will also be established to minimize temporary impacts to adjacent wetlands within the area of groundwater drawdown associated with the construction dewatering pumping. Appendix C describes the proposed wetland and stream mitigation measures. See Appendix C, Figure 3 for a schematic of the pumping system, holding pond, and irrigation system.

2. Hydrogeologic Description

Information required for the Hydrogeologic description is provided in the following excerpt from the Bell Bend Nuclear Power Plant Construction Dewatering Design Report (Sargent and Lundy, 2010). The complete text of this document is provided in Appendix B.

> ***6.2 Geology***
>
> *The geologic conditions described below are generally based on FSAR Sections 2.4.12 (Reference 10.5), 2.5.4 (Reference 10.9) and the recent boring logs (Reference 10.2). Subsurface conditions beneath the site are characterized by sand and gravel deposits that are underlain by shale bedrock.*
>
> *The Pleistocene Age overburden soils range in thickness from 0 to 100 feet with the thinner overburden encountered on the ridges and hills. With the exception of some loose sand pockets, the overburden consists of over-consolidated, brown silty sand and sand containing gravel and large rounded cobbles and boulders. The frequency of the boulders increases with depth. The bedrock generally consists of folded, jointed and fractured Devonian-Age shales of the Mahantango Formation extending approximately 1000 to 1200 feet beneath the site. The Mahantango Formation consists primarily of dark gray, silty to very silty claystone. Frequent joints and intense cleavage development causes the claystone to become splintery, and fragmented upon weathering. The Mahantango Formation has low to moderate resistance to weathering.*
>
> ***6.3 Hydrogeology***
>
> *The hydrogeologic conditions described below are generally based on FSAR sections 2.4.12 (Reference 10.5) and 2.5.4 (Reference 10.9), the Rizzo Monitoring Well Test Data Report (Reference 10.3) and the Weaver Boos report (Reference 10.6).*
>
> *Generally, borings in the vicinity of the NI and cooling towers did not encounter groundwater in the overburden soils. In the vicinity of the ESWEMS pond and pump*

house, groundwater levels in the overburden typically range from 2 to 15 feet below the ground surface (bgs). Along the south side of the proposed ESWEMS pond, the depth to water was approximately 2 to 8 feet bgs, and flows generally southerly and westerly towards Walker Run. In the vicinity of the ESWEMS pond and pump house, the overburden aquifer is recharged by downward percolating precipitation and upflow from the deeper bedrock aquifer. Groundwater discharges from the surficial aquifer as springs and seeps into ponds, the wetlands along the southern border of the site, and into Walker Run.

The underlying Mahantango Shale Formation is also considered an aquifer. There are no extensive aquitards in the vicinity of the BBNPP site. Vertical groundwater flow in the upland areas to be developed as the power block and cooling towers is generally downward. Vertical groundwater flow is generally upward from the bedrock aquifer to the overburden aquifer in the area to be developed as the ESWEMS pond.

6.4 Hydraulic Properties by Layer

Groundwater flow is simulated in seven layers. Walker Run, the site wetlands and the excavations for the ESWEMS pond are generally located within Layer 1, which is a relatively high conductivity zone. The base of the ESWEMS pond excavation is generally at the top of the competent rock, which is within Layer 2 and exhibits a lower conductivity than Layer 1. The excavations for the NI and cooling towers extend through Layer 1 and well into Layer 2. Layer 2 includes the upper weathered rock zone, the transition zone and the upper extent of the competent rock. Layer 2 is also the primary component of the highland ridges. Layers 3 through 7 are deeper shale bedrock.

Layer 1 exhibits a varying thickness across the model domain, since its upper surface is based on the topography of the site and the lower surface is based on the interface with weathered bedrock (Reference 10.2). Rizzo performed and documented (References 10.3 and 10.5) both slug and pump tests to quantify the horizontal hydraulic conductivity of Layer 1. The Rizzo pump test methods stress a more widespread area of the aquifer than a slug test, and are therefore considered more representative than the slug test results. Thus, Sargent and Lundy considers the geometric mean value obtained during the pump test, which is the highest mean value for the site, as a representative, yet conservative value for the horizontal hydraulic conductivity in the overburden aquifer. The horizontal hydraulic conductivity value of 5.9×10^{-2} cm/s for Layer 1 is based on the geometric mean of the results from a 24-hr pump test. Because sand and gravel deposits comprising the overburden aquifer are horizontally stratified as described in the boring logs, the deposit is likely anisotropic, and the vertical hydraulic conductivity (which has not been measured) is considered to be 5.9×10^{-3} cm/s, which is 1/10th of the mean horizontal value from the pump testing.

To quantify the hydraulic conductivity of the shale strata, Rizzo performed slug, packer and pump tests during the field exploration activities of 2007, 2008 and 2010 (References 10.3 and 10.5). For the reasons discussed above, the geometric mean values obtained during the pump tests are considered to be more representative than values obtained from slug tests. However, results for the packer testing program are also considered representative for the intervals that were tested. Of the values reported for the shale bedrock, the geometric mean horizontal hydraulic conductivities are selected as conservatively high values for use in the dewatering evaluation.

Layer 2 also varies in thickness, since it extends from the interface with the overburden down to elevation 600 feet and is also referred to as the shallow shale bedrock. The geometric mean pump test conductivity value of 5.4×10^{-4} cm/s was selected as representative and conservative for shallow bedrock occurring above an elevation of approximately 600 feet.

Layers 3 through 7 are considered to be uniform in thickness and extend from elevation 600 feetdown to elevation 0 feet. These layers are assigned the conductivity for the deep bedrock (1.6×10^{-4} cm/s), which is the geometric mean of deep rock pump tests. These values are regarded as conservative because their selection is likely to over-predict rather than under-predict the flow of groundwater to be yielded by a dewatering system.

As was selected for the overburden, Weaver Boos also considered the vertical conductivities of the bedrock (shallow and deep) to equal 1/10th of their respective horizontal values obtained during the pump tests due to the general layering characteristics of the bedrock.

Although the shale bedrock is correctly described as an aquifer in Reference 10.5, the conductivity of Layer 2 is about 1/1,100th of the overburden aquifer, while Layers 3 through 7 are about 1/3,700th of the overburden aquifer. The contrast in conductivity between the two aquifers means that the majority of groundwater flow will be through the overburden rather than the bedrock aquifer.

6.5 Groundwater Level Observations

Monthly water table elevations in the overburden and the head elevations in the bedrock were previously measured between October 2007 and September 2008 (Reference 10.5, Table 2.4-44). The groundwater elevation data obtained in 2007 and 2008 indicate a slight seasonal variation in groundwater elevation has been observed during the monitoring period. Generally, the groundwater elevation is at a minimum in autumn, followed by gradually increasing levels in winter, peak groundwater elevations are noted in the early spring and then decreasing elevations through the summer. For the overburden monitoring wells, the differences between the annual high and low elevations for each well ranged from 1.67 to 5.49 feet. Elevations measured on January 26, 2008 appear to represent "average" conditions, and elevations measured on March 24, 2008 are taken to represent "high" water levels.

Monthly groundwater levels were most recently reported for the period between May 2010 and July 2010 (Reference 10.3). Measurements taken during 2010, which include measurements from the initial round of wells (MW300 series) and the recently installed MW400-series observation wells (MW401 through MW410), are generally somewhat lower than the "average" levels measured during January 2008. In order for this evaluation to conservatively consider the reasonably foreseeable maximum future groundwater elevations that may occur in the 2010 –2011 12-month monitoring period, two feet was added to the "high" groundwater elevations previously reported during March 2008. These higher values were then selected as flow model calibration targets. The highest recently measured water levels in the MW400-series wells were "corrected" to reasonably foreseeable maximum future groundwater levels by adding 5.0 feet to the new rock wells and 4.6 feet to the new overburden well for the calibration targets to evaluate the groundwater model simulations. The resulting conservatively high groundwater elevations selected for use herein are listed in Table 2 of Reference 10.6, which is Appendix A of this report.

Table 1. Hydrogeologic Boundaries

Boundary Type	Feature	Figure 2 Designation
Bedrock Ridges	Shale Ridges Confining Overburden Aquifer	Indicated by extent of overburden aquifer

Legend

- Well
- Cross Section A
- Cross Section B
- Stream

Groundwater Basin

- Glacial Overburden
- Shale Ridges (<10' overburden)

Figure 2. Topographic Map with Contributing Geology

N

1 inch = 1,500 feet

0 750 1,500 3,000 Feet

Berwick, PA USGS 7.5 minute quadrangle, 2006

Figure 3a. Hydrogeologic Cross Section

FSAR Fig 2.4-65 w/ notation

Figure 2.4-65— {Hydrogeological Cross Section A-A'}

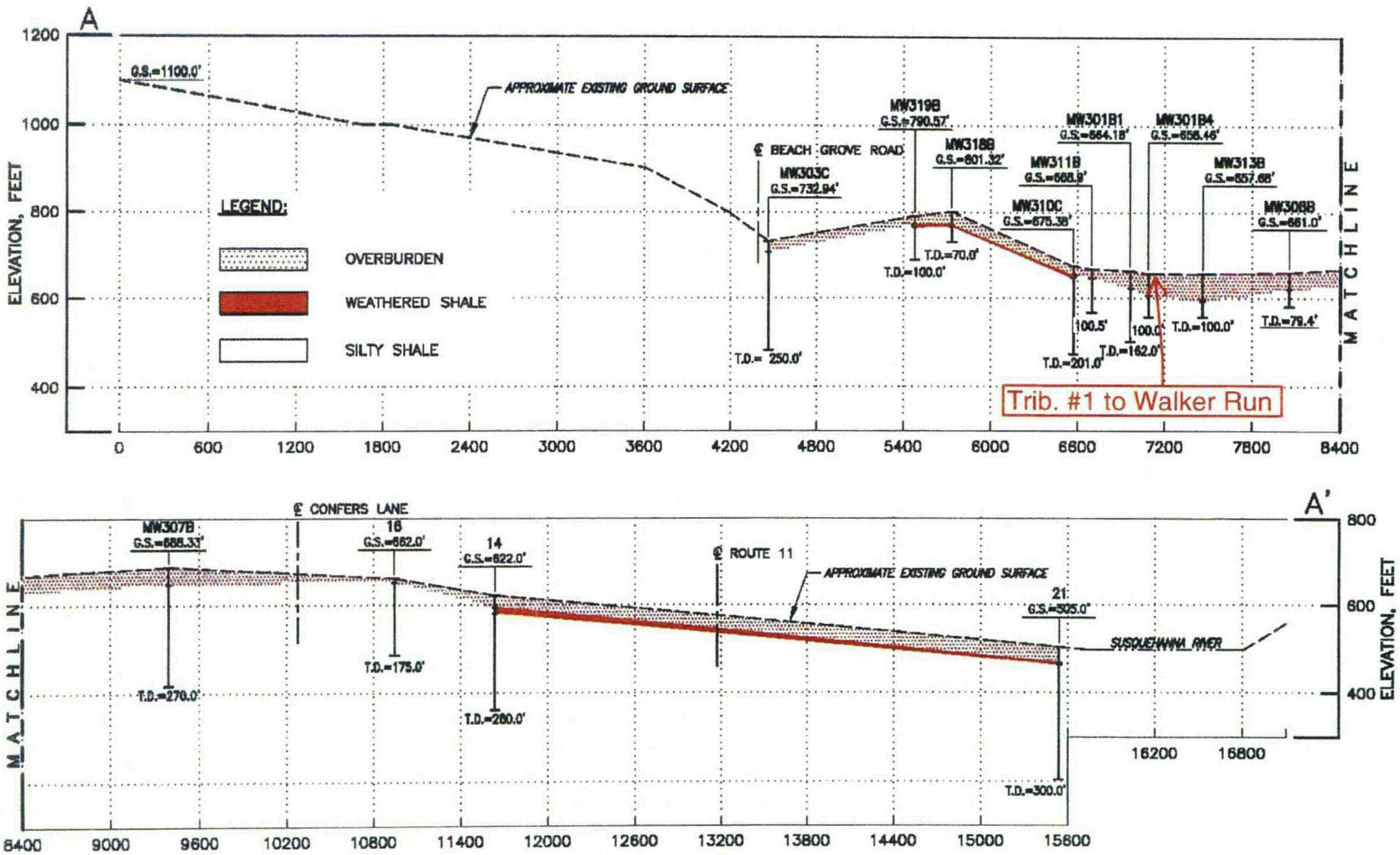


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Figure 3b. Hydrogeologic Cross Section
FSAR Fig 2.4-66 w/ notation

Figure 2.4-66— {Hydrogeological Cross Section B-B'} I1356452

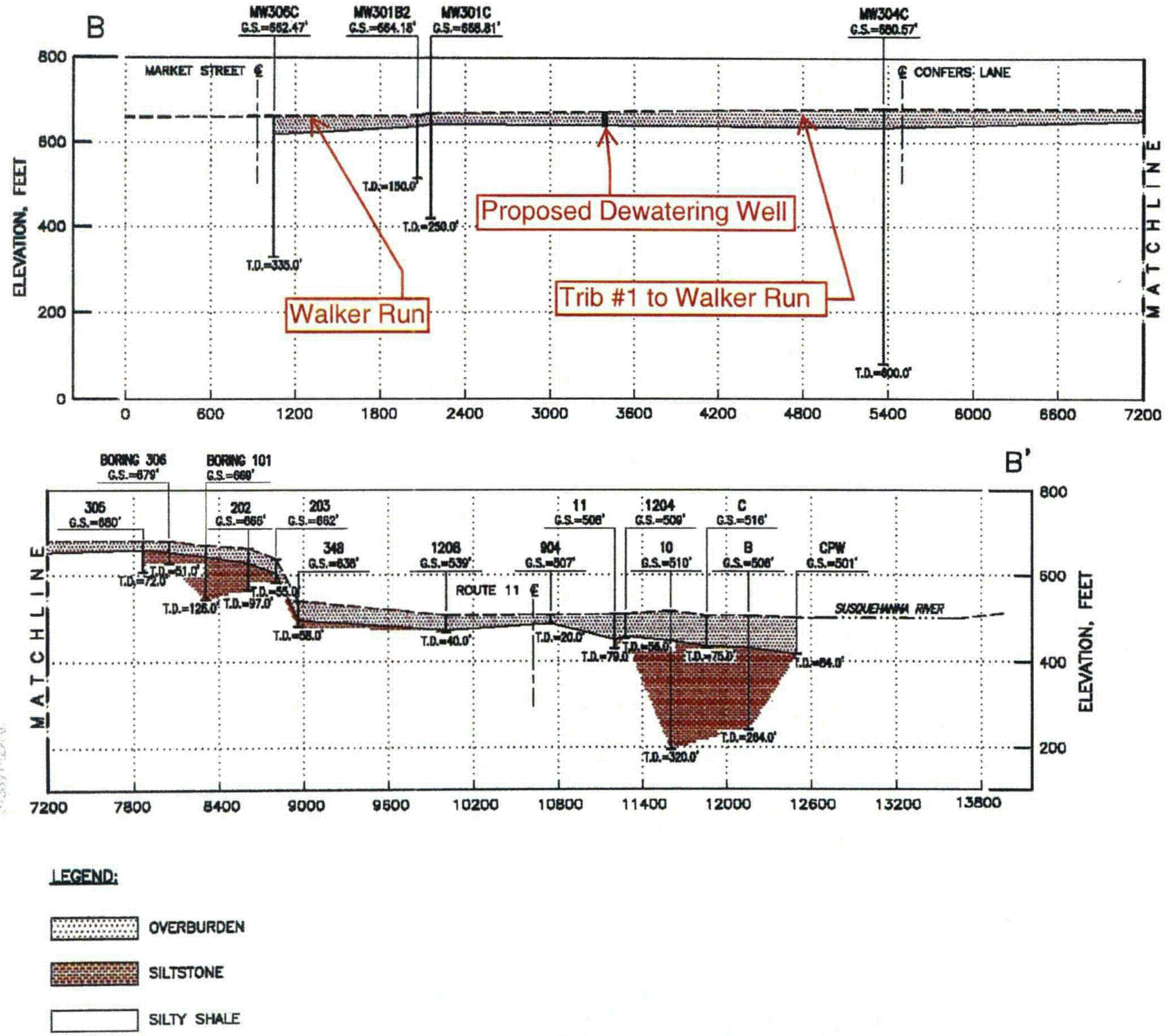

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Figure 4
Potential Area of Dewatering Impacts

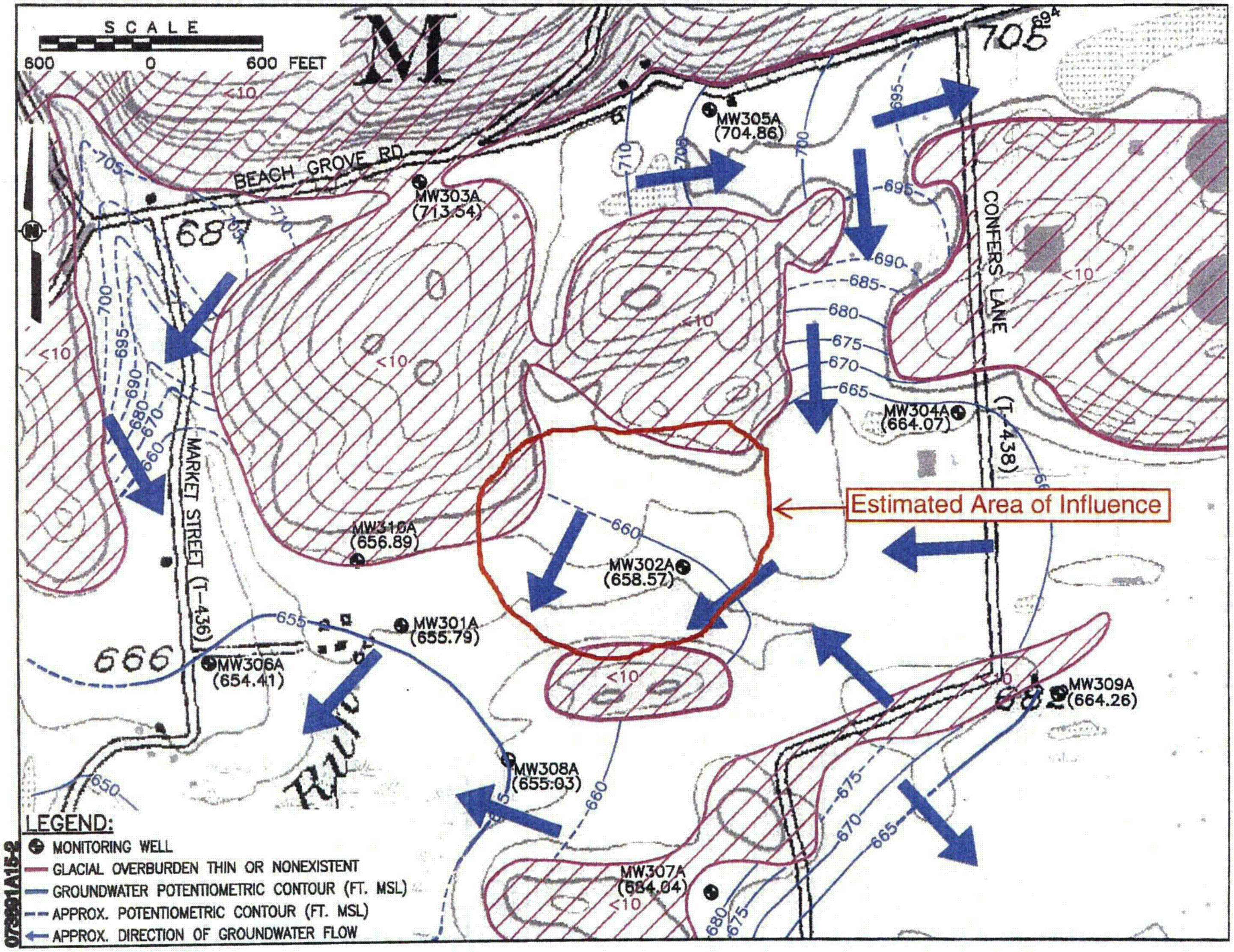
Land Studies
717-627-4440
fax: 717-627-4660
landstudies.com
land@landstudies.com
315 North Street | Lititz, PA 17543

PA 042324

Figure 5. Groundwater Contour Map

FSAR Fig 2.4-88 w/ notation

Figure 2.4-88— {Potentiometric Surface Map of Glacial Overburden Aquifer, July 2008} 11357333



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3. Phase 1 Groundwater Availability Analysis

Table 2. Phase 1 Groundwater Recharge Estimate

Aquifer (Formation)	Contributing Area from the Identified Formation (mi^2)	1-in-2-year Recharge Rate (mgd/mi^2)*	1-in-10-year Recharge Rate (mgd/mi^2)*	Available 1-in-10-year Drought Recharge (gpd)
Glacial Overburden	0.58	0.015	0.010	5,800

*Groundwater Recharge Rates based on USGS RORA estimation method using Wapwallopen Creek Gage data (Gage # 01538000). Wapwallopen Creek is immediately across the Susquehanna River from the BBNPP site and has similar geology, land use, and climate conditions. Data and methods can be found in the following references:
http://pa.water.usgs.gov/recharge/station_text/01538000_text.html
Risser, et.al. *Estimates of Ground-Water Recharge Based on Streamflow-Hydrograph Methods, Pennsylvania*. USGS 2005

Table 3. Existing Groundwater Withdrawals

Owner	Withdrawal Identification on Figure 6	Withdrawal Quantity (mgd)	
		Existing or Registered	Permitted or Approved
PPL Company	PA Well ID 129135	0 mgd**	N/A
Total GW Withdrawal		0 mgd**	

** This well is 225 feet deep, and is therefore drawing primarily from the Mahantango Shale aquifer, and not the glacial overburden aquifer. This well is also located outside of and up-gradient of the estimated area of influence of the proposed well.

Table 4. Phase 1 Groundwater Availability

Line		Total (mgd)
1	Groundwater Recharge (Table 2, total)	0.0058
2	Groundwater Withdrawals (Table 3, total)	0
3	Phase 1 Groundwater Availability (Line 1 minus Line 2)	0.0058
4	Proposed Withdraw (Well being Tested)	0.5 ***
5	Remaining Groundwater	0
6	Percent Utilization of 1-in-10-year Drought Recharge [100-(Line 5/line 1)]	100%

***The anticipated withdrawal is a maximum to maintain a dewatered condition within the excavation area for the ESWEMS pond foundation. This rate will be reduced, as needed, based on water seepage through the flow barrier. In a drought condition, it is anticipated that less water would need to be pumped to maintain dry conditions within the excavation.

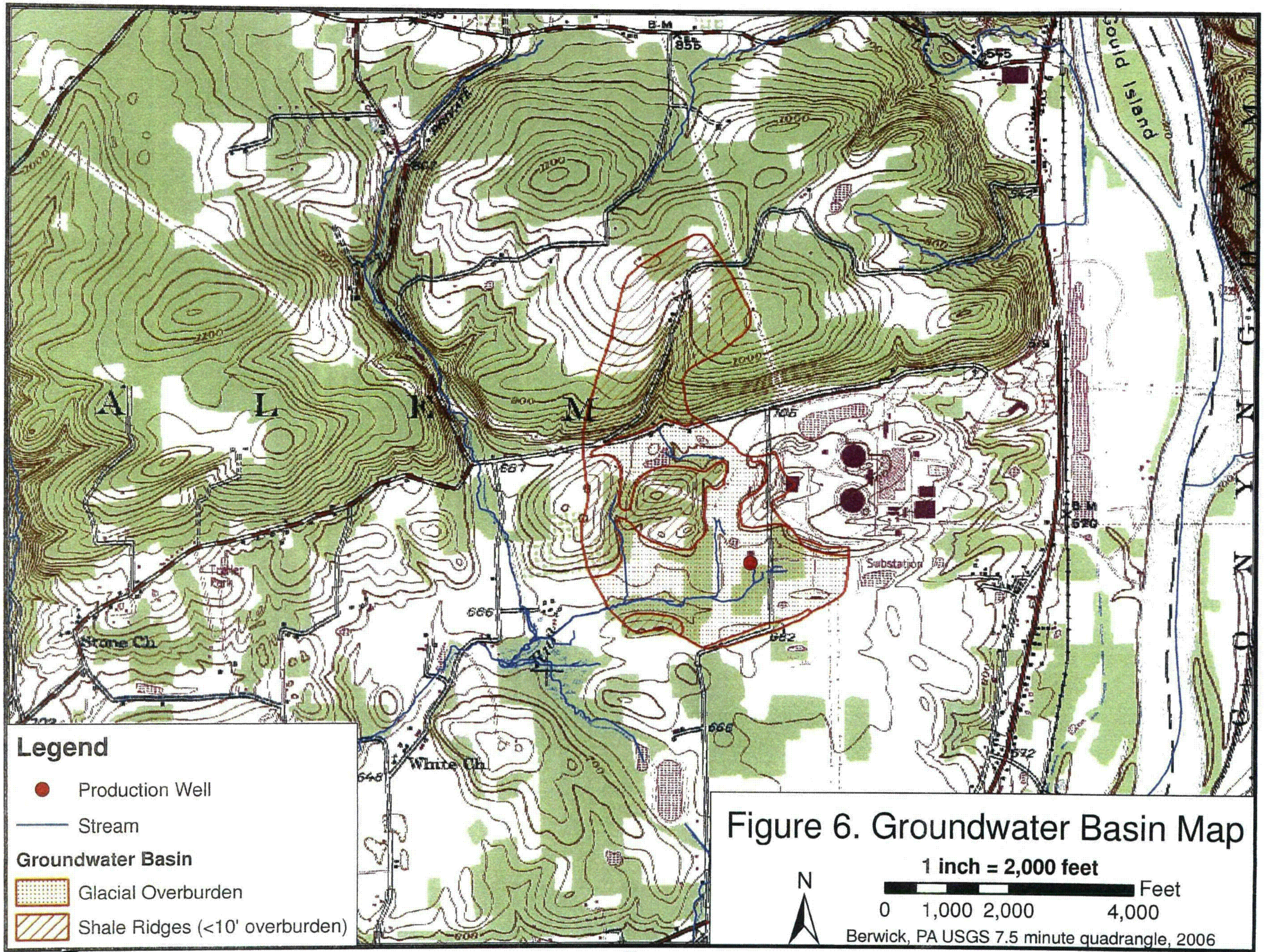


Figure 6. Groundwater Basin Map

4. Phase 2 Groundwater Availability Analysis (Waiver Request)

A waiver of the Phase 2 Groundwater Availability Analysis is hereby requested. The justification for this request is based on the following considerations:

- There are no other production wells drawing primarily from this aquifer
- The purpose of this well is to provide dry conditions for the placement of structural fill material as part of the construction of the safety-related ESWEMS Pond for the BBNPP.
- A flow barrier will be used to minimize the pumping requirements and subsequent drawdown of the aquifer.
- The pumping rate will be limited to that necessary to maintain dry conditions within the excavation.
- All pumped water, minus evaporative losses, will be returned to the stream or wetlands adjacent to the excavation via overflow of the holding pond or irrigation intended to maintain wetland hydrology and stream flow (See Appendix B, Construction Dewatering Mitigation Plan).
- The groundwater flow model indicates a limited area of influence associated with this pumping operation (See Appendix B, Construction Dewatering Design Report,).

Based on these facts, there will be no impacts to other users, and the area of effect of the proposed dewatering well will be relatively small in aerial extent. In addition, measures will be established to protect existing surface water resources from adverse effects due to localized groundwater drawdown.

5. Aquifer Test Procedures (Waiver Request)

A waiver of the Aquifer Test is hereby requested. The justification for this request is based on the following considerations:

- No impacts to other production wells is anticipated as a result of the construction dewatering activities, as there are no other users withdrawing primarily from this aquifer.
- An extensive network of monitoring wells and shallow piezometers is already in place, with additional piezometers and soil moisture probes to be established as part of the pre-construction monitoring of the area of influence.
- Monitoring of existing baseline conditions will be conducted for a period of at least two years, as described in the Appendix C, Construction Dewatering Mitigation Plan.
- Shallow groundwater and surface soil moisture will be monitored daily during construction to identify any deviation from baseline conditions and trigger the activation of the temporary irrigation system, as needed, to maintain hydrology in the adjacent wetlands and streams, as described in Appendix B, Construction Dewatering Mitigation Plan.

Based on these facts, the applicant asserts that an aquifer test is not necessary prior commencement of construction dewatering activities.

Appendix A

Application for Aquifer Test Plan Approval (Checklist)

APPLICATION FOR AQUIFER TEST PLAN APPROVAL

Directions

The aquifer test plan should consist of the following items, in the order presented below:

1. Title page (with the signature of the project hydrogeologist and seal, when applicable).
2. A completed copy of the Project Information form (SRBC Form #72; Attachment 1) and required plan review fee.
3. A completed (checked) copy of the Application for Aquifer Test Plan Approval, signed by the project hydrogeologist and sealed, when appropriate.
4. All of the completed items in the Application for Aquifer Test Plan Approval, labeled, and in the order shown.
5. Any additional information may be attached as an appendix.

Submit two bound copies and a .pdf version on compact disc of the aquifer test plan for review to the Susquehanna River Basin Commission (Commission). Aquifer test plans are reviewed in the order of receipt. Due to workload and scheduling, an aquifer test plan should be received by the Commission at least sixty (60) days prior to the proposed test date to assure adequate time for Commission staff's review.

SECTION 1. BACKGROUND INFORMATION

[X] General description of the proposed project. Describe the project, including but not limited to, information on the following:

1. Anticipated long-term owner and operator, if different;
2. Use;
3. Current water need (million gallons per day [mgd]);
4. Anticipated future water need (mgd);
5. Planned water storage (million gallons); and
6. Location of return flow outfall.

SECTION 2. HYDROGEOLOGIC DESCRIPTION

[X] Description of contributing aquifer(s); use the Aquifer Description Sheet for Items 1 and 2 (Attachment 2), and use Table 1 (Hydrogeologic Boundaries) for Item 3:

1. For the geologic formations/aquifers within the contributing groundwater basin, provide generalized lithologic descriptions and the dominant permeability types.
2. For the aquifer(s) that the water-bearing zones are located in, determine and describe the dominant type(s) of permeability (fractures, joints, faults, bedding planes, etc.), the spatial characteristics (spacing and orientation) of the features, and how these features relate to the area of influence. Site-specific information and structural data (that is, information obtained or measured in the field) will be needed in most cases to satisfy this requirement.

3. List and describe (Table 1) any potential boundary conditions, both restricting geologic features or aquitards (for example, diabase dikes, confining impervious beds) and sources of recharge (for example, streams, lakes, wetlands), referencing Figure 2 for locations.
4. Describe the geologic and hydrologic properties of and classify the overburden (for example, alluvium, colluvium, flood plain fines, glacial outwash, stratified drift, till, residuum, saprolite, etc.). This information may require examination of shallow road cuts, stream channel banks, drainage ditches, well logs, and geotechnical boring logs.

Table 1. Hydrogeologic Boundaries

Boundary Type	Feature	Figure 2 Designation

[X] **<u>Figure 1. Construction and Hydrogeologic Well Log</u>**

Provide a scaled diagram of the well to be tested, showing well construction and geology. The geologic description must include lithology, lithologic contacts, and the depth, yield, and lithologic characterization of water-bearing zones (fractures, conduits, clay seams, gravel beds, etc.). A textural and mineralogic description of the unconsolidated and weathered materials must be included. <u>A driller's log is not acceptable.</u> The driller and the project hydrogeologist should work together closely in the field so that the information in the well log is a synthesis of the data collected by each. The log must include the ground surface elevation (reported as feet above mean sea level).

[X] **<u>Figure 2. Topographic Map with Contributing Geology</u>**

Clearly identify the following on a map:

1. Saturated lithified and unconsolidated materials within the area of contribution of the proposed well.
2. Location(s) of recorded field measurements (water elevations, structural geologic features, lithologic changes, etc.).
3. Locations of surface water features.
4. Fracture traces.
5. Contributing aquifer(s) and the presence of any aquitards.
6. Potential boundary conditions that may be encountered during testing.
7. Location of hydrogeologic cross sections.

☒ **Figure 3a. Hydrogeologic Cross Section (strike-perpendicular)**
☒ **Figure 3b. Hydrogeologic Cross Section (strike-parallel)**

Provide strike-perpendicular and strike-parallel hydrogeologic cross sections at a scale ranging from 1:1 to 5:1. For wells sited in valley-fill sediments, the cross sections should be parallel and perpendicular to the trend of the main valley. For wells sited in horizontally bedded rocks or massive crystalline rocks, the cross sections should be oriented approximately parallel and perpendicular to the dominant direction of natural groundwater flow. Additional cross sections at vertical scales up to 5:1 exaggeration may be submitted as needed. The location of the cross sections should be indicated on Figure 2. The cross section must pass through the well to be tested, cover 1,000 to 5,000 feet of length, and also include any significant hydrogeologic boundaries (surface water features, dikes, etc.). The cross section should include the following:

1. Water table or piezometric surface;
2. Surface water bodies and wetlands;
3. Geologic structure (confirmed by on-site field measurements);
4. Aquifers, aquitards, and hydrogeologic boundaries;
5. Top of rock;
6. Unconsolidated deposits – thickness and extent;
7. Well bore, casing, pump intake, and water-bearing zones, or screened intervals;
8. Surficial materials that are a saturated part of the flow system; and
9. Key scale(s).

☒ **Figure 4. Estimated Area of Influence**

Provide a topographic map at an appropriate scale ranging from 1 inch = 1,000 feet to 1 inch = 2,000 feet delineating the estimated area of influence of the proposed production well. The area of influence should be based on the best available information regarding the aquifer properties (dominant types of permeability and their spatial characteristics such as bedding and fracture orientations, anisotropy, etc. and their approximate values), topography, hydraulic gradient, groundwater flow direction(s), recharge boundaries, confining boundaries, etc. The map must include the aquifer properties (bedding strike, fracture traces, joints, etc.) used in determining the area of influence.

☒ **Figure 5. Groundwater Contour Map**

Using the "Topographic Map with Contributing Geology" (Figure 2), provide a groundwater contour map of adequate scale (1 inch = 1,000 feet to 1 inch = 2,000 feet) using recent water level data (measured by project personnel) from on-site wells and proposed monitoring points (observation wells and surface water features). Indicate the approximate hydraulic gradient, direction(s) of groundwater flow, and date of measurements. Clearly indicate the estimated area of influence for the proposed well (Figure 4), at the proposed pumping rate, on the groundwater contour map.

SECTION 3. PHASE I GROUNDWATER AVAILABILITY ANALYSIS

[X] **Figure 6. Groundwater Basin Map (Phase I Groundwater Availability)**

Provide a topographic map with a delineation of the groundwater basin. The following must be included:

1. Useable scale (1 inch = 2,000 feet). At a minimum, maps must occupy an entire 8.5-by-11-inch sheet with margins. (Note, it is oftentimes necessary to use sheets that are larger than 8.5 by 11 inches to provide the necessary information on a useable figure.)
2. Compass (north arrow); topographic map names (source map identification); map scale bar.
3. Potential hydrogeologic boundaries (divides, discharge areas or points [springs], dikes, sharp permeability changes).
4. Production wells within the contributing recharge area of the proposed pumping well (residential, municipal, industrial, irrigation, etc.).
5. Permitted surface water withdrawals.

[X] **Table 2. Phase I Groundwater Recharge Estimate**

Using the delineated recharge area (Figure 6), complete the provided table (Table 2), which includes the following:

1. Name of aquifer.
2. Contributing groundwater recharge area, in square miles, per formation.
3. Recharge rates for the 1-in-2-year and 1-in-10-year drought return intervals. In the event that a published 1-in-10-year rate is not available, 60 percent of the 1-in-2-year rate may be used.
4. Estimated groundwater availability for the proposed groundwater withdrawal point (well). (Recharge rate[s] multiplied by the proposed contributing recharge area.) (Table 2)

Table 2. Phase I Groundwater Recharge Estimate

(a) Aquifer (Formation)	(b) Contributing Area from the Identified Formation (mi^2)	(c) 1-in-2-year Recharge Rate (mgd/mi^2)	(c) 1-in-10-year Drought Recharge Rate (mgd/mi^2)	(d) Available 1-in-10-year Drought Recharge (gpd)
				Total mgd

mi^2 – square miles
mgd – million gallons per day
gpd – gallons per day

☒ **Recharge Rate Rationale and Reference (source)**

Provide the rationale for selecting the applied recharge rate(s), along with the referenced source. Why is the chosen rate applicable to the project area?

☒ **Table 3. Existing Groundwater Withdrawals**

Identify withdrawals (groundwater or surface water users) within the identified groundwater basin for the proposed production well.

Table 3. Existing Groundwater Withdrawals

Owner	Withdrawal Identification on Figure 6	Withdrawal Quantity (mgd)	
		Existing or Registered	Permitted or Approved
		Subtotal mgd	Subtotal mgd
Total Groundwater Withdrawal		mgd	
mgd – million gallons per day			

☒ **Table 4. Phase I Groundwater Availability**

Calculate the available groundwater by subtracting the existing withdrawals (sum of Table 3) from the estimated availability (sum of Table 2). Provide a final estimation of the groundwater that is presumed to be available for withdrawal from the proposed production well.

Table 4. Phase I Groundwater Availability

Line		Total (mgd)
1	Groundwater Recharge (Table 2, total)	
2	Groundwater Withdrawals (Table 3, total)	
3	Phase I Groundwater Availability (Line 1 minus Line 2)	
4	Proposed Withdrawal (well being tested)	
5	Remaining Groundwater	
6	Percent Utilization of 1-in-10-year Drought Recharge (100 - [Line 5/Line 1])	
mgd – million gallons per day		

If Line 6 (Table 4) is greater than 50 percent, then the Phase II Groundwater Availability Analysis must be completed.

SECTION 4. PHASE II GROUNDWATER AVAILABILITY ANALYSIS

The Phase II groundwater availability analysis is required if the water budget indicates that greater than 50 percent of the available resources will be allocated with the addition of the new well. A Phase II groundwater availability analysis refines the Phase I groundwater availability analysis by including significant water returns (National Pollutant Discharge Elimination System [NPDES] discharges greater than or equal to 0.100 mgd) and recharge losses due to impervious cover.

☐ **Table 5. NPDES Discharges (0.100 mgd or greater)**

Table 5 is a listing of all NPDES permitted discharges greater than or equal to 0.100 mgd that are located within the delineated recharge area. These potentially add to the available water if the proposed production well draws water from the stream to which they discharge, as demonstrated by aquifer testing results.

Table 5. NPDES Discharges (0.100 mgd or greater)

NPDES #	Permit Holder	Permitted Discharge (mgd)
		Total mgd
Note: Water imported from outside the area of contribution must be documented by a note in Table 5.		

☐ **Figure 7. Map of Zoning and Impervious Cover**

Provide a map delineating existing zoning of the land within the contributing recharge area, as well as any proposed changes in land use.

☐ **Table 6. Impervious Cover Recharge Loss**

For each aquifer, list zoning/land use types, their area, percent impervious cover, and their area of impervious cover.

Table 6. Impervious Cover Recharge Loss

Aquifer	Land Use/ Zoning Type	Percent Impervious Cover	Area (mi^2)	1-in-10-year Drought Recharge Rate (mgd/mi^2)	Recharge Loss (mgd)
		Total Impervious Cover Recharge Loss			**mgd**
mi^2 – square miles mgd – million gallons per day					

☐ **Table 7. Surface Water Withdrawals**

List the surface water withdrawals exceeding 100,000 gallons per day (gpd) during any 30-day period annually, and calculate a total. This should include any seasonal agricultural and recreational withdrawals.

Table 7. Surface Water Withdrawals

Owner	Identification on Figure 6 (map)	Withdrawal Quantity (mgd)
Total Surface Water Withdrawals		**mgd**
mgd – million gallons per day		

☐ **Table 8. Phase II Groundwater Availability Analysis**

The Phase I groundwater availability estimate is refined by subtracting out impervious cover recharge losses. For the wells being tested that demonstratably draw water from a stream, the withdrawals returned within the area of contribution (NPDES discharges >0.100 mgd) are added to the water resources available to the well, and the surface water withdrawals within the area of contribution are subtracted from the water resources available to the well being tested.

Table 8. Phase II Groundwater Availability Analysis

Line	Water Budget Component	Quantity (mgd)
1	Phase I Groundwater Availability (Table 4, Line 3)	
2	Impervious Cover Recharge Loss (Table 6, total)	
3	Phase II Groundwater Recharge (difference of Lines 1 and 2; see Note 1)	
4	Return Flows (Table 5, total)	
5	Sum of Lines 3 and 4	
6	Surface Water Withdrawals (Table 7, total)	
7	Total Water Available to the Well Being Tested (difference of Lines 5 and 6; see Note 2)	

mgd – million gallons per day

Notes:

1. The total water resources available to wells demonstrably drawing only upon groundwater is given on Line 3.
2. The total water resources available to wells demonstrably drawing some water from a stream is given on Line 7.

SECTION 5. AQUIFER TEST PROCEDURES

☐ **General Plan Description**

Provide short, concise answers to the following:

1. Estimated/desired rate of withdrawal;
2. Proposed pump setting (depth below ground surface);
3. Describe the flow control valving and metering;
4. Describe the proposed monitoring of water chemistry, including parameters measured, monitoring devices, and where samples will be taken (proposed pumping well, nearby streams, ponds, springs, and wetlands); and
5. Describe how precipitation will be monitored during the testing.

☐ **Figure 8. Map of Proposed Monitoring Locations**

On a topographic base map, indicate the locations of all of the proposed features to be monitored (wells, wetlands, ponds, streams, piezometers, weirs, etc.). All proposed locations should be identified on the map with a symbol for each type of monitoring point accompanied with a unique identification for each point. Surface water levels of all proposed monitoring points must be included on this map.

☐ **Table 9. Groundwater Monitoring Locations**

Provide as much of the following information as possible for each well or piezometer: well identification (property owner name, address, etc.), total depth, estimated yield, casing lengths, diameter, well construction (screened or open bedrock), depth to water/date , location (GPS latitude/longitude), wellhead elevation (feet above mean sea level), aquifer, and distance from proposed production well.

Table 9. Groundwater Monitoring Locations

Parameter	Description
Well Identification (property owner name, address, etc.)	
Total Depth (feet)	
Estimated Yield (gpm)	
Casing Lengths (feet)	
Diameter (inches)	
Well Construction (screened or open bedrock)	
Depth to Water (feet)/Date	
Location (GPS latitude/ longitude[1])	
Wellhead Elevation (feet amsl)	
Aquifer (geologic formation)	
Distance from Proposed Production Well (feet)	

[1]GPS coordinates should be based on NaD 1983 (in decimal degrees).
gpm – gallons per minute
amsl – above mean sea level

☐ **Table 10. Surface Water Locations**

Provide the following information: monitoring point identification, monitoring point construction (piezometers, stilling wells, weirs, flumes, etc.), estimated flow during test (when applicable), location (GPS latitude/longitude), elevation of monitoring device (wellhead for piezometers, top of weir, etc.), and distance from proposed production well.

Table 10. Surface Water Locations

Parameter	Description
Monitoring Point Identification	
Monitoring Point Construction (piezometers, stilling wells, weirs, flumes, etc.)	
Estimated Flow During Test (when applicable) (gpm)	
Location (GPS latitude/ longitude[1])	
Distance from Proposed Production Well (feet)	
[1]GPS coordinates should be based on NaD 1983 (in decimal degrees). gpm – gallons per minute	

Proposed Start of Testing:______________________________
(Date)

Project Hydrogeologist:

Seal
(when applicable)

____
Print Name

____
Signature

____
Date

Appendix B

Construction Dewatering Design Report

Construction Dewatering Design

Bell Bend Nuclear Power Plant

UniStar Nuclear Energy

Non-Safety-Related

Report No. SL-009655

Revision 2

November 23, 2010

Sargent & Lundy LLC

Approval Page

Construction Dewatering Design

Non-Safety-Related

Revision Summary

Revision 0	**For OAR Review**
Revision 0	**For Use**
Revision 0A	**For OAR Review**
Revision 1	**For Use**
Revision 2A	**For OAR Review**
Revision 2	**For Use**

Prepared By: D. E. Nielson — Date: 11/23/2010

Reviewed By: Daniel C. Kocunik — D. C. Kocunik — Date: 11/23/2010

Approved By: R. A. Hameetman — Date: 11/23/2010

Table of Contents

1. PURPOSE/OBJECTIVE

The purpose of this report is to evaluate the existing groundwater conditions around the proposed

- Nuclear Island (NI), which includes:
    - Reactor Building;
    - Fuel Building;
    - Reactor Auxiliary Building;
    - Safeguard Buildings;
    - Radioactive Waste Building;
    - Emergency Diesel Buildings;
    - Ultimate Heat Sink Buildings;
    - Turbine Building;
    - Essential Service Water Emergency Makeup System (ESWEMS) pond and pump house;
- ESWEMS Pipeline between the pump house and NI; and
- Two Cooling Towers,

at the Bell Bend Nuclear Power Plant (BBNPP) and provide recommendations for the temporary construction dewatering system during the construction of the power plant. Attachment A depicts a conceptual layout of the major elements of the plant.

This information will be used to support the Combined Operating License Application (COLA) for the BBNPP. This evaluation will be the basis for the discussion of the construction dewatering system and the disposal of the extracted water as addressed in the Environmental Report (ER).

The purpose of Revision 2 is to evaluate the existing groundwater condition around the NI based on its new location 972 feet north and 300 feet west of the original plant location (Reference 10.1). Revision 2 is a comprehensive revision and thus, revision bars are not indicated.

2. BACKGROUND

The explored site conditions and plant layout result in two distinct conditions. The NI and cooling towers will be located in an area of unsaturated granular soils above the shale bedrock. In the vicinity of the ESWEMS pond and pump house, the lower granular soils that overlie the bedrock are saturated.

For structural and seismic design considerations, the safety related structures, will be supported on bedrock or engineered fill (concrete or granular) extending from the bearing elevation down to the top of competent rock. Although considered safety related, the ESWEMS pond will be supported on cohesive fill extending from the pond floor down to the competent rock.

This construction detail and the site geologic setting requires an approximate maximum of 56 feet of water-bearing sands and gravels to be excavated (References 10.2, 10.3 and 10.4) for the ESWEMS pond. Proper placement of the backfill requires the work be performed in a dry condition. As such, an active construction dewatering system will be implemented prior to construction to maintain dry conditions and it will continue until the subgrade portions for these structures are completed and the excavation is backfilled. The dewatering system will be decommissioned as the structures are completed and the backfill is placed to a level above the groundwater and up to the final grade.

3. DESIGN INPUTS

The following design inputs and assumptions are used in this report:

a. Three months of available groundwater levels are provided in the Paul C. Rizzo and Associates (Rizzo) response to RFI SL-BBNPP-111 (References 10.3).

b. Twelve months of groundwater levels for monitoring wells installed in 2008 as documented in FSAR Section 2.4.12 (Reference 10.5).

c. Locations of the monitoring wells, subsurface soil and rock descriptions, and top of rock elevations as provided by Rizzo in their responses to RFI SL-BBNPP-132 and RFI SL-BBNPP-111 (References 10.2 and 10.3, respectively). Attachment C presents the locations of the groundwater monitoring wells.

d. Dewatering system criteria, groundwater levels with various dewatering approaches and comments as provided by Weaver Boos Consultants North Central, LLC (Weaver Boos) (Reference 10.6 – included as Appendix A of this report).

e. Potential construction reuse of groundwater pumped from the excavation (Reference 10.7).

f. General site layout per the Reduced Scale Standard Utilization Plot Plan (SUPP) (Reference 10.1), which is provided as Attachment A.

g. Final yard high-point finished grade is established at Elevation 719 feet per the North American Vertical Datum of 1988 (NAVD 88), with the design finished floor elevation of the NI structures at 720 feet (Reference 10.8). Note, all elevations in this report refer to the NAVD 88 and are in feet.

h. The approximate elevation of the invert of the pipes from the ESWEMS pump house to the NI is 694 feet (Reference 10.13).

i. Water quality information from on site wells and water sampling (Reference 10.10).

j. Conceptual Excavation Plan as prepared by Rizzo and provided in their response to RFI SL-BBNPP-149 (Reference 10.4). Attachment B presents a compilation of the data presented in Reference 10.4.

4. ASSUMPTIONS

Design inputs 3a, 3b, 3c, 3e, 3h, 3i and 3j listed in Section 3 (above) are the latest available information based on responses to Requests For Information (RFI) and are considered as verified information for the conceptual design of the construction dewatering system. Design inputs 3f and 3g are the site layout and grading drawings and are the latest information for the conceptual design.

Integration of the Site conceptual model with a mathematical computer code to simulate flow requires several simplifying assumptions. The following assumptions and idealizations apply to the model utilized herein (from Reference 10.6):

a. The model domain is underlain by a conductive overburden aquifer extending through the basin lowlands and restricted in its horizontal extent by surrounding rises in the less conductive bedrock.

b. The complex natural flow system may be represented using a system of seven discrete layers, while the natural conditions likely result in a more gradual variation in hydrogeologic properties.

c. The baseline groundwater flow system is in equilibrium and is modeled on a steady-state basis.

Assumptions 4a, 4b, and 4c, listed above, are consistent with the available data and do not need further verification for this evaluation. Adjustments can be made during construction of the dewatering system to account for any subsurface discrepancies, which may be encountered during construction. All assumptions for this report are considered to be verified for its current use. However, this report will be reviewed after receipt of the 6-month and 12-month water levels in the piezometers currently being monitored and updated as necessary.

5. METHODOLOGY AND CRITERIA

The groundwater modeling and calculations discussed in this report were primarily performed by Weaver Boos based on field data obtained and evaluated by Rizzo. The Weaver Boos report is documented as Reference 10.6, which is attached as Appendix A to this report. The Rizzo findings from the field investigations and testing are documented in References 10.2, 10.3, 10.5, and 10.10.

Prior to assessing applicable dewatering technologies, Weaver Boos developed a conceptual model, which to the extent practicable, incorporates natural hydrogeologic boundaries for the flow system of interest. Preparation of the conceptual model included the following general steps:

- Defining hydrostratigraphic units based on the data presented in References 10.2, 10.3, 10.5, and 10.10;
- Defining the flow system; and
- Preparing a water budget of flows into and out of the area of interest.

Evaluation of groundwater flow was performed by Weaver Boos utilizing a seven-layered conceptual model implemented using Visual MODFLOW Version 2009, by Schlumberger Water Services. This software is a widely used implementation of the USGS's globally recognized MODFLOW-2000 program. Weaver Boos selected this software for its capability to reliably model groundwater flow in three dimensions and relative ease of use offered by its integrated graphical user interface. The modeling reflected two principal groundwater dewatering strategies:

- Open excavation and water table depression without groundwater flow barriers; and,
- Dewatering and excavation using a slurry wall, diaphragm wall, or other type of subsurface flow barrier to mitigate potential off-site water level drawdown and subsequent impact to potentially sensitive areas around the ESWEMS pond.

Since the ESWEMS pump house is contiguous with the ESWEMS pond dike alignment, the term ESWEMS pond incorporates the excavation for the pump house.

5.1 Model Domain

The digital model domain is based on a rectangular block-centered grid network that covers a 1.8-square mile flow domain representing the local drainage basin. The grid includes 316 rows and 245 columns, with their spacing refined as needed to assess small-scale effects in the area where dewatering is needed. In the areas where the greatest detail was desired, the grid node spacing is approximately 22 by 22 feet and provides site-scale detail without creating a computationally excessive number of model nodes.

5.2 Model Calibration

Calibration of the baseline flow model consisted of initial simulations, with the model-estimated groundwater elevations compared to the adjusted target values discussed in Section 6.5. To adjust for discrepancies in the model predicted and actual groundwater elevations, adjustment of selected model elements such as recharge flux and distribution, river boundary condition parameters along the edges of the model domain and along Walker Run were made. The calibration is iterative to allow a suitable set of recharge and boundary conditions to be formulated.

An evaluation of the calibration for all layers indicates a correlation coefficient of 0.90, which is considered reasonable given the distribution of the groundwater monitoring wells and the relatively short duration of groundwater monitoring in the recently installed wells. The calibration indicated the model estimate groundwater elevations were typically slightly lower than the target values.

The model calculated heads are considered a reasonable match with the observed values given the objective of the flow model (Reference 10.6).

This calibrated digital model was then used to simulate the dewatering program parameters as presented in the following sections. Additionally traditional hand calculations were used to check the results of the computer modeling, determine near well hydraulics, and to determine the well spacing. These methods are presented in Appendix D of Reference 10.6.

There are no acceptance criteria for this evaluation since its purpose is to provide recommendations for the need of a flow barrier to mitigate the drawdown effects of dewatering.

6. EVALUATION

6.1 Topography

The topography of the site is gently rolling with an east-west trending set of ridges. At the BBNPP, ground elevations range from 650 feet along Walker Run in the southwest corner of the site up to elevations slightly higher than 800 feet on the hilltop located in the vicinity of the NI and cooling towers (Reference 10.8). North of Beach Grove Road (north of the site), the elevation rises sharply upward to elevations of 1,100 to 1,150 feet along the crest of the ridge. Thus, total topographic relief in the immediate vicinity of BBNPP is approximately 500 feet. The ground surface elevation in the area of the NI generally ranges from approximately 700 to 800 feet. The ground surface elevation in the area of the ESWEMS pond ranges from approximately 680 to 740 feet. The existing grade elevation in the area of the cooling towers varies from 700 to 800 feet. Attachment A provides a general site layout for the BBNPP along with the general topography.

6.2 Geology

The geologic conditions described below are generally based on FSAR Sections 2.4.12 (Reference 10.5), 2.5.4 (Reference 10.9) and the recent boring logs (Reference 10.2).

Subsurface conditions beneath the site are characterized by sand and gravel deposits that are underlain by shale bedrock.

The Pleistocene Age overburden soils range in thickness from 0 to 100 feet with the thinner overburden encountered on the ridges and hills. With the exception of some loose sand pockets, the overburden consists of over-consolidated, brown silty sand and sand containing gravel and large rounded cobbles and boulders. The frequency of the boulders increases with depth.

The bedrock generally consists of folded, jointed and fractured Devonian-Age shales of the Mahantango Formation extending approximately 1000 to 1200 feet beneath the site. The Mahantango Formation consists primarily of dark gray, silty to very silty claystone. Frequent joints and intense cleavage development causes the claystone to become splintery, and fragmented upon weathering. The Mahantango Formation has low to moderate resistance to weathering.

6.3 Hydrogeology

The hydrogeologic conditions described below are generally based on FSAR sections 2.4.12 (Reference 10.5) and 2.5.4 (Reference 10.9), the Rizzo Monitoring Well Test Data Report (Reference 10.3) and the Weaver Boos report (Reference 10.6).

Generally, borings in the vicinity of the NI and cooling towers did not encounter groundwater in the overburden soils based on the field exploration performed by Rizzo (References 10.3 and 10.5). Although not encountered, it is not uncommon for groundwater to become perched in granular soils at the soil-bedrock interface. The occurrence and quantity of this perched groundwater is often seasonally affected and highly variable in areas of a sloped interface between the granular overburden and the less permeable bedrock. The conceptual design for the temporary construction dewatering system considers this potential source of water, which must be controlled to facilitate the planned work. In the vicinity of the ESWEMS pond and pump house, groundwater levels in the overburden typically range from 2 to 15 feet below the ground surface (bgs). Along the south side of the proposed ESWEMS pond, the depth to water was approximately 2 to 8 feet bgs, and flows generally southerly and westerly towards Walker Run. In the vicinity of the ESWEMS pond and pump house, the overburden aquifer is recharged by downward percolating precipitation and upflow from the deeper bedrock aquifer. Groundwater discharges from the surficial aquifer as springs and seeps into ponds, the wetlands along the southern border of the site, and into Walker Run.

The underlying Mahantango Shale Formation is also considered an aquifer. There are no extensive aquitards in the vicinity of the BBNPP site. Vertical groundwater flow in the upland areas to be developed as the power block and cooling towers is generally downward. Vertical groundwater flow is generally upward from the bedrock aquifer to the overburden aquifer in the area to be developed as the ESWEMS pond.

6.4 Hydraulic Properties by Layer

Groundwater flow is simulated in seven layers. Walker Run, the site wetlands and the excavations for the ESWEMS pond are generally located within Layer 1, which is a relatively high conductivity zone. The base of the ESWEMS pond excavation is generally at the top of the competent rock, which is within Layer 2 and exhibits a lower conductivity than Layer 1. The excavations for the NI and cooling towers extend through Layer 1 and well into Layer 2. Layer 2 includes the upper weathered rock zone, the transition zone and the upper extent of the competent rock. Layer 2 is also the primary component of the highland ridges. Layers 3 through 7 are deeper shale bedrock.

6.4.1 Layer 1

Layer 1 exhibits a varying thickness across the model domain, since its upper surface is based on the topography of the site and the lower surface is based on the interface with weathered bedrock (Reference 10.2). Rizzo performed and documented (References 10.3 and 10.5) both slug and pump tests to quantify the horizontal hydraulic conductivity of Layer 1.

The horizontal hydraulic conductivity values calculated from slug tests conducted in the overburden aquifer ranged from 1.19×10^{-5} cm/s to 3.4×10^{-2} cm/s, with a geometric mean of 3.63×10^{-3} cm/s (Reference 10.5, Section 2.4.12.3.2.1). A single slug test in the overburden was completed in observation well MW410 during 2010, indicating a horizontal hydraulic conductivity of 1.72×10^{-3} cm/s (Reference 10.3). Slug tests of the kind implemented during the site investigation measure horizontal hydraulic conductivity only near a test well, and may reflect influences by filter pack storage or low-conductivity borehole skins remaining after conventional rotary drilling using mud.

The horizontal hydraulic conductivity values calculated based on a 24-hr pump test at approximately 60 gpm ranged from 3.63×10^{-2} cm/s to 1.26×10^{-1} cm/s, with a geometric mean of 5.93×10^{-2} cm/s (Reference 10.5, Section 2.4.12.3.2.1). A pump test of the kind implemented during the site investigation stresses a much broader area of the aquifer than a slug test, and is therefore considered more representative than the slug test results.

S&L considers the geometric mean value obtained during the pump test, which is the highest mean value for the site, as a representative (yet conservative) value for the horizontal hydraulic conductivity in the overburden aquifer. Because sand and gravel deposits comprising the overburden aquifer are horizontally stratified as described in the boring logs, the deposit is likely anisotropic, and the vertical hydraulic conductivity (which has not been measured) is considered to be $1/10^{th}$ of the horizontal value obtained during the pump test. The specific yields computed for the pump test indicated values ranging between 0.253 and 0.500, with a geometric mean of 0.344, and a median value of 0.322. For a well- to fairly well-graded material such as the overburden, the median value of 0.322 appears reasonable and is therefore considered appropriate for use in the model. Thus, conservative values to quantify the hydraulic properties of the overburden aquifer were selected for use in this conceptual dewatering evaluation.

6.4.2 Layers 2 Through 7

Layer 2 also varies in thickness, since it extends from the interface with the overburden down to elevation 600 feet and is also referred to as the shallow shale bedrock. Layers 3 through 7 are considered to be uniform in thickness and extend from elevation 600 feet down to elevation 0 feet.

The horizontal hydraulic conductivity values calculated from slug tests conducted in the shallow bedrock aquifer during 2007 and 2008 ranged from 3.70×10^{-4} cm/s to 1.36×10^{-2} cm/s, with a geometric mean of 1.41×10^{-3} cm/s (Reference 10.5, Section 2.4.12.3.2.2). The horizontal hydraulic conductivity values calculated from slug tests conducted in the shallow bedrock during 2010 ranged from 4.69×10^{-5} cm/s to 1.32×10^{-3} cm/s, with a geometric mean of 2.86×10^{-4} cm/s (Reference 10.3, Table 3).

The horizontal hydraulic conductivity values calculated from slug tests conducted in the deep bedrock aquifer ranged from 1.15×10^{-5} cm/s to 1.51×10^{-3} cm/s, with a geometric mean of 1.18×10^{-4} cm/s (Reference 10.5, Section 2.4.12.3.2.2). No further slug testing of wells screened in the deep bedrock was reported during 2010.

Packer tests were performed in 56 intervals of the shale bedrock during 2007 and 2008. Of these tests, nearly one-half (26) indicated impermeable rock. In the other 30 tests, the horizontal hydraulic conductivity ranged from 2.39×10^{-7} to 1.63×10^{-4} cm/s (Reference 10.5, Section 2.4.12.3.2.2). Packer tests were performed in 34 additional intervals of shale bedrock during 2010. In these most recent tests, seven (7) tests indicated impermeable rock. In the other 27 tests, the horizontal hydraulic conductivity ranged from 3.99×10^{-7} cm/s to 3.82×10^{-4} cm/s (Reference 10.3).

The horizontal hydraulic conductivity values calculated based on a 24-hr pump test at approximately 6 gpm ranged from 1.93×10^{-5} cm/s to 7.23×10^{-4} cm/s, with a geometric mean of 1.64×10^{-4} cm/s (Reference 10.5, Section 2.4.12.3.2.2) during 2007 to 2008. This pump test was completed in wells screened from elevations ranging from 502 to 582 feet. Additional pump tests were performed using wells screened in the bedrock during 2010. The horizontal hydraulic conductivities calculated on the most recent pump tests ranged from 6.42×10^{-6} cm/s to 2.88×10^{-4} cm/s, with a geometric mean calculated equal to 5.43×10^{-4} cm/s (Reference 10.3, Table 4). The recent pump tests utilized wells screened in the bedrock at elevations ranging from 618 to 670 feet.

For the reasons discussed in Section 6.4.1, S&L considers the geometric mean values obtained during the pump tests as more representative than values obtained by slug testing. However, results from the packer testing program are also considered representative for the intervals that were tested. Of the values reported for the shale bedrock, the geometric mean horizontal hydraulic conductivities from the pump tests are selected as conservatively high values for use in the dewatering evaluation. S&L selected the geometric mean pump test conductivity value of 5.43×10^{-4} cm/s as representative and conservative for shallow bedrock occurring above an elevation of approximately 600 feet (based on 2010 pump test). The geometric mean pump test conductivity value of 1.64×10^{-4} cm/s is similarly selected as representative and conservative for deep bedrock occurring below an elevation of approximately 600 feet (based on 2007 and 2008 pump tests). These values are regarded as conservative because their selection is likely to over-predict rather than under-predict the flow of groundwater to be yielded by temporary dewatering systems. As was selected for the overburden, S&L also considered the vertical conductivities of the bedrock (shallow and deep) to equal 1/10th of their respective horizontal values obtained during the pump tests.

Although the shale bedrock is correctly described as an aquifer in Reference 10.5 (Section 2.4.12.3.2.2), the conductivity of Layer 2 is about 1/1,100th of the overburden aquifer conductivity, while Layers 3 through 7 are about 1/3,700th of the overburden aquifer. The contrast in conductivity between the overburden and bedrock aquifers means the preferential flow path is through the overburden rather than the bedrock aquifers.

6.5 Groundwater Level Observations

Monthly water table elevations in the overburden and the head elevations in the bedrock were previously measured between October 2007 and September 2008 (Reference 10.5, Table 2.4-44). The groundwater elevation data obtained in 2007 and 2008 indicate a slight seasonal variation in groundwater elevation has been observed during the monitoring period. Generally, the groundwater elevation is at a minimum in autumn, followed by gradually increasing levels in winter, peak groundwater elevations are noted in the early spring and then decreasing elevations through the summer. For the overburden monitoring wells, the differences between the annual high and low elevations for each well ranged from 1.67 to 5.49 feet. Elevations measured on January 26, 2008 appear to represent "average" conditions, and elevations measured on March 24, 2008 are taken to represent "high" water levels.

Monthly groundwater levels were most recently reported for the period between May 2010 and July 2010 (Reference 10.3). Measurements taken during 2010, which include measurements from the initial round of wells (MW300 series) and the recently installed MW400-series observation wells (MW401 through MW410), are generally somewhat lower than the "average" levels measured during January 2008. In order for this evaluation to conservatively consider the reasonably foreseeable maximum future groundwater elevations that may occur in the 2010 – 2011 12-month monitoring period, two feet was added to the "high" groundwater elevations previously reported during March 2008. These higher values were then selected as flow model calibration targets. The highest recently measured water levels in the MW400-series wells were "corrected" to reasonably foreseeable maximum future groundwater levels by adding 5.0 feet to the new rock wells and 4.6 feet to the new overburden well for the calibration targets to evaluate the groundwater model simulations. The resulting conservatively high groundwater elevations selected for use herein are listed in Table 2 of Reference 10.6, which is Appendix A of this report.

6.6 Excavation Approaches and Dewatering Implications

6.6.1 Collection Ponds for Dewatering Output

Prior to initiating dewatering activities, preparations must be made to receive the water discharged from the dewatering systems. Final selection of the site ponds, which will receive the flow from the dewatering system, as well as the precipitation that falls in the excavation, should be based on the location of the ponds, piping routes, pond volumes and the sequence of construction of the ponds. The following paragraphs address the possible ponds which may be selected to receive the waters.

6.6.1.1 Temporary Groundwater Storage Pond

Effluent from the dewatering system could be routed through the Temporary Groundwater Storage Pond (TGWSP), which is to be located between the ESWEMS and the NI. Thus, it would be beneficial to construct this pond prior to excavation activities in order to use it as a collection area for the dewatering system. The design elevation of the bottom of the TGWSP is anticipated to be approximately elevation 665 to 670 feet (to be determined during final design), while the current ground surface is at approximately elevation 672 feet. Table 5 of Reference 10.3 documents the range of measured groundwater elevations from 656.58 to 658.91 feet in this area. Given this information, it is anticipated that dewatering for the construction of the TGWSP will not be needed.

6.6.1.2 Combined Waste Water Retention Pond

The Combined Waste Water Retention Pond (CWWRP) is located east of the ESWEMS Pond. Reference 10.16 indicates the design elevation of the bottom of the CWWRP is 686.5 feet. The current ground surface elevation in the vicinity of the CWWRP ranges from approximately 676 to 728 feet (Reference 10.8). The estimated groundwater level is estimated to be below elevation 675 feet (Reference 10.3), except where the groundwater may be perched on top of the bedrock. Although the field exploration program by Rizzo did not encounter groundwater perched on the bedrock, some perched groundwater can be anticipated. Given this information, it is anticipated that dewatering for the construction of the CWWRP will not be required. However, if any groundwater is encountered at the soil/rock interface, this can be controlled by utilizing diversion trenches and sumps around the periphery of the excavation to maintain a dry condition. Where soil is present beneath the pond floor, the groundwater is estimated to be below the excavation limits.

The CWWRP could be used for storage and exfiltration of the dewatering effluent provided it is constructed early enough and that the lining designed for the permanent pond is not installed until after the dewatering is complete. However, the excavation for the placement of engineered fill below the ESWEMS pond (as depicted in the drawing attachments to the Response to RFI SL-BBNPP-149 [Reference 10.4]) appears to intersect the western portion of the CWWRP. Thus, the final excavation plan for the ESWEMS pond construction or the final design of the CWWRP will require some slight modifications to allow the use of this waste pond for dewatering effluent while the ESWEMS pond excavation and dewatering system is active.

6.6.1.3 Other Ponds

In addition to the TGWSP and the CWWRP, other impoundments such as the Temporary Sediment Basin (TSB) and the ESWEMS Pond could receive dewatering system output, provided they are operable prior to completion of the dewatering activities for the NI and the cooling towers.

6.6.2 ESWEMS Pond

The ESWEMS pond excavation is expected to fully penetrate the overburden soils and the upper weathered bedrock to establish the bearing surface (subsurface information from References 10.2 and 10.4) on the competent rock at elevations ranging from 610 to 640 feet. The excavation in the vicinity of the southern portion of the ESWEMS pond will extend approximately 56 feet through saturated granular deposits. Existing groundwater elevations are discussed in Section 6.3.

To facilitate quality construction methods in the ESWEMS area, the excavations should be performed in a dry condition. A dewatering system consisting of deep wells surrounding the excavation is conceptually designed. The excavation can proceed as the dewatering takes place provided the dewatering system maintains the groundwater level below that of the excavation. As the excavation advances, a series of groundwater monitoring wells will be monitored to verify the effectiveness of the dewatering system in reducing the groundwater level.

6.6.3 Nuclear Island and Cooling Towers

The final plant grade in the vicinity of the nuclear island and cooling towers is at elevation 719 and 699 feet (Reference 10.8), respectively, while the current ground surface ranges from approximately 700 to 800 feet (Reference 10.8) in these areas. These structures and/or the fill supporting these structures will extend down to the upper surface of the competent rock, which is at an approximate minimum elevation of 650 feet in the NI and elevation 565 feet in the vicinity of the cooling towers, as indicated by References 10.2 and 10.4. Thus, the excavations associated with construction of the NI and cooling towers will extend from the current ground surface, through the surficial soils and into the bedrock. Based on References 10.2 and 10.3, the overburden soils are not saturated. General groundwater conditions for the site are discussed in Section 6.3. Thus, an active dewatering system for the upper soils is not likely to be required. It is expected that groundwater inflows from localized water bearing zones in the overburden and from the bedrock (weathered and unweathered) may be controlled using trench drains at the soil bedrock interface as well as some trenches cut into the bedrock excavation slopes and floor. The trench drains can be sloped to sumps where the water can be pumped out if a proper slope cannot be attained to drain the trenches to the groundwater storage pond by gravity.

An area of uncertainty is located at the northwest portion of the cooling towers excavation, where the available boring data is limited. Specifically, Rizzo developed excavation plans (Reference 10.4) for the cooling towers based on a boring located at the proposed center of each tower. From these two borings, they extrapolated the bedrock surface elevation and likely excavation depth. Reference 10.4 indicates the northwest quadrant of the cooling towers excavation will extend down to elevation 646 feet. Figure 2.4-33 of Reference 10.5 indicates that the stream bed of Walker Run near the intersection of Market Street and Beach Road is at an approximate elevation of 675 feet. If the overburden extends below the elevation of Walker Run, it is likely that the overburden will be saturated. Figure 5 of Reference 10.3 did not indicate groundwater in the overburden soils in this area. If the overburden soils are saturated, it is likely that excessive groundwater pump rates and subsequent dewatering of the adjacent wetlands and possibly Walker Run will occur. The groundwater pumping rates and subsequent drawdown determined and presented in this evaluation does not consider this potential outcome since the Rizzo groundwater data does not indicate the overburden in this area to be water-bearing. It should be noted that if the overburden extends below the wetlands, this condition could be mitigated by installing a flow barrier wall as discussed for the ESWEMS pond and pump house. No further discussion is provided for the cooling towers since this condition and the extent of the cooling towers excavation will be determined during the subsurface exploration and construction phases for the cooling towers.

6.6.4 ESWEMS Pipeline

The ESWEMS pipeline from the ESWEMS pump house to the NI will have an approximate invert elevation of 694 feet, with the pipe bedding supported on the natural soils (Reference 10.13). Since the construction activities for the ESWEMS pipeline is above the groundwater elevation of 665 feet (Figure 5 of Reference 10.3), construction dewatering will not be needed.

6.6.5 Groundwater Flow Barrier

Dewatering for the ESWEMS excavation can be performed either with or without a flow barrier as discussed later. Based on the inputs for this work, the ESWEMS excavation is the only area where a flow barrier was considered. However, based on the site conditions (which may be identified when additional exploratory borings and wells are performed), a flow barrier may also be considered for the northwestern area of the cooling towers excavation.

If a flow barrier, such as a slurry wall, is constructed, a significant reduction in the required pumping rate and aerial extent of drawdown will be achieved. Reference 10.6 considered the effect of implementing a flow barrier along a preliminary alignment. If the final design of the flow barrier is combined with a construction phase excavation support to minimize the pond excavation, the alignment may be adjusted inward (made smaller). An open excavation (sloped sidewalls not structurally supported) is currently planned for construction of the ESWEMS pond as indicated in the response to RFI SL-BBNPP-149 (Reference 10.4). The extent of the excavation with this approach is quite wide. If a construction phase excavation support (earth retention system) is used, the planned dimension of the excavation will be smaller since the cut slope out of the excavation will be eliminated. Since the dimension of the excavation is now smaller, the barrier can be closer to the pond, making the overall area to be dewatered smaller.

6.7 Definition of the Flow System

Weaver Boos reviewed the available information and formulated the following definition of the flow system as presented in Reference 10.6. This review indicates that the BBNPP site may be viewed as located within a small groundwater basin storing water mostly in the overburden aquifer. The overburden aquifer basin is defined to the north by the system of higher ridges, to the east by a bedrock ridge and groundwater flow divide corresponding approximately to the route of Confers Lane, to the south by a bedrock ridge forming in the knolls, and to the west by a bedrock ridge forming in the uplands west of Walker Run. Surface water and groundwater enter the overburden basin from the north and exit the basin via Walker Run, its small tributary located on the BBNPP site.

Deeper groundwater flows through the bedrock are less constrained than in the overburden basin and are assumed to reflect high upland recharge occurring to the north, followed by upward flow just south of the site, and deeper horizontal southerly and southeasterly flow towards the Susquehanna River.

6.7.1 <u>Water Flow Budget (Initial Steady State Conditions)</u>

The groundwater digital model is presented in Reference 10.6 (included as Appendix A of this report), and is summarized in the following sections. Based on the baseline flow budget presented in Reference 10.6, the basin receives and discharges groundwater from three potential sources of groundwater flow:

- The first is groundwater discharge, assumed equal to groundwater recharge, reported in Table 2.4-42, of Reference 10.5 for the Wapwallopen Creek Basin as ranging from 6.6 to 21.8 inches per year, with an average equal to approximately 14.2 inches per year.
- The second is groundwater exchange with Walker Run that flows along the west side of the model domain.
- The third is groundwater inflow originating in the ridge that rises to elevations as high as 1,100 feet directly north of the site. This source cannot be directly measured, yet its significance is inferred from the upward vertical flow of groundwater in the lowland areas south of the proposed power block and ESWEMS pond.

Potential discharges of groundwater originating beneath the site include bank and bottom discharge to Walker Run and subsurface outflow to the south (much of which likely occurs in overburden deposits beneath Walker Run), with eventual discharge to the Susquehanna River. Additional southerly and southeasterly discharges of groundwater through the shallow and deep bedrock are also inferred from the bedrock potentiometric surfaces provided by Reference 10.3.

6.7.2 Water Flow Budget and Drawdown Forecast for Dewatering Without a Flow Barrier

The mass flow budget for this model includes drains that represent the collective withdrawal of groundwater by multiple dewatering wells to temporarily (about three years) depress the groundwater to facilitate construction of the ESWEMS excavation and drains to represent dewatering trenches and/or well points to dewater the minor inflows in the NI and cooling towers excavations.

Zone budgets were set in the model to separately account for the dewatering system outflows from the power block, cooling towers, and ESWEMS excavation. The dewatering system under this scenario is suggested to remove water at a rate of 0.11 cfs (50 gpm) at the power block excavation and 0.16 cfs (70 gpm) from the cooling towers excavation. The total flow from the ESWEMS excavation is 2.0 cfs (920 gpm), which is the sum of approximately 0.56 cfs (250 gpm) from the ESWEMS drains, and 1.5 cfs (670 gpm) from the ESWEMS dewatering wells. The total pump flow rate of 2.3 cfs (1040 gpm) will be required to maintain steady state conditions in all three excavations. These rates are steady state and will be much higher when dewatering is first initiated. The flow rates when the dewatering program is implemented will be dependent upon the desired schedule to achieve the target groundwater elevations.

The digital model results of drawdowns in Layer 1 for the dewatering system without the use of flow barriers are illustrated in Attachment D. The drawdowns are shown in feet, and represent water table depression from the steady state head calculated by the calibrated model. Review of Attachment D indicates deep water table depression (5 to 40 feet) in the areas extending west, south, and east of the proposed ESWEMS pond. The model predicts an area of up to 25 feet of groundwater table depression extending approximately 400 feet south and east of the ESWEMS pond. This pumping scheme would most likely result in extensive dewatering of the wetlands south of the ESWEMS pond.

6.7.3 Water Flow Budget and Drawdown Forecast for Dewatering With a Flow Barrier

Installation of a flow barrier, such as a soil-bentonite slurry wall, or diaphragm wall substantially reduces the steady-state outflow from the ESWEMS pond excavation dewatering system.

Considering the preliminary alignment of the flow barrier depicted on Attachment H, the model calculated (Reference 10.6) the steady state flow rate required to dewater the ESWEMS excavation to be approximately 0.51 cfs (230 gpm) (0.35 cfs from the rock drains and 0.16 cfs from the wells) as compared with 2.0 cfs (920 gpm) without the barrier. Total dewatering system outflow for the NI, cooling towers and ESWEMS excavations is approximately 0.78 cfs (350 gpm) considering a flow barrier around the ESWEMS and approximately 2.3 cfs (1040 gpm) without a flow barrier. The model also indicates that with the flow barrier around the ESWEMS, the flow from the drains in the rock portion of the three excavations (NI, cooling towers and ESWEMS pond) will yield approximately 0.62 cfs (280 gpm). However, the actual flow may be less due to the wide range of hydraulic conductivities reported in References 10.3 and 10.5. Numerous packer tests conducted in the shale during the site investigation indicate hydraulic conductivity values much lower than considered in the model, and in approximately one-half of the tests, the hydraulic conductivity was effectively zero. Thus, these hydraulic conductivities and the resultant flow values are considered to be conservatively high.

The flow rates discussed herein are steady state and will be higher when dewatering is initiated. The initial rates of dewatering within the flow barrier are dependent upon the schedule allocated to achieve the target groundwater elevation and the volume of water stored in the pore space of the soils within the barrier wall. As the alignment of the barrier wall is adjusted, the initial flow rate and/or schedule of achieving the target groundwater elevation will need to be reconsidered.

As before, the flow model (modified to include a groundwater barrier wall around the ESWEMS pond and pump house, wells and drains) used the initial heads computed by the baseline flow model and the expected drawdowns are plotted on Attachment E. Review of this figure again shows the deep drawdown required at the ESWEMS pond. However, the simulated drawdown elsewhere in the basin is very much less than the simulation without the flow barrier. Drawdown greater than 5 feet is focused immediately west and southwest of the flow barrier. This effect is likely not primarily due to the withdrawal of water from within the flow barrier, but rather due to the partial cutoff of natural westerly flow of groundwater through the position of the barrier. Groundwater levels are expected to diminish on the down-gradient side of a flow barrier and possibly build along the upgradient side. The close proximity of the wetland to the flow barrier wall at the northwest corner of the ESWEMS pond (near the 50-foot buffer zone) and construction of the ESWEMS pumphouse structure directly south of the wetland may result in some mounding of groundwater upgradient of these impermeable barriers. This groundwater mounding may result in a rise in the groundwater level and subsequent expansion of the wetlands into the 50 foot buffer zone. Thus, there will be a need to monitor the water level fluctuation in this wetland area.

6.8 Conceptual Dewatering Design

In general, the dewatering system should be designed to remove the flows suggested by the flow budgets and to evacuate the precipitation that falls into the excavation during construction. The flows discussed herein, only consider those flows originating from the groundwater and not those associated with evacuation of precipitation into the excavation. However, due to the conservatism used in this conceptual design, as noted later, the dewatering system should be capable of extracting most of the precipitation that falls within the limits of the excavation. Considering that sound construction practice dictates the area around the excavations will be graded to prevent stormwater from flowing into the excavation, the only additional water to be evacuated will be the direct precipitation that falls into the excavations. The approximate cumulative aerial extent of the excavations is 53.7 acres (from the plans provided in RFI No SL-BBNPP-149). Considering the storm water report (Report No. SL-009446 [Reference 10.15]), the 100 year storm event is 7.49 inches in a 24 hour period. The increased flow from this storm event is 10,921,000 gallons per day (10.9 mgd) or 7580 gpm. This flow, combined with seepage into the excavations equates to a flow of 7,930 gpm. This flow should be within the capacity of the pumps for the sumps which collect and discharge the flow. These pumps will be sized in final design.

Dewatering wells could be drilled at this site using direct rotary, reverse-circulation rotary, cable tool, or other methods such as Rotosonic drilling. Reverse-circulation rotary will provide wells with the greatest efficiency and should therefore be considered. The other methods listed might tend to compact the aquifer formation, or leave low-conductivity borehole skins that cannot be completely removed during development. Because the overburden aquifer contains boulders, it may be necessary to use a chisel, or other methods to remove or penetrate them.

6.8.1 Conceptual Design Without Flow Barrier

Deep dewatering wells may be located around the perimeter of the ESWEMS excavation to implement the first stage of water table depression. Because wells cannot depress the water table to the base of the aquifer in areas between the wells, a level of approximately 10 feet above the shale is selected as a target for use in computing cumulative drawdowns. By inspection of the drawdown curves presented in Appendix D of Reference 10.6, an inter-well spacing of approximately 100 feet will provide for a cumulative drawdown of slightly more than 50 feet at locations between the wells. Dewatering wells may be located as shown on Attachment F, based on this conceptual design criterion. A total of approximately 28 dewatering wells appear to be appropriate for conditions at the ESWEMS pond excavation. Given the large number of wells required and potentially very large initial flows that such a system might develop, individual pumps should be sized for maximum flows of approximately 100 to 150 gpm each. The discharge lines should be fitted with throttling valves to control the overall flow rate of the system and avoid overwhelming the body receiving the discharge. A schematic diagram showing a typical dewatering well considered appropriate for conditions at this site is provided as Attachment I.

The ESWEMS excavation will likely require a method to control groundwater at the interface of the overburden and weathered shale in the form of a system of vacuum well points positioned as shown on Attachment F. Each of the headers shown will draw water from well points that are typically 2-in. diameter that may be drilled, driven or jetted in if conditions allow. Each header will need to be connected to its own vacuum pump. Individual vacuum pumps will need to be sized based on conditions encountered and the length of each header.

Final stages of the dewatering conceptual design for the ESWEMS excavation include the installation of trench drains and sumps into the exposed bedrock surface at the base of the ESWEMS excavation. Such trenches might be excavated 3 to 5 feet wide, and 2 to 3 feet deep, and sloped to collection sumps for ejection from the excavation. Groundwater flow from the bedrock is expected to vary over a wide range, and additional trenches or sumps might be needed at locations to be determined. Three such trenches were incorporated into the digital flow model at the ESWEMS pond as shown on Attachment F.

Groundwater observations at the NI and cooling towers excavations suggest that little saturated overburden is present in either area. It is therefore expected that groundwater inflows may be controlled using trench drains cut into the bedrock at the locations and elevations suggested on Attachments F (NI) and G (cooling towers). The trench drains can be sloped to sumps where the water can be pumped to the TGWSP or other disposal points if gravity drainage to the ponds cannot be established.

The effectiveness of the dewatering system should be monitored to compare observed drawdown with the estimates described herein (or more detailed design estimates developed prior to implementation). Water levels may be monitored for this dewatering strategy using existing monitoring well clusters that have been drilled at the site. Additional monitoring wells or piezometers should be installed at select locations to provide further points for comparison. A typical schematic diagram for monitoring wells or piezometers is provided on Attachment J.

Operation of this conceptual dewatering system will require an uninterrupted source of power for electrically operated submersible pumps and vacuum pumps, and an uninterrupted source of fuel for internal combustion vacuum pumps if selected for use. Provisions for convenient maintenance should be included for all system elements as needed for a project duration approaching 3 years.

6.8.2 Conceptual Design of a Flow Barrier

Temporary construction dewatering of the site was simulated to evaluate the potential benefits of a flow barrier encompassing the proposed ESWEMS pond excavation (See Paragraph 6.7.3). Wall boundaries considered in the flow model were a 3-feet thick flow barrier characterized by a hydraulic conductivity of 1×10^{-6} cm/s. The wall boundaries form a continuous flow barrier around the proposed excavation and extend from top to bottom in Layer 1 of the model. This model simulation utilized 14 pump wells, located inside the flow barrier wall to achieve dry conditions in the ESWEMS pond. The preliminary alignment of the flow barrier and the wells is presented on Attachment H.

As discussed in Paragraph 6.6.3 an area of uncertainty is located at the northwest portion of the cooling towers excavation, where the available boring data is limited. If the overburden extends below the elevation of Walker Run or the associated wetlands, it is likely that the overburden soils are saturated it is likely that excessive groundwater pump rates and subsequent dewatering of the adjacent wetlands and possibly Walker Run occur. If these conditions are present the installation of a flow barrier wall should be considered in the area of the cooling towers excavation where the overburden extends below the groundwater table.

The NI excavation will not require a flow barrier.

If a soil-bentonite (S-B) slurry wall is selected for use as a flow barrier, it might be installed along an alignment as shown on Attachment H, and should reflect the following guidelines in its final design:

- The slurry wall will be a minimum of three feet thick, and will be at least ½-foot-thick for each 10 feet of hydraulic head across the wall.
- The slurry wall will be keyed into competent shale such that the flow underneath the wall through the shale is less than or equal to the flow directly through the soil-bentonite slurry wall. The minimum depth of penetration of the slurry wall key will be two feet into the shale below any permeable lenses or weathered shale zones.
- The slurry will consist of 4 to 7 percent bentonite in water, and the backfill will contain bentonite at a rate of 3 percent. If the groundwater barrier is also designed to act as a temporary excavation support wall, Portland cement may also be incorporated into the slurry.

- The slurry wall will have a designed in-situ permeability less than or equal to 1 x 10^{-7} cm/s. A value of 1 x 10^{-6} cm/s is used to account for any minor imperfections in the wall. Some plastic fines may need to be imported to meet this criterion.

- The slurry wall will have a minimum of a five-foot overlap at corners.

- The slurry wall will be constructed vertically.

- Slurry levels will be maintained at least seven feet above the groundwater table during construction. Depending upon the groundwater levels along the southern leg of the wall for the ESWEMS pond, this will likely require the construction of a berm to raise the ground level at several locations along the specified alignment.

- Extensive quality control measures should be taken to assure that the S-B slurry wall is constructed without gaps or windows.

- Because the overburden aquifer contains boulders, it may be necessary to use an orange peel, clamshell, chisel, or other methods to remove or penetrate through them.

If final design incorporates the flow barrier wall into an excavation support structure, sheet piling, concrete diaphragm walls, intersecting caissons or secant piles, or cofferdams should be considered. All aspects of ground support and excavation stability will require extensive additional evaluation and detailed designs beyond the scope of this evaluation.

Appendix D of Reference 10.6, which is attached to this report as Appendix A, estimates potential flux rates through the flow barrier wall when the maximum gradient is established. Assuming that the in-situ hydraulic conductivity will achieve 1 x 10^{-6} cm/s, flux across the wall is estimated at approximately 8 gpm. If the design criterion of 1 x 10^{-7} cm/s is achieved, the corresponding flux rate is about 1 gpm. If the barrier wall is discontinuous over 1 percent of its vertical surface area due to gaps or windows, excess inflows approaching 5,000 gpm might occur. This finding underscores the need for adequate quality assurance and quality control (QA/QC) during construction. Furthermore, it indicates that if the wall is discontinuous, the presence of discontinuities should be obvious shortly after the initiation of interior dewatering as the excavation proceeds downward.

Operation of the barrier wall and interior dewatering system should include a piezometric monitoring program to compare expected groundwater withdrawals and drawdown rates with those calculated in advance. This program should include continuous monitoring of the existing and proposed monitoring wells or piezometers at select locations. Data logging pressure transducers with remote telemetry are recommended for this purpose so that head levels may be continuously monitored during initial drawdown and later during the extended phase of construction activity. If any windows or gaps in the flow barrier are indicated by the piezometric monitoring program, then pressure grouting or other remedial measures will be necessary to correct these deficiencies. Additional groundwater monitoring wells may be warranted in the immediate vicinity of significant repairs to the flow barrier wall.

6.8.3 Conceptual Dewatering System Design With a Flow Barrier

When determining the spacing between wells within the flow barrier for the ESWEMS pond, they can be spaced at greater distances than without a barrier, since the flow barrier will effectively prevent inflows.

Considering the use of the flow barrier along the preliminary alignment, dewatering wells may be located as shown on Attachment H. A total of approximately 14 dewatering wells appear appropriate when the flow barrier is utilized. Given the number of wells required and the potential flows (steady state total in flow of 350 gpm, for the three excavations evaluated) that such a system might develop, individual pumps can be sized for a maximum flow rate of 150 gpm each.

The model of this dewatering strategy suggests that interior dewatering might require a steady-state flow on the order of 230 gpm at the ESWEMS pond excavation; however, the actual flow may be less as discussed in paragraph 6.7.3.

Appendix D of Reference 10.6 (which is attached to this report as Appendix A), determined the volume of groundwater contained in the saturated pore space of the soils within the ESWEMS flow barrier to be approximately 166 acre-feet. Approximately 85 days are required to remove this stored water (not considering inflow from upward flow through the soil rock interface or through the barrier wall), at a flow rate of 600 gpm (Reference 10.6). During the initial dewatering, the inflow through the rock interface and flow barrier can be estimated as one half the steady state flow rate. Thus if 85 days are scheduled to drain the saturated soils within the ESWEMS flow barrier, the average flow rate during initial dewatering is approximately 715 gpm (600 gpm + (0.5 x 230 gpm) = 715 gpm [1.6 cfs]).

A second stage of water table depression to the shale surface or near the shale surface may require the use of vacuum well points positioned as shown on Attachment H. Each of the headers shown will draw water from well points that are typically 2-in. diameter that may be drilled, driven, or jetted in if conditions allow. Each header will need to be connected to its own vacuum pump. Individual vacuum pumps will need to be sized based on conditions encountered and the length of each header.

Final stages of the dewatering conceptual design include the excavation of trench drains and sumps into the exposed bedrock surface in front of the toe of the slope at the base of the ESWEMS excavation. Such trenches might be excavated 3 to 5 feet wide, and 2 to 3 feet deep, and sloped to collection sumps for ejection from the excavation. Groundwater flow from the bedrock is expected to vary over a wide range, and additional trenches or sumps might be needed at locations to be determined. Three such trenches were incorporated into the digital flow model at the ESWEMS pond as shown on Attachment H.

Groundwater observations at the NI and cooling towers excavations suggest that little saturated overburden is present in either area. It is therefore expected that groundwater inflows may be controlled using trench drains cut into the bedrock at the locations and elevations suggested on Attachments H (NI) and G (cooling towers). The trench drains can be sloped to sumps where the water can be pumped to the TGWSP or other disposal points, if gravity drainage to the ponds cannot be established.

Operation of this conceptual dewatering system should be less sensitive to brief interruptions in electrical power because the flow barrier will retard inflows to the excavation. However, provisions for convenient maintenance should still be included for all system elements as needed for a project duration approaching 3 years.

6.9 Disposal of Groundwater

As stated in Section 6.7.3 above, the steady state discharge from a dewatering system without the use of a seepage cutoff wall would be approximately 1040 gpm (approximately 1.5 million gallons per day [mgd]). Considering the use of a seepage cutoff wall around the ESWEMS excavation, the discharge will be reduced to an estimated flow of 350 gpm (0.5 mgd). For this report, an average value of 350 gpm (0.5 mgd) will be considered as the average daily quantity of water that will be discharged with the installation of a competent seepage cutoff wall and after steady state conditions are established.

There are several options for the disposal of the groundwater pumped from the excavations. PPL may or may not choose to implement any one or more of these options. They include:

- Discharge into the Susquehanna River.
- Temporary storage/sedimentation in the temporary groundwater storage pond (TGWSP) or other discharge ponds, with or without infiltration into the overburden prior to release.
- Injection / infiltration into the overburden (away from the excavation) to replenish the drawdown in groundwater levels.
- Treatment for human consumption.
- Used for various construction activities, such as:
    - Dust control;
    - Water for compaction control of fill and backfill; and
    - Concrete mixing.

The use of injection wells to replenish the drawdown in the groundwater level in the overburden soils can be considered, but these wells have a tendency to clog due to sedimentation or fowling and may require extensive maintenance. Therefore, the potential use of injection wells to maintain the groundwater levels in the nearby wetlands is not feasible or recommended.

Water obtained from the dewatering activities will not be used for human consumption. A potable water line would be constructed from a local municipality (Reference 10.7, Section A4.2.1.3).

There is the possibility that the amount of water extracted during dewatering will trigger the need for a Susquehanna River Basin Commission (SRBC) Groundwater Withdrawal Permit. Also, Pennsylvania DEP Regulation §110.201 has a requirement: "The following persons shall register the information specified in §110.203 (relating to content of registration) with the Department: (3) Each person whose total withdrawal from a point of withdrawal, or from multiple points of withdrawal operated as a system either concurrently or sequentially, within a watershed exceeds an average rate of 10,000 gallons per day in any 30 day period."

Of these disposal options, the most likely beneficial uses are for construction activities and to aid in recharge of the overburden soils and associated wetlands in the vicinity of the ESWEMS excavation. These likely uses are discussed in Section 6.10.

Even with the installation of the seepage cutoff around the excavation, there will be some drawdown of the water within the wetlands south of the NI as noted in Reference 10.6. The use of the pumped water to restore the groundwater level in this wetlands area would be beneficial. The surface water present in the wetlands at the site is hydraulically connected to the groundwater. Therefore, the water chemistry is very similar (Reference 10.10). The various water quality components tested from the shallow bedrock wells also indicated similar values for these components. Thus, the direct discharge of any groundwater pumped from the excavation would not have any detrimental chemical effect on the water in the wetlands. However, direct discharge would require permits, a sedimentation basin, a suitable area with erosion protection measures, and a controlled outlet. If the discharge water is pumped directly into the temporary groundwater storage pond (TGWSP) to be constructed on the southeast side of the NI, then the outlet facilities of the pond would provide the necessary controlled outlet and erosion protection. Since the in situ soils are granular and permeable, the water pumped from the excavation would naturally infiltrate through the bottom of the pond and replenish the wetlands naturally. Additionally, waters discharged from the TGWSP into Walker Run (if allowed) will aid in the recharge of the wetlands since Walker Run has a granular bottom. It is important to construct this TGWSP as one of the first construction activities for this project.

It was stated in Reference 10.7, Section A4.2.1.3, that the water obtained from the dewatering activities would not be used for human consumption and is no longer a consideration for water reuse. A potable water line would be constructed from a local municipality.

The anticipated maximum flow which may be discharged to the Susquehanna River during dewatering activities (with proper permitting) could be considered to be the average value of steady state discharge from the dewatering systems for all areas of 0.5 mgd (350 gpm). This flow is well within the design parameters for the 24 inch CWWRP blowdown discharge drain (if used) which will have a flow capacity of 9356 gpm (Reference 10.14, Section 4.1).

6.10 Beneficial Water Reuse

The most beneficial uses of the groundwater pumped from the excavations would be reuse as a source of non-potable water for construction use and replenishment of the wetlands.

Construction uses for non-potable water include dust control for the construction roads and water to be used for moisture conditioning of fill during placement and compaction. Approximately 40,000 gallons of water per day will be required for dust control (Reference 10.7, Table 4.2-1, Note d).

Approximately 1.3 million cubic yards (cy) of granular and cohesive backfill will be placed from the top of competent rock to the bottom of foundations or plant grade, where applicable (Reference 10.4, Table 3). This fill volume does not include fill placed around the site for general site grading operations or the concrete fill beneath select safety related structures. Estimating an addition of 2 percent (approximately 2.5 pounds of water per cubic foot of material) moisture to material for soil placement and compaction, a total of 10.5 million gallons will be required (1.3×10^6 cy x 27 cf/cy x 2.5 lbs/cf / 8.34 lbs/gal = 10.5×10^6 gallons). Considering 180 days per year for 3 years of work, the daily usage would be approximately 19,000 gallons per day [$10.5 \times 10^6/(180 \times 3) = 19{,}000$].

Concrete mixing requires the use of potable water to preclude the addition of impurities to the concrete that may result in improper strength in the concrete. Based on the groundwater quality data available from on-site pumping tests (Reference 10.10, Table 2.3-41), the water to be extracted during dewatering appears to be acceptable for concrete mix water; however, test batches should be performed per ASTM C 1602 (Reference 10.11) when non-potable water is used. It is estimated that 2,220,000 gallons of water will be required per year to mix and cure concrete (Reference 10.7, Table 4.2-1). Considering concrete placement 250 days per year, this equates to 8,900 gallons per day (2,220,000 / 250 = 8,900).

The anticipated daily average beneficial water use in construction activities is approximately 68,000 (40,000 [dust control] + 19,000 [soil compaction] + 8,900 [concrete mixing and curing] = 67,900 say 68,000 gallons per day), which is substantially less than the anticipated average daily flow of 500,000 gallons per day anticipated from the dewatering systems. The remaining 432,000 gallons per day could, with proper evaluation and permits, be used to recharge the wetlands near the ESWEMS excavation.

The surface water present in the wetlands at the site is hydraulically connected to the groundwater. Therefore, the water chemistry is very similar (Reference 10.10). The various water quality components tested from the shallow bedrock wells also indicated similar values for these components. Thus, the direct discharge of any groundwater pumped from the excavation would not have any detrimental chemical effect on the water in the wetlands. However, direct discharge would require permits, a sedimentation basin, a suitable area with erosion protection measures, and a controlled outlet.

With proper design and construction, the TGWSP (1.5 acre pond - Reference 10.8) could act as a natural recharge facility to the wetlands near the ESWEMS excavation. Since the steady state dewatering system flow rate (with a flow barrier) minus the anticipated average beneficial use for construction is approximately 432,000 gallons per day, approximately 1.3 acre-feet/day is available for recharge to the wetlands (432,000 gallons/day / 7.48 gallons/cf / 43,560 sf/acre = 1.3 acre-feet/day). This indicates that if exfiltration rates through the pond floor are established and maintained in excess of 10.4 inches/day (1.3 acre feet/day x 12 inches/foot / 1.5 acres = 10.4 inches/day), under average conditions the dewatering system effluent would not discharge into the wetlands via the discharge structure. If the exfiltration rate is less than 10.4 inches/day, the excess effluent from the dewatering systems, with proper permits, could be released into the adjacent wetlands via the discharge structure.

The final design of the TGWSP should consider both the steady state flow from all three excavations as well as peak flows from the ESWEMS dewatering system startup combined with the flows from the other excavations to the extent they will have concurrent flows based on the construction sequencing. It is important to construct this TGWSP as one of the first construction activities for this project.

In summary, the most prudent approach for the disposal of the water pumped from the excavation would be to pump it directly into the TGWSP located southeast of the NI. This pond could act as a natural recharge facility to the wetlands near the ESWEMS excavation. Water for beneficial use in construction (dust control, fill conditioning and concrete mixing and curing) could be extracted from the TGWSP. A pumping facility could easily be established adjacent to this detention pond for ease of extraction. No additional storage facilities (tanks) would need to be constructed. However, the use of a storage tank for water, if it was to be used for concrete mixing, may be prudent for ease of testing. The excess water from the TGWSP could then flow through the controlled outlet structure and into the wetlands and Walker Run.

6.11 Environmental Effects

Infiltration may be required for the disposal of water produced from dewatering activities. However, if disposal into ponds is allowed, some of the discharge from the construction dewatering system will potentially directly enter the surrounding environment through overflow from these detention ponds (sedimentation basins).

As such, prior to land disturbance and construction, an NPDES Stormwater Discharge Permit (PAG-2) will be required. The major components of the permit include:

- Notice of Intent (NOI);
- Erosion and Sediment (E&S) Control Plan;
- Pennsylvania Natural Diversity Inventory (PNDI) Search;
- Post Construction Stormwater Management (PCSM) Plan;
- Thermal Impact Analysis; and

- Antidegradation Analysis.

Walker Run is classified as a wild trout stream by the PA Fish and Boat Commission (PFBC). The wetlands associated with such a stream are considered “exceptional value” by the PA Department of Environmental Protection (PADEP). It may not be possible to obtain a "General NPDES Permit". An Individual NPDES Permit will be required, as referenced in 25 Pennsylvania. Code Chapter 92. Coordination with the Luzerne Conservation District would most likely be required. Water sampling and testing will most likely be required as part of this permit to ensure that the water contains no material detrimental to the environment (Reference 10.12).

The Pennsylvania Department of Environmental Protection does not specify a limit on the flow rate of the discharge. However, they do specify that "Best Management Practices (BMPs) be implemented to maximize infiltration technologies, eliminate (where possible) or minimize point source discharges to surface waters, preserve the integrity of stream channels, and protect the physical, biological and chemical qualities of the receiving surface water." Therefore, high discharge rates that would not preserve the integrity of the stream channel or the physical qualities of the receiving surface water may be restricted. This permit will also require the use of proper erosion control measures and other BMP, such as hay bales and silt fences for any discharges to the surface bodies of water.

Since the groundwater in the overburden aquifer and the shallow bedrock have water quality parameters similar to the existing surficial water in the wetlands and Walker Run, no detrimental effects are anticipated from disposing the pumped water into the wetlands and Walker Run or reusing it for dust control or water content control during compaction operations.

6.11.1 Possible Impacts of Dewatering Without Flow Barrier

The extent and magnitude of groundwater drawdown projected for dewatering without a flow barrier is shown on Attachment D (Reference 10.6, Figure 15). Review of this figure indicates deep drawdown (25 feet or more) at distances of up to approximately 800 feet south and east of the ESWEMS pond. The extent and magnitude of groundwater drawdown projected from dewatering using the flow barrier is shown on Attachment E (Reference 10.6, Figure 15), which indicates drawdowns of 5 feet extend no further than approximately 400 feet west of the ESWEMS pond. However, groundwater recharge from the groundwater storage pond (if unlined) will reduce both the magnitude and aerial extent of drawdown.

The majority of residents near the site obtain water from domestic wells. Several industries including the Susquehanna Steam Electric Station (SSES) obtain water from wells. There are six domestic use wells and one commercial use well within one-half to three-quarters of a mile from the site. Given the drawdown projected to occur during dewatering without a flow barrier, some potential exists for negative impact on nearby domestic and industrial water supply wells.

In the case where the flow barrier is utilized, little or no impact to nearby wells is anticipated.

Numerous and extensive wetlands are located both on the BBNPP site and in adjoining areas, particularly to the west, south, and east. Such features are often expressions of the natural water table at or near the surface, and are therefore quite sensitive to impact via water table depression.

If dewatering is implemented without the flow barrier, substantial adverse impact is expected on the levels of surface water and groundwater in the wetland south of the ESWEMS pond. A very small area to the northwest of the ESWEMS pond is shown with a drawdown of 5 feet, suggesting a minor potential for adverse impact to the wetland at that location. As stated in Section 6.7.3, the presence of the flow barrier may counteract this drawdown due to a slight mounding effect. A very small area of drawdown of 5 feet is also shown immediately west of the proposed power block excavation. This very small area of drawdown does not appear to extend to the wetland located west of the power block.

If dewatering is implemented utilizing flow barrier(s) around the ESWEMS and any other areas where the overburden soils are saturated, the potential for adverse impact on the wetland is significantly reduced. The actual impact is likely to be less than indicated by the model (Attachment E) because the flow barrier will be keyed several feet into bedrock. The digital model can only simulate the extension of the flow barrier to the top of the bedrock. Potential drawdown to the northwest of the ESWEMS pond appears to be nearly eliminated. Potential drawdown immediately west of the power block excavation remains unchanged since no flow barrier is used for the power block and is not expected to affect the wetland to the west.

6.11.2 <u>Mitigation of Potential Impact</u>

Potential impacts due to water table drawdown may be mitigated by any method that reduces or eliminates drawdown in areas beyond the excavation. Aquifer recharge is one potential method to reduce drawdown in areas where drawdown of the groundwater is not desired. This might be implemented using injection wells or by allowing exfiltration from the TGWSP if constructed without a lining. It will be difficult; however, to control extensive drawdown using these means alone if dewatering is undertaken without the flow barrier around the ESWEMS pond.

Given the physical constraints posed by the location of the site and adjoining wetlands, a vertically-oriented flow barrier, such as a S-B slurry wall, or diaphragm wall appears to be a viable and effective means to mitigate potential impacts due to projected water table drawdown. Drawdown outside the flow barrier extends mostly west and south of the ESWEMS pond as shown on Attachment E.

If the overburden soils in the northwestern quadrant of the cooling towers excavation extend below the groundwater level an additional flow barrier wall should be implemented to reduce the adverse impacts of the planned excavation.

7. CONCLUSIONS AND RECOMMENDATIONS

The following **conclusions** are based on this evaluation of the conceptual dewatering system for the construction of the BBNPP:

a. An active dewatering system will be required to lower the groundwater for the excavation to allow for construction of the foundations for the ESWEMS structures to be performed under dry conditions. The dewatering system will consist of deep wells penetrating the overburden soils down to the top of the bedrock and collector trenches or well points near the interface of the soil overburden and weathered rock.

b. A passive dewatering system (collection trenches) will be required to excavate the area where the NI and two cooling towers are to be located. Extensive excavation of both overburden soils and bedrock will be required. Based on the available data, trenches and ditches at the soil/rock interface and at select locations in the rock excavations can be designed to collect and divert any groundwater from the NI and cooling towers excavations.

c. The radius of influence of dewatering wells for the ESWEMS excavation would extend significant distances to the south and east from the site. Anticipated drawdown of 25 feet being experienced approximately 400 feet from the wells if a flow barrier is not utilized. This would result in a significant impact on the nearby wetlands. Some of the nearby wetlands could become fully dewatered.

d. The use of a flow barrier, such as a soil-bentonite slurry wall, around the ESWEMS excavation would greatly reduce the drawdown effect of the dewatering wells since the wells would be located within the limits of the flow barrier. Considering a groundwater barrier wall around the ESWEMS pond and pump house, the model forecasts drawdowns will be much less than the simulation without the flow barrier. Drawdown greater than 5 feet is focused immediately outside (west and southwest) the flow barrier. These impacts should be characterized in the Environmental Assessment and the Permanent and Temporary Wetland Impact Report.

e. There is the potential for significant water seepage through the bedrock in the bottom of the NI, cooling towers and ESWEMS excavations. The numeric groundwater model calculated the flow collected from the rock portion of the three excavations to be approximately 0.62 cfs (280 gpm). However, this calculated flow rate is based on the mean value of hydraulic conductivity from pump tests, which were considered conservative and resulted in higher forecast flow rates than if the values for hydraulic conductivity had been chosen. Trenches and ditches will most likely be required in the bottom of the excavation to direct this upward flow through the rock away from the center of the excavation to the perimeter ditches. Sumps and pumps will be utilized to remove this water from the excavation.

f. With a competent flow barrier around the ESWEMS excavation and no barrier around the NI and cooling towers excavations, inflow into the three excavations considered (through the flow barrier and up through the bedrock) is anticipated to be 0.78 cfs (350 gpm). The initial flow rate, to remove the groundwater from within the flow barrier, will be contingent upon the time period allowed. If 85 days are scheduled to remove the water from within the flow barrier of the ESWEMS (not considering initial flow from NI and cooling towers excavations), an average flow rate of approximately 1.6 cfs (715 gpm) would be required from within the ESWEMS barrier wall.

g. Direct discharge of the groundwater into Walker Run will most likely not be permitted. The use of a detention/sedimentation pond and the use of Best Management Practices to reduce the total solids in the runoff will be required. Disposal of water produced from dewatering activities will most likely be accomplished by allowing infiltration from the TGWSP and possibly other ponds provided bottom liners are not installed to prevent infiltration. During periods of excessive flows from the excavations due to precipitation or at the start of pumping, the excess water will likely be allowed to settle and thermally stabilize before discharge directly into the Susquehanna River via the Combined Waste Water Retention Pond blowdown pipeline if the pipeline has been installed. If disposal in surface water or wetlands is allowed, an NPDES permit will be required at a minimum."

h. There is the possibility that the amount of water extracted during dewatering will trigger the need for a Susquehanna River Basin Commission (SRBC) Groundwater Withdrawal Permit. Also, Pennsylvania DEP Regulation §110.201 defines the filing requirements.

i. The water removed from the excavation should be suitable for reuse as dust control, soil compaction, and concrete mixing and curing based on the available water quality information. Some testing of the water will be required if it is to be used for concrete mixing.

j. The ESWEMS pipeline will be constructed above the groundwater level, thus a dewatering system is not required.

k. The Temporary Groundwater Storage Pond will most likely be constructed above the groundwater level, thus a dewatering system will not be required.

l. The Combined Waste Water Storage Pond will most likely be constructed above the groundwater level, thus a dewatering system will not be required. Trenches to divert the groundwater in the northwest corner where rock is present may be needed.

The following **recommendations** for a dewatering system are based on this evaluation of the conceptual dewatering system for the construction of the BBNPP:

a. A flow barrier, such as a soil-bentonite slurry wall should be installed around the ESWEMS excavation, which includes the pump house. One continuous wall is recommended for the portions of the excavation where water bearing overburden (sand and gravel) will be encountered. The flow barrier would be installed by keying it into the underlying bedrock.

The minimum design permeability of the flow barrier is 1 x 10^{-7} cm/s with an approximate thickness of three feet.

b. With a flow barrier around the ESWEMS excavation, a total of 14 dewatering wells, as shown on Attachment H, will be required to create and maintain a dry condition at the bottom of the excavation. These wells should have a capacity of up to 150 gpm. If a build up of groundwater occurs on the north side of the ESWEMS excavation or extreme levels of seepage are encountered, additional pumping wells can be integrated into the pumping system. To control seepage at the interface of the soil and rock, a series of well points is also shown on Attachment H.

c. Sufficient ditches and trenches should be installed at the soil/rock interface in the NI and cooling towers excavations to preclude groundwater from flowing into the excavations. Based on the available data, flow barriers are not required for the NI and cooling towers excavations.

d. Trenches will be required in the underlying bedrock in the bottom of the NI, cooling towers and ESWEMS excavations to direct any up flow of groundwater through the rock to the perimeter ditches where it can be removed through the use of sumps and pumps.

e. The Temporary Groundwater Storage Pond, to be located south east of the NI should be constructed prior to any dewatering activity. This pond can be utilized as the detention and release point for the discharge from the dewatering systems established for the ESWEMS, NI and cooling towers.

f. The Combined Waste Water Retention Pond, the Temporary Sediment Basins and possibly the Essential Service Water Emergency Makeup System Pond could be used as depositories for dewatering outflow, if they are constructed prior to the completion of all on site dewatering activities.

g. The existing monitoring wells should be utilized to monitor the effectiveness of the temporary construction dewatering program. Additional monitoring wells should also be installed to provide adequate monitoring on all four sides of each excavation. The monitoring program should include recording water levels on both the inside and outside of the flow barrier at the ESWEMS excavation.

h. If the monitoring wells indicate an open window within the flow barrier, remedial measures, such as pressure grouting, will be required to mitigate this condition.

i. Prior to implementation of dewatering using the conceptual designs provided with this evaluation, the subsurface conditions along the alignment of the proposed flow barrier and along the horizontal limits of the planned excavations should be better defined using soil borings advanced several feet into the underlying competent bedrock. Such borings should be advanced on 100 foot centers (or less) along the flow barrier alignment for the ESWEMS excavation and at 200 foot centers (or less) along the perimeter of the excavations for the NI and cooling towers, and if significant variations in bedrock elevation or groundwater conditions are encountered, additional borings or wells should be advanced to assess conditions in such areas.

j. Groundwater conditions at the northwest corner of the cooling towers excavation should be defined by advancing additional borings and by installing monitoring groundwater monitoring wells in the overburden and upper bedrock. The required extent of excavation for the cooling towers should also be reevaluated once the additional data is available.

k. The groundwater model was constructed using the available data. Since the exploratory testing to date is based on low flow pump and packer tests along with slug tests, this testing may not have stressed the aquifer sufficiently to allow a complete understanding of the flow regime in the fractured rock. To further evaluate the potential fractured flow regime and the potential aerial extent of dewatering in the fractured rock, a long-term high-flow-rate pump test program can be implemented.

l. Conceptual evaluations presented herein should be reviewed to consider additional data and information as it becomes available at the end of the 12-month monitoring period and the conceptual designs further refined and developed to provide final designs suitable for use in construction.

8. LIMITATIONS

This conceptual construction dewatering evaluation was performed consistent with the principles of hydrogeology in accordance with the prevailing standards for professionals practicing under similar circumstances in the same geographical area. This warranty is in lieu of all other warranties either expressed or implied.

This evaluation is conceptual in nature, and the conceptual evaluations presented herein will require confirmation and refinement prior to development of final designs for the purposes stated herein. The input data and information considered during this evaluation were developed primarily by others. The soil and groundwater conditions in areas between soil borings and wells are interpolated or extrapolated, and the actual soil and groundwater conditions may differ from those considered in this report.

The following specific technical qualifications and limitations should be considered by the users of this report:

a. This evaluation was prepared using subsurface characterization data that are limited in several respects. Relatively few exploratory borings were drilled in the area of the cooling towers and ESWEMS pond. Actual subsurface conditions, including the depth to bedrock, are therefore uncertain in these areas and may differ significantly from the interpolations and extrapolations used to develop the excavation plans and groundwater potentiometric surface maps (prepared by others), which were used in this evaluation.

b. Groundwater mass budgets, flow rates, projected drawdowns, and projected dewatering system yields are estimated based on digital flow models and manual calculations using available hydraulic conductivity and specific yield data. The actual groundwater flow system may therefore differ from the conceptual models used in the digital and manual calculations.

c. The dewatering operations, without a flow barrier and to a lesser extent with a flow barrier, evaluated herein will locally stress the groundwater flow system. The aquifers' actual response to such stress (e.g., actual dewatering system flow rates, basin drawdown, and changes in the mass flow budgets) has not been verified at high rates of test pumping and may therefore vary significantly from the estimates projected herein.

9. ATTACHMENTS AND APPENDICES

This report includes the following Attachments and Appendices.

Attachment A – Reduced Scale SUPP, Reference 10.1 (1 Page)

Attachment B – Construction Excavation Plan, Reference 10.6 - Figure 3, which is based on Reference 10.4 (4 Pages)

Attachment C - Groundwater Monitoring Wells (Location Plan), Reference 10.3 - Figure 1 (1 Page)

Attachment D – Drawdown in Overburden Aquifer Without Flow Barrier at ESWEMS, Reference 10.6 - Figure 15 (1 Page)

Attachment E – Drawdown in Overburden Aquifer With Flow Barrier at ESWEMS, Reference 10.6 - Figure 16 (1 Page)

Attachment F – Conceptual Dewatering Strategy Power Block and ESWEMS Without Flow Barrier, Reference 10.6 - Figure 20 (1 Page)

Attachment G – Conceptual Dewatering Strategy Cooling Towers, Reference 10.6 - Figure 21 (1 Page)

Attachment H – Conceptual Dewatering Strategy Power Block and ESWEMS With Flow Barrier, Reference 10.6 - Figure 22 (1 Page)

Attachment I – Typical Dewatering Well Schematic, Reference 10.6 - Figure 23 (1 Page)

Attachment J – Typical Monitoring Well (Piezometer) Schematic, Reference 10.6 - Figure 24 (1 Page)

Appendix A – Weaver Boos Consultants North Central, LLC, "Evaluation of Temporary Construction Dewatering Strategies Proposed Bell Bend Nuclear Power Plant Berwick, Pennsylvania", Dated October 20, 2010, on 3 CDs.

CD-1 Evaluation of Temporary Construction Dewatering Strategies

CD-2 Visual MODFLOW Project Files (Disc 1 of 2)

CD-3 Visual MODFLOW Project Files (Disc 2 of 2)

10. REFERENCES

10.1 Sargent & Lundy LLC drawing SK-12198-400-015, Rev. 4, "Reduced Scale SUPP".

10.2 Paul C. Rizzo Associates, Inc. 2010. Response to RFI SL-BBNPP-132, Approved for Use by UniStar August 12, 2010 (Final Boring Logs).

10.3 Paul C. Rizzo Associates, Inc., Response to RFI SL-BBNPP-111, Approved for Use by UniStar August 31, 2010 (3-Month Groundwater Monitoring data Report).

10.4 Paul C. Rizzo Associates, Inc., Response to RFI SL-BBNPP-149, Approved for Use by UniStar September 13, 2010 (Excavation Plans).

10.5 BBNPP, Final Safety Analysis Report, Section 2.4.12 – Groundwater, Rev. 2.

10.6 Weaver Boos Consultants North Central, LLC, "Evaluation of Temporary Construction Dewatering Strategies Proposed Bell Bend Nuclear Power Plant Berwick, Pennsylvania", Dated October 20, 2010.

10.7 Areva, Response to RFI SL-BER-069, Approved for Use by UniStar August 19, 2008 (Water Use).

10.8 Sargent & Lundy LLC drawings:

- SK-12198-400-015, Sheet 1, Rev. 5, "Conceptual Grading & Drainage Plan, Sheet 1".
- SK-12198-400-015, Sheet 2, Rev. 5, "Conceptual Grading & Drainage Plan, Sheet 2".
- SK-12198-400-015, Sheet 5, Rev. 5, "Conceptual Grading & Drainage Plan, Sheet 5".
- SK-12198-400-015, Sheet 6, Rev. 5, "Conceptual Grading & Drainage Plan, Sheet 6".

10.9 BBNPP, Final Safety Analysis Report, Section 2.5.4 – Stability of Subsurface Materials and Foundations, Rev. 2.

10.10 BBNPP, Environmental Report, Section 2.3 – Water, Rev. 2.

10.11 ASTM International C 1602 – 06, "Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete".

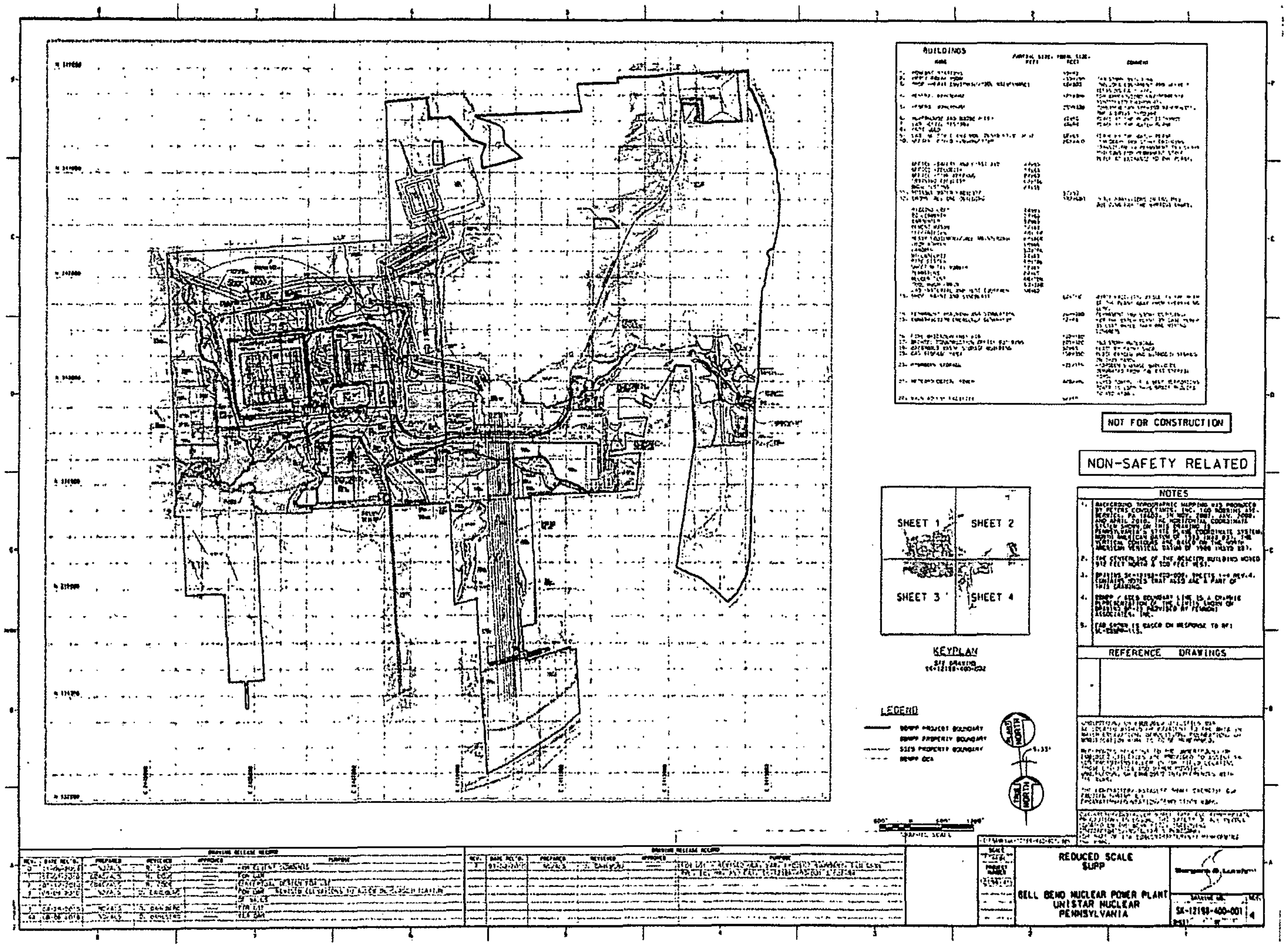
10.12 Paul C. Rizzo Associates, Inc., Response to RFI SL-BER-070, Approved for Use by UniStar September 9, 2008 (Water Discharge).

10.13 Black and Veatch, 2010. Response to RFI SL-BBNPP-143, Approved for Use by UniStar July 27, 2010 (ESWEMS Pipeline).

10.14 Sargent & Lundy, LLC, Report No. SL-0009498, "Conceptual Design of the Circulating Water System, Bell Bend Nuclear Power Plant, UniStar Nuclear Energy", Dated October 28, 2010, Revision 6.

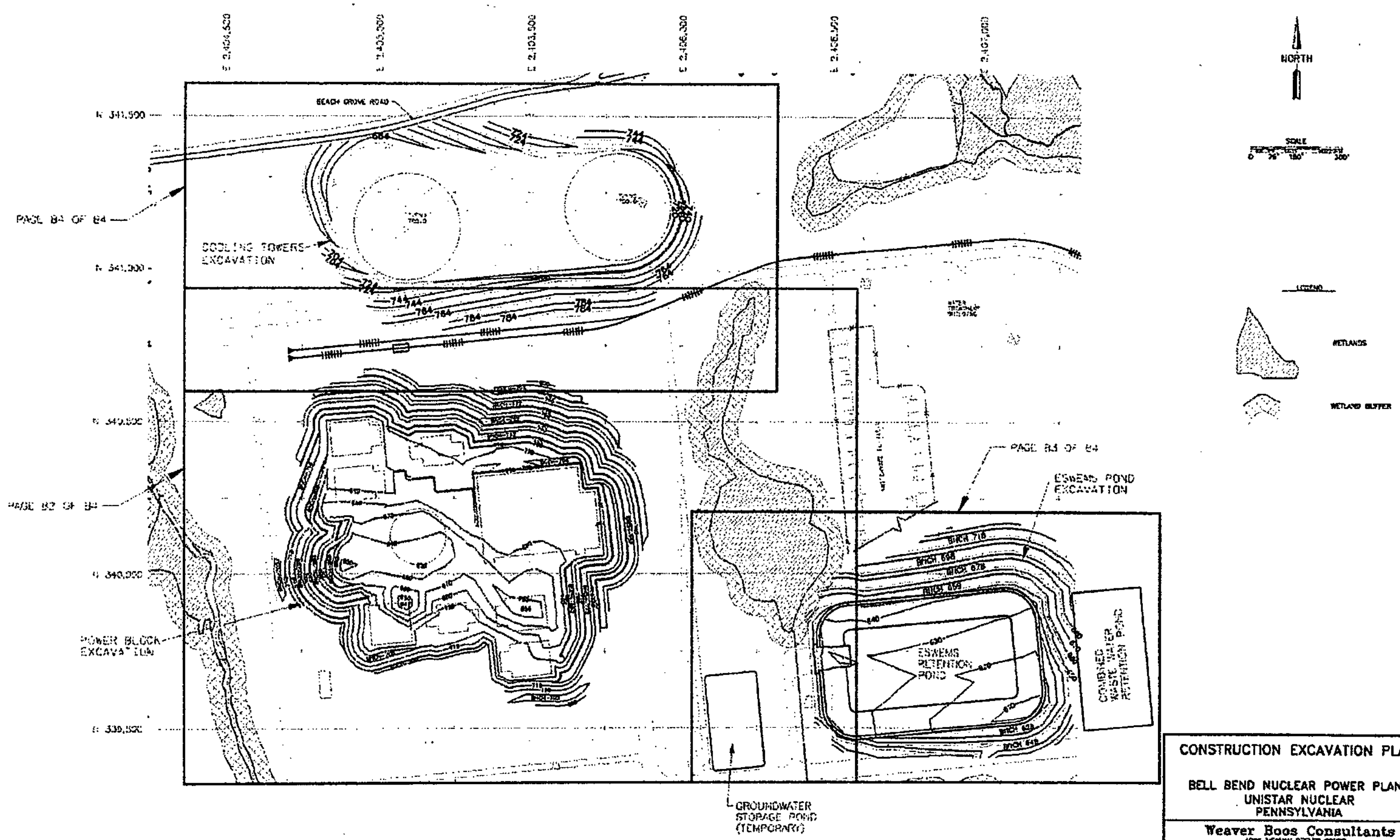
10.15 Sargent & Lundy, LLC, Report No. SL-0009446,"Conceptual Design of Stormwater Management, Bell Bend Nuclear Power Plant, UniStar Nuclear Energy", Dated July 28, 2010, Revision 5.

10.16 Sargent & Lundy LLC drawing SK-12198-400-01512198-400-CWS-003, Rev. 0, "Conceptual Combined Waste Water Retention Pond General Arrangement".



ATTACHMENT A

ATTACHMENT B
B1 of B4



DRAWING ADAPTED FROM REFERENCES 5 AND 8

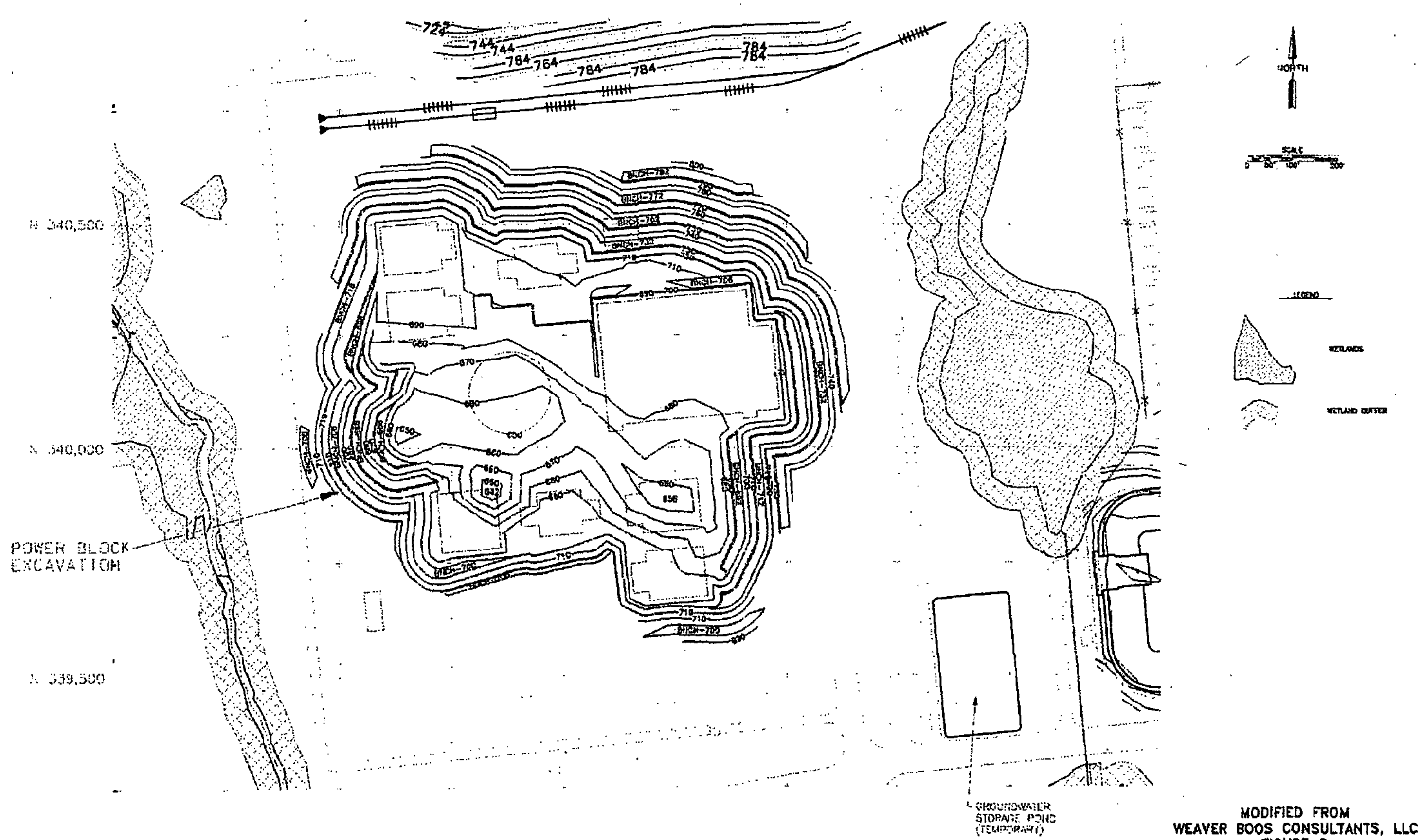
PAGE B1 OF B4

CONSTRUCTION EXCAVATION PLAN

BELL BEND NUCLEAR POWER PLANT
UNISTAR NUCLEAR
PENNSYLVANIA

Weaver Boos Consultants

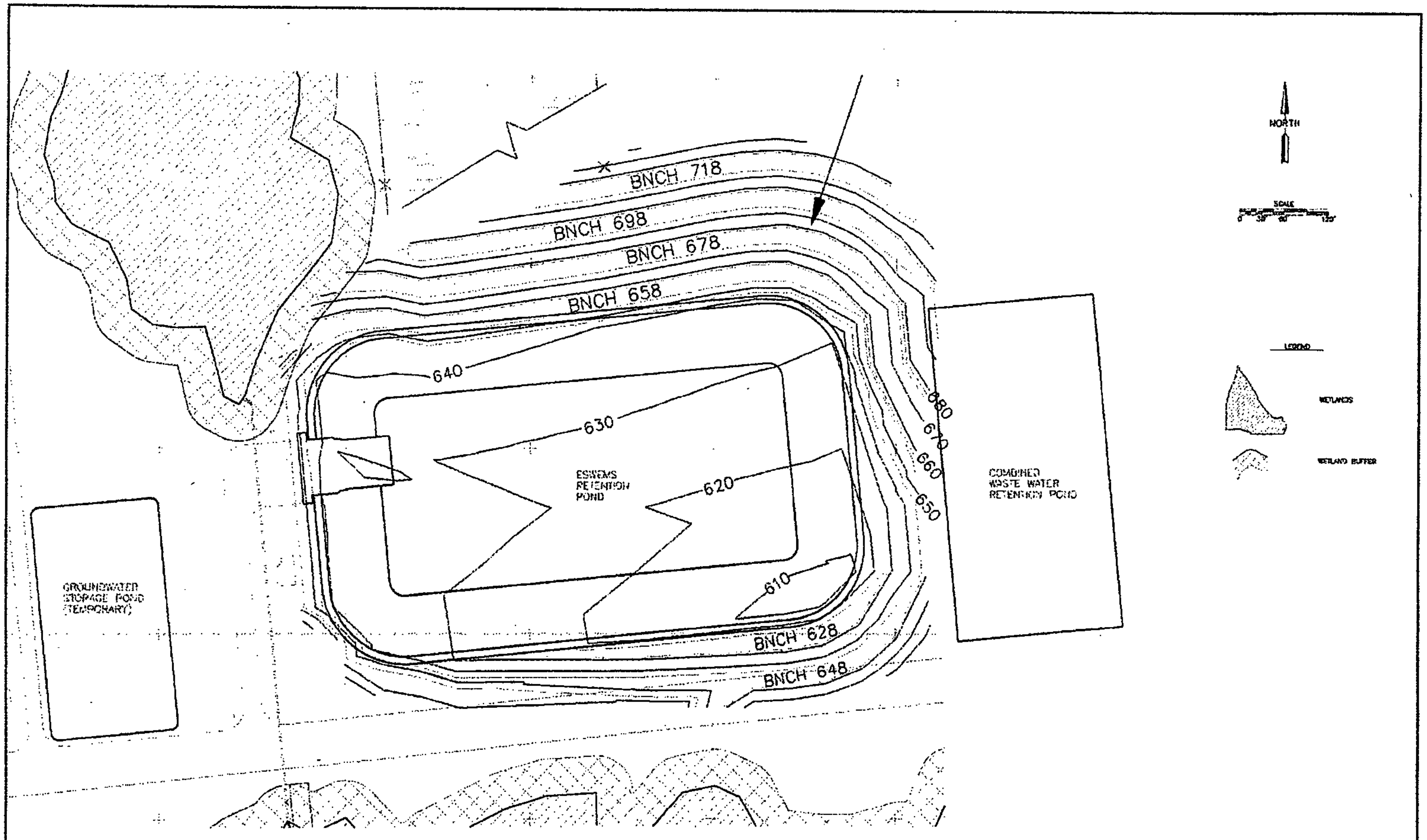
DRAWN BY: TAO	DATE: 9/16/10	FILE: F52301-01-01
REVIEWED BY: SMS	CAD: FIC3.DWG	FIGURE 3



MODIFIED FROM
WEAVER BOOS CONSULTANTS, LLC
FIGURE 3
CONSTRUCTION EXCAVATION PLAN
PAGE B2 OF B4

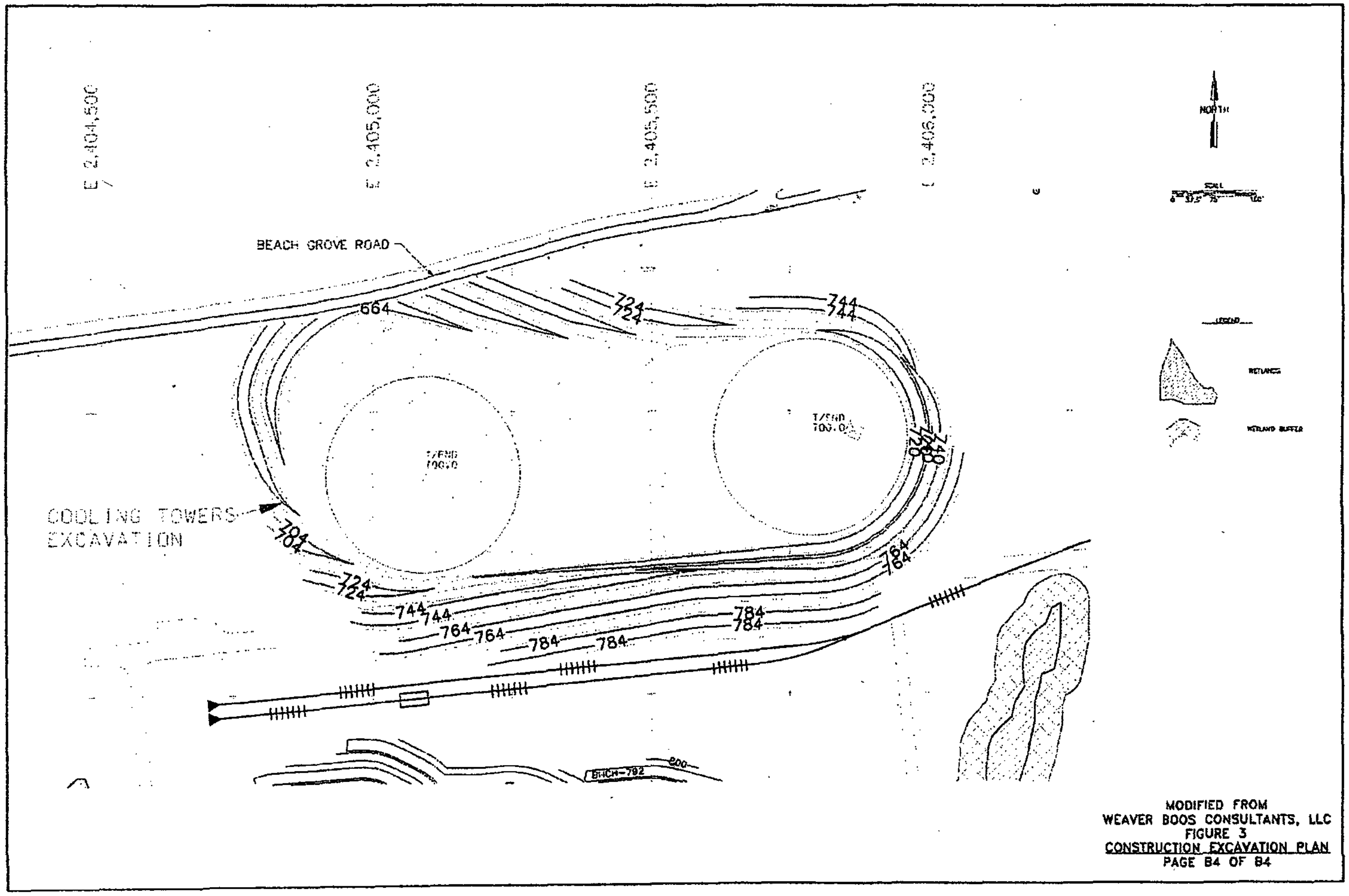
ATTACHMENT B
B2 of B4

ATTACHMENT B
B3 of B4

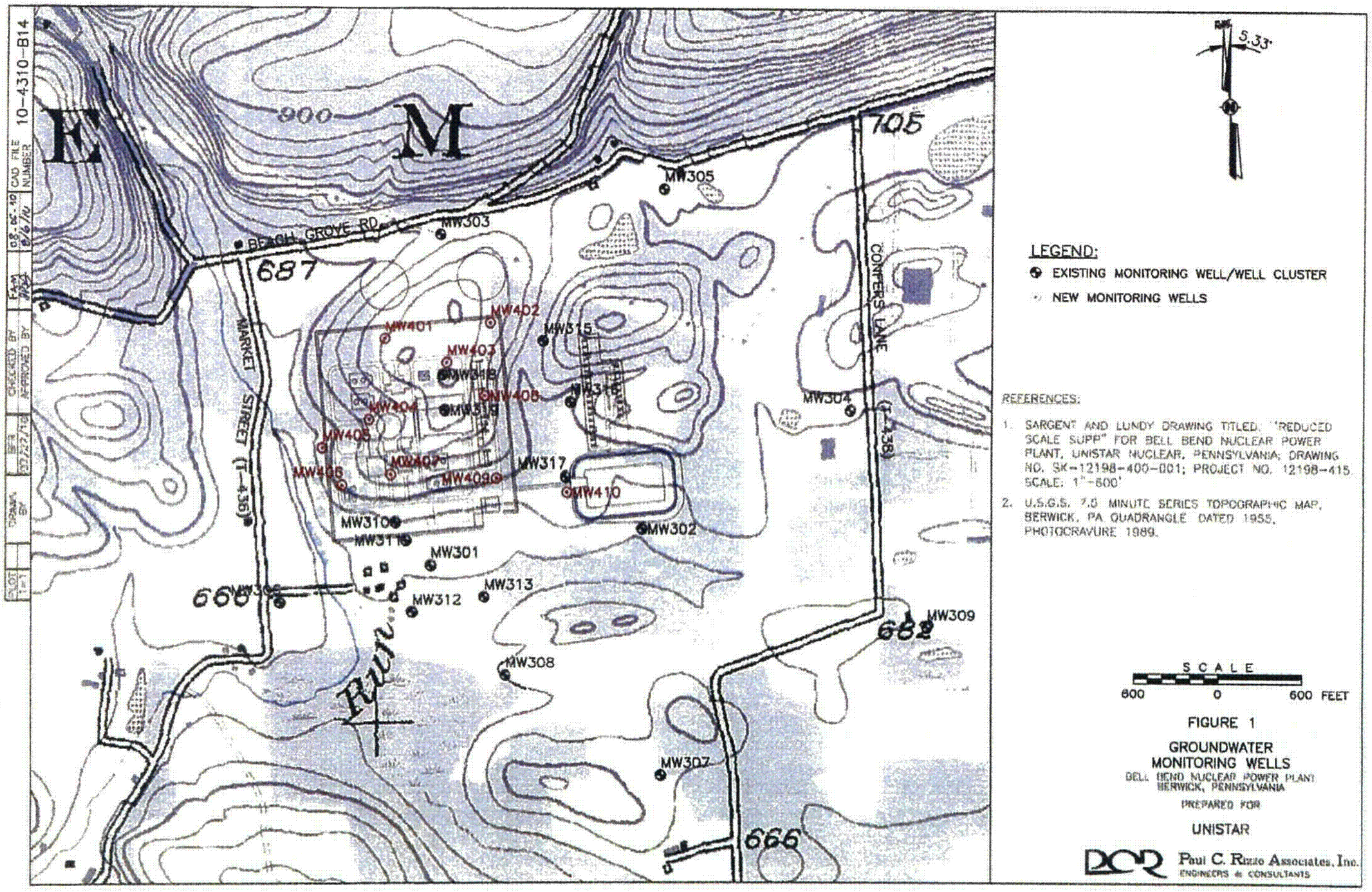


MODIFIED FROM
WEAVER BOOS CONSULTANTS, LLC
FIGURE 3
CONSTRUCTION EXCAVATION PLAN
PAGE B3 OF B4

ATTACHMENT B
B4 of B4



ATTACHMENT C



ATTACHMENT D

FIGURE 15
Drawdown in Overburden Aquifer Without Flow Barrier at ESWEMS

WEAVER BOOS CONSULTANTS
4085 Meghan Beeler Court
South Bend, Indiana 46628

Bell Bend Nuclear Power Plant - Non Safety Related
Berwick, Pennsylvania

ATTACHMENT E

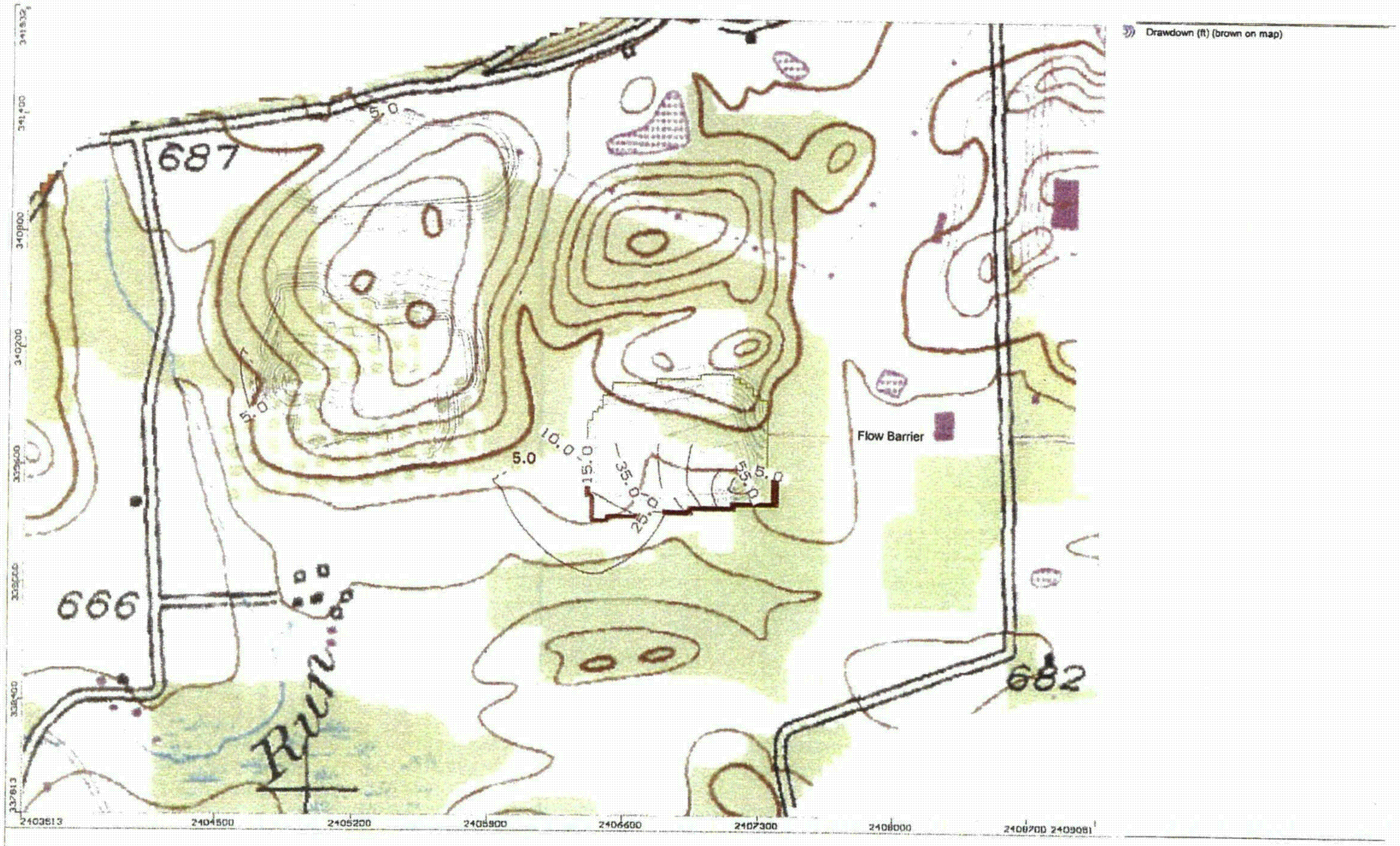
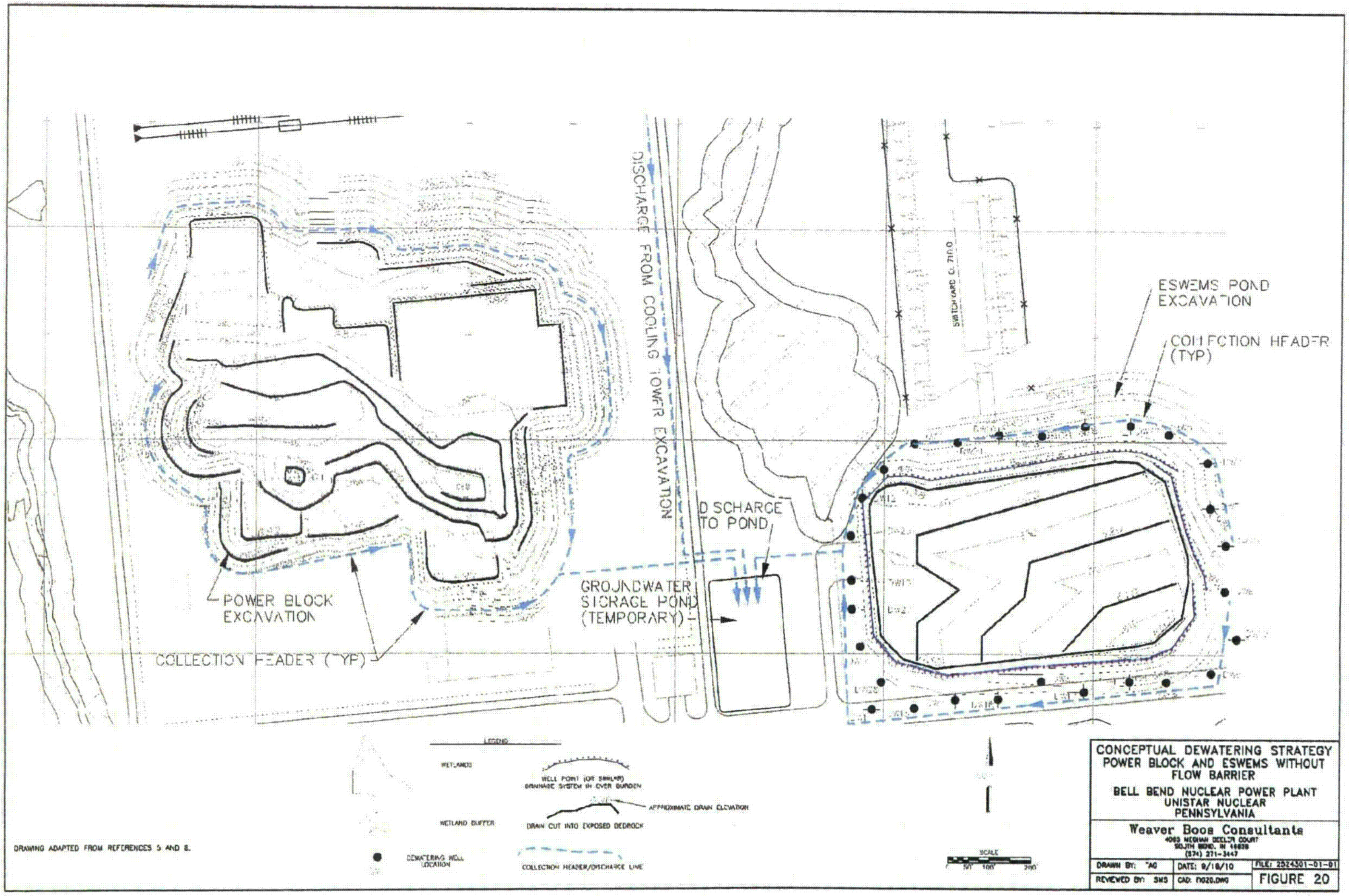


FIGURE 16
Drawdown in Overburden Aquifer With Flow Barrier at ESWEMS

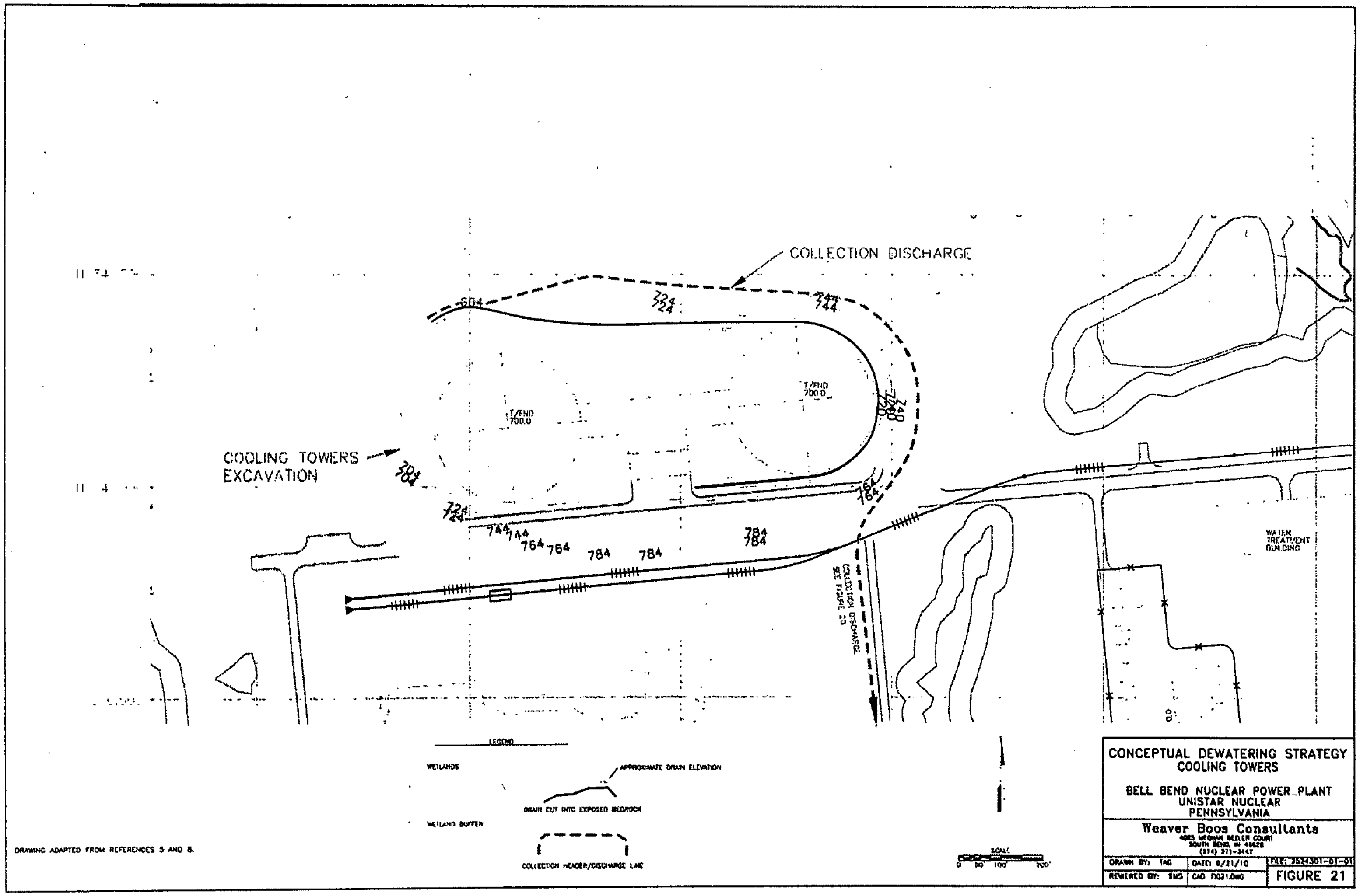
WEAVER BOOS CONSULTANTS
4085 Meghan Beeler Court
South Bend, Indiana 46628

Bell Bend Nuclear Power Plant - Non Safety Related
Berwick, Pennsylvania

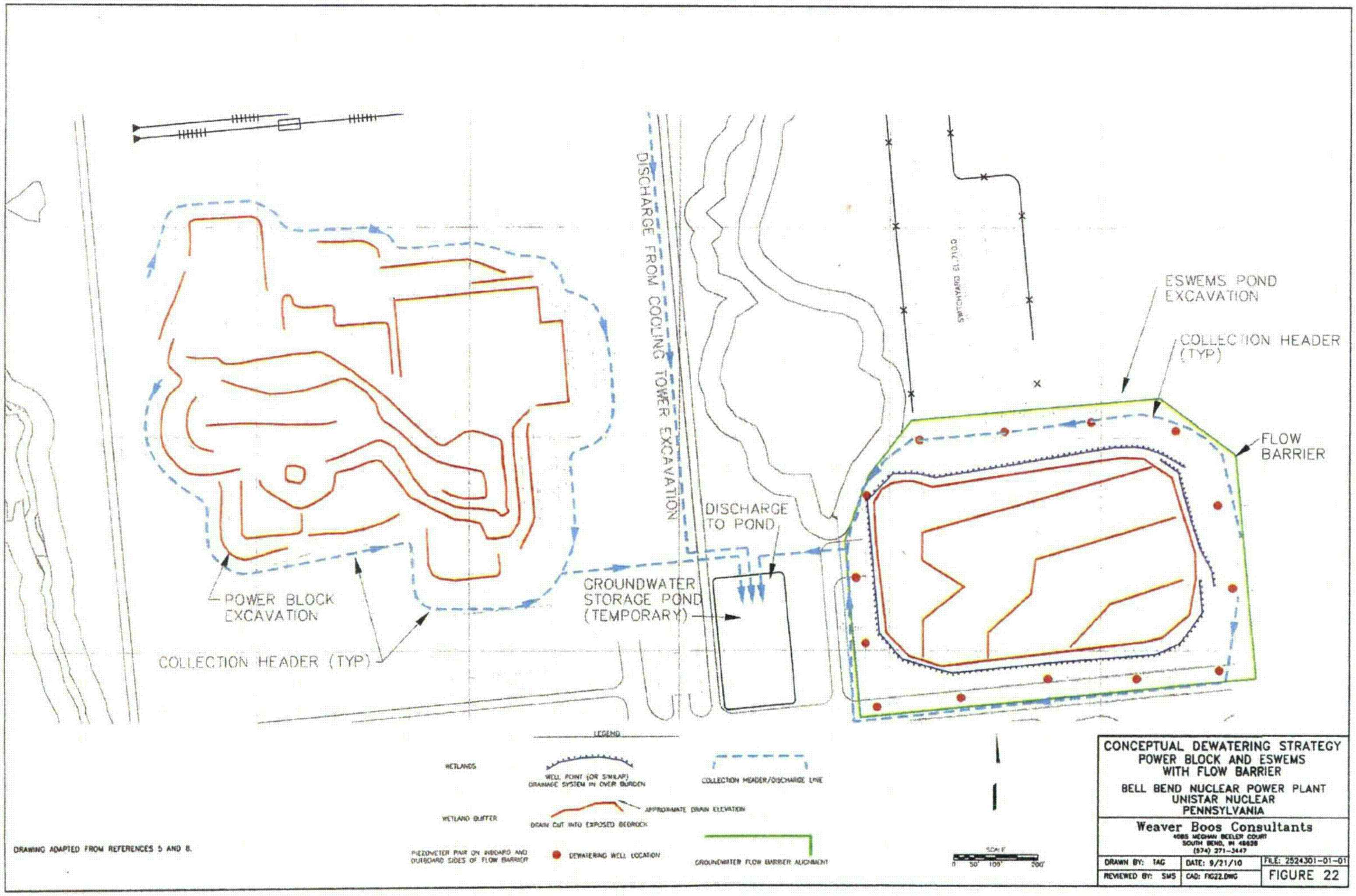
ATTACHMENT F



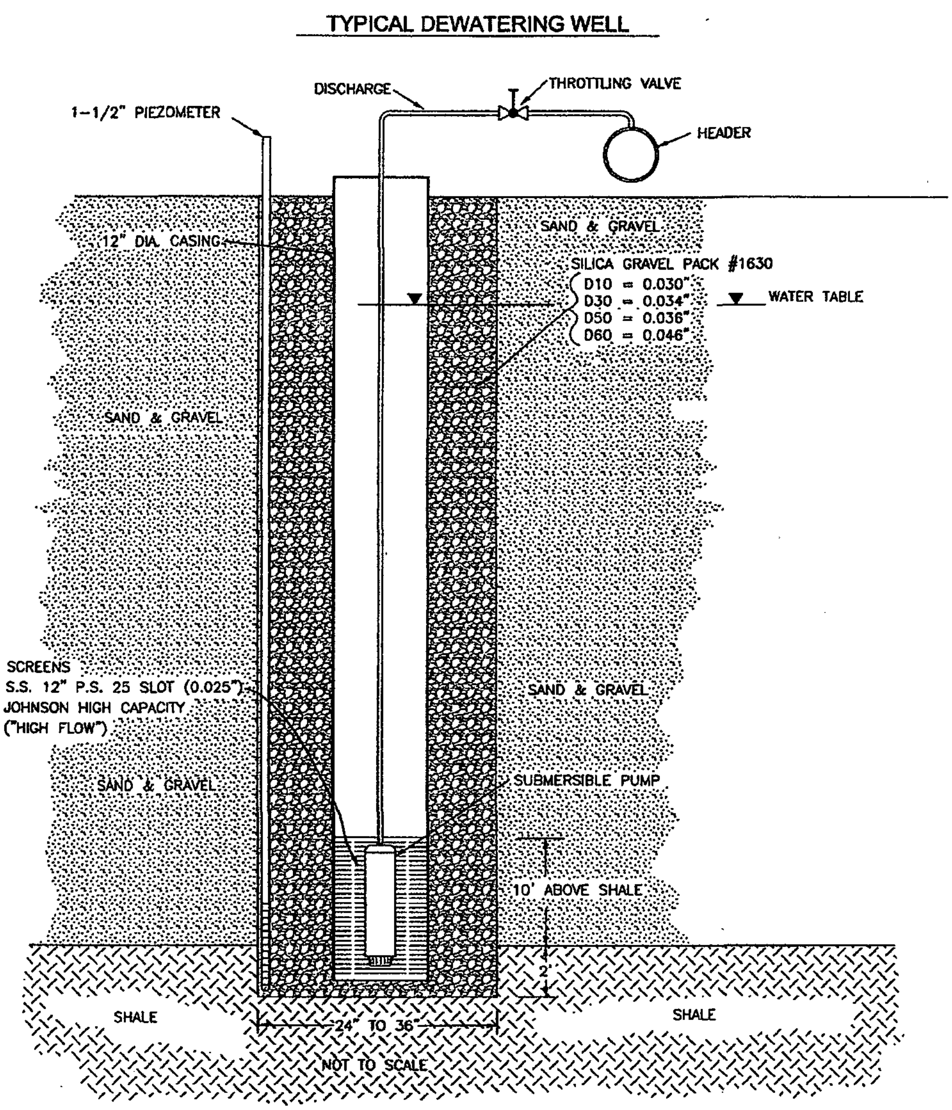
ATTACHMENT G



ATTACHMENT H



ATTACHMENT I



NOTES:
1) SUBMERSIBLE PUMP RATED AT APPROXIMATELY 100 TO 150 GPM
2) 1" DIA. SAMPLING PORT AT EACH PIPE DISCHARGE

TYPICAL
DEWATERING WELL SCHEMATIC
BELL BEND NUCLEAR POWER PLANT
UNISTAR NUCLEAR
PENNSYLVANIA

WEAVER BOOS CONSULTANTS
NORTH CENTRAL, LLC

DRAWN BY: TAG	DATE: 09/21/10	FILE: 2524301-01-01
REVIEWED BY: SHS	CAD: WELLSCHEM.DWG	FIGURE 23

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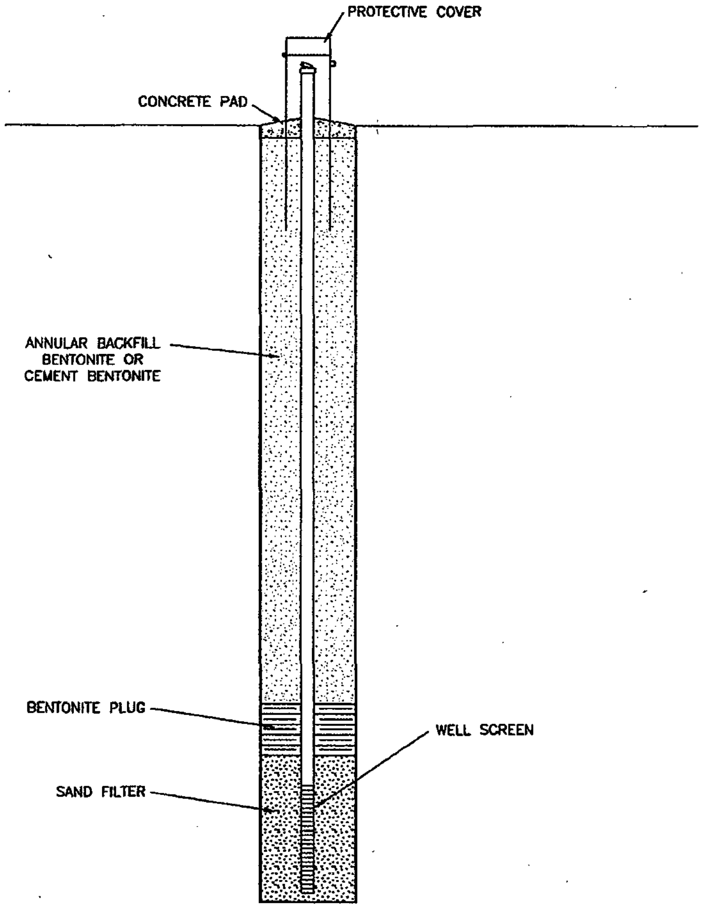
ATTACHMENT J

TYPICAL 2-INCH MONITORING WELL SCHEMATIC



NOT TO SCALE

TYPICAL MONITORING WELL
(PIEZOMETER) SCHEMATIC
BELL BEND NUCLEAR POWER PLANT
UNISTAR NUCLEAR
PENNSYLVANIA

WEAVER BOOS CONSULTANTS
NORTH CENTRAL, LLC

DRAWN BY: TAG	DATE: 09/21/10	FILE: 2524301-01-01
REVIEWED BY: SMS	CAD: PIEZSCHEM.DWG	FIGURE 24

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APPENDIX A

Weaver Boos Consultants North Central, LLC
Evaluation of Temporary Construction Dewatering Strategies
Proposed Bell Bend Nuclear Power Plant Berwick, Pennsylvania
Dated: October 20, 2010

(On Three CDs)

CD-1 Evaluation of Temporary Construction Dewatering Strategies

CD-2 Visual MODFLOW Project Files (Disc 1 of 2)

CD-3 Visual MODFLOW Project Files (Disc 2 of 2)

CDs available upon request

Appendix C

Construction Dewatering Mitigation Plan

Construction Dewatering Mitigation Plan

PPL Bell Bend Nuclear Power Plant
Salem Township, Luzerne County, PA

1. Executive Summary

Certain elements of the BBNPP infrastructure are proposed to be constructed in locations which will require dewatering to support completion of construction under dry conditions. The need to dewater prior to and during construction exists in part because the construction of critical safety-related structures will require excavation of soil and weathered rock as well as placement of engineered fill beneath foundations. This section will provide descriptions of dewatering activities, explain the impact that site activities will have on groundwater levels during and post-construction, discuss the environmental impacts that may result from dewatering, and explain proposed monitoring and mitigation measures.

During construction activities, three different site areas will be excavated down to competent bedrock. These three areas include the Power Block (Nuclear Island) area, the Essential Service Water Emergency Makeup System (ESWEMS) Pond area, and the area beneath the Cooling Towers. During excavation, variable amounts of groundwater will be encountered at each of these three areas. Because the excavation, backfilling, and construction activities need to be performed in dry conditions, temporary groundwater controls will be required during construction. The groundwater elevations will be drawn downward to below the deepest portion of each excavation with dewatering wells and/or sumps. Construction dewatering for the Power Block and Cooling Towers is anticipated to be minor and will be accomplished with a series of gravity drains and sump pumps. No adverse impacts to jurisdictional waters are anticipated as a result of construction dewatering in these areas.

Dewatering required for the construction of the ESWEMS pond will be more extensive, and is the subject of this narrative. Based upon computer modeling of groundwater levels in the vicinity of the proposed ESWEMS Pond, absent mitigation a depression of groundwater levels will occur over the multi-year pumping period. This depression would range from near-zero impact to many feet of groundwater elevation depression within wetlands nearby the source of withdrawal.

While a slurry wall will be constructed to aid in containing the aerial extent and depth of groundwater depression, this measure alone will not likely prevent adverse impacts to nearby wetlands and watercourses. Therefore, PPL is proposing to implement appropriate mitigation to maintain suitable hydrologic conditions in affected wetlands during periods of intense groundwater withdrawal.

To effectively determine mitigation needs, baseline monitoring of hydrologic conditions within the zone of influence of pumping is proposed. A series of shallow piezometers and soil moisture monitoring devices will be installed in strategic locations, and data collected during a baseline monitoring period will be used to complement data from existing flow gauges and monitoring wells at BBNPP. This record of information will serve as a benchmark for comparison to determine the mitigation needs during the pumping period.

Mitigation measures will include introduction of water to affected wetlands and/or watercourses, as needed, from one or more subsurface storage reservoirs constructed on the site to store pumped groundwater. Application of stored water will be completed by a temporary irrigation system, and continued monitoring of the wetlands will be completed to allow real-time flow corrections to maintain conditions reflecting the baseline.

Post-construction evaluation of affected wetlands will be completed to determine if any additional restoration activities are required to offset any unintended impacts. The compensatory mitigation program for BBNPP includes mitigation measures provided to offset any loss of function or value of affected wetlands during the period of impact from groundwater withdrawal.

2. Background

Avoidance of groundwater impacts was evaluated with regard to the placement of safety-related structures. Given the location of the main power block and the resulting location of the Bell Bend Switchyard, the Cooling Towers and the ESWEMS Retention Pond were placed in the only obvious locations. They must be located in the protected area, near the power block, and meet NRC design specifications. Within these constraints the facilities were sited to avoid permanently impacting the exceptional value wetlands.

The safety-related ESWEMS Retention Pond provides 27 days of makeup to the cooling tower basins. The total design volume of this pond includes the make-up water requirements (i.e. evaporation and drift) for the cooling towers, 30 days of seepage through the pond clay liner, and the volume of water lost to an ice cover. To satisfy these design requirements, the resulting pond measures 700 ft. by 400 ft. at grade level, contains at normal operating levels about 76.6 acre-ft of water and has a water depth of 17 feet. During construction the ESWEMS pond excavation is expected to fully penetrate the overburden soils and the upper weathered rock. The excavation will in a worst-case require removal of up to 56 feet of overburden and weathered bedrock.

The location of the ESWEMS Pond and the depth of the associated excavation requires a depression of existing groundwater elevations by over 50 feet to ensure dry conditions. An active dewatering system will be installed to support dewatering activities, which will be maintained continuously for up to 24 months. Analyses of the dewatering system requirements and modeling of predicted impacts to groundwater elevations is described in technical reports completed in 2010 (Ref. 1, 2).

3. Dewatering Activities

Dewatering will be accomplished through the installation of an active extraction system of wells and collection trenches situated at the interface of the overburden/rock interface. Additional passive dewatering via construction of collection trenches may also be necessary north of the nuclear island in the location of the proposed cooling towers. One or more sedimentation/detention ponds will be used to store extracted groundwater, and provide suitable treatment to ensure it is suitable for beneficial reuse.

A subsurface bentonite slurry flow barrier will be installed around portions of the areas to be excavated and dewatered. A continuous wall with its lowest elevation situated upon bedrock will be installed to contain the area of impact from dewatering.

The predicted volume of groundwater to be extracted would average 350 gallons per minute (gpm), which is equivalent to 0.5 million gallons per day (gpd). The period of dewatering will be concurrent with the period of time required to complete subsurface construction of the facilities in the area of groundwater extraction. This period is approximately two years.

3.1 Potential Impacts from Dewatering

Modeling of steady-state aquifer conditions under various scenarios was completed, using the Schlumberger Water Services Visual MODFLOW software (2009 version). Water flow budget and drawdown forecasts for dewatering using a flow barrier is the condition germane to the prediction of potential impacts to wetlands and streams, and is used as the basis for the evaluation of impacts presented here.

3.2 Area of Effect

The estimated area of detectable groundwater elevation depression within wetlands is depicted in Figure 1. This Area of Effect, focused to the west of the ESWEMS pond, includes approximately 5.6 acres of Wetlands 11 and 12 and approximately 1400 lineal feet of Tributary 1 to Walker Run and Tributary 2.

3.3 Extent of Impacts

The estimated level of groundwater elevation variation from "normal," or baseline conditions (described in Section 4.9) is expected to range from imperceptible at lower pumping volumes up to several feet of depression during maximum pumping conditions if mitigation measures are not implemented. In an unmitigated condition, this level of variation is likely to have an impact on hydrophyte growth and speciation as well as overall wetland biochemistry, and would affect the functions and values of the affected wetlands over the period of impact (Ref 3).

4. Monitoring Plan

Monitoring of hydrologic conditions and inputs are proposed as part of the dewatering impact evaluation and mitigation program in the pre-dewatering, active dewatering, and post-dewatering periods. The goal of the monitoring programs are to accurately establish baseline conditions, to ensure that mitigation actions mimic the baseline, and to evaluate any adverse impacts to affected wetlands following completion of dewatering activities.

Baseline conditions are herein defined as records of streamflow, shallow soil moisture levels, and groundwater (or perched water) elevations within the area of effect. The baseline will include these data, which PPL proposes to collect for a minimum two year period prior to the initiation of groundwater withdrawal. This data will be evaluated on a monthly, seasonal, and total average basis with applicable statistical analyses. The baseline data set will also include precipitation and temperature over the study period, allowing a generalized normalization of baseline to account for water balance inputs and outputs such as precipitation and evapotranspiration.

4.1 Monitoring (Pre-Construction)

Collection of data for the purpose of defining baseline conditions is proposed to be completed over a time span of at least two years. The determination of whether two full seasons of data is enough to establish pre-construction conditions or if augmentation of the data record is needed is dependent upon the level of variability observed within shallow groundwater and streamflow conditions during the first two seasons of monitoring.

Low variability in the hydrologic measurements collected will be taken as an indication that the data collected is suitable for use as a representative baseline condition that can be employed to guide mitigation measures designed to avoid long- and short-term hydrologic impacts to streams and wetlands within the Area of Effect. Moderate to high variability may dictate collection of additional data to ensure the baseline conditions captures a realistic range of hydrologic conditions.

The methods of data collection, as well as the interpretation and analysis of monitoring results will generally follow the standards set forth in the ACOE publication "Technical Standard for Water Table Monitoring of Potential Wetland Sites," a Wetlands Regulatory Assistance Program report (ERDC TN-WRAP-05-2) published in June, 2005.

Primary parameters to be collected as part of the monitoring program include shallow groundwater (or perched water) elevations, streamflow depths, and soil moisture.

The purpose of monitoring and baseline establishment for all 3 parameters is to support appropriate mitigation, with an operation goal of mimicking baseline conditions through direct addition of water following initiation of dewatering activities.

Figure 2 illustrates the proposed location of shallow wells (piezometers), stream gauges, and soil moisture probes, as well as the locations of existing piezometers and in-stream pressure transducers. The existing instrumentation has been recording data at 10 minute intervals since November 2009, and was installed to support other mitigation efforts.

Shallow groundwater will be measured through the installation of shallow groundwater wells, or piezometers. Six piezometers are proposed to be installed in the wetlands within the Area of Effect. These six piezometers will be installed along two transects spanning the wetland features located within the area of effect. Data logging pressure transducers will be installed in the piezometers and record shallow groundwater elevations to 0.01 ft increments at 10-minute intervals.

Two soil moisture probes will be installed on each transect, between the piezometers, for a total of four soil moisture sensors. Average soil moisture in the upper 12" of the soil profile will be measured. These probes will be connected to data loggers that will be set to record at intervals similar to the pressure transducers. These measurements will reveal whether or not shallow soils within the wetlands are between saturation and field capacity, being roughly equivalent to the range of appropriate growing season root zone wetland hydrology. The extent of saturation as well as the number of weeks during the growing season that saturated/moist soil conditions exists will add to the definition of baseline hydrology within the Area of Effect.

Streamflow monitoring at BBNPP has been ongoing in select areas since 2008. Flow depth has been recorded in 10-minute intervals at the locations shown in Figure 2 since November 2009. Flow within the streams located in the Area of Effect will continue to be monitored in four locations, as shown on Figure 2.

4.2 Monitoring (Active Withdrawal)

Following initiation of groundwater withdrawal continued monitoring of streamflow, shallow groundwater elevations, and soil moisture will be maintained. While the measurement and monitoring schedule is proposed to be the same during the pre-withdrawal period as during pumping, data will be downloaded and evaluated daily to determine the need for supplemental irrigation to maintain the baseline hydrologic conditions. Seasonal and diurnal fluctuations, as well as recent rainfall data will be evaluated on a daily basis and compared to baseline conditions for the current season and rainfall history. Deviation of the shallow groundwater depth, soil moisture, and/ or streamflow from the baseline conditions will serve as a trigger to initiate irrigation, as needed, to sustain the baseline hydrology.

4.3 Monitoring (Post-Construction)

Monitoring of identical parameters at the same frequency following completion of groundwater withdrawal activities is proposed to ensure that hydrologic conditions return to a steady-state condition. Post-construction monitoring data will be downloaded daily for the first two weeks following completion of dewatering activities, and weekly for an additional six weeks. After that time, monitoring will continue for at least the remainder of the growing season with monthly data download and comparison to baseline conditions. If the post construction monitoring results indicate a return to baseline conditions with no supplemental irrigation for the growing season following the completion of dewatering activities, then subsequent monitoring may be suspended.

5. Mitigation

Mitigation of potential negative impacts to wetlands and streams resulting from groundwater withdrawal is proposed via direct provision of makeup water. For the purposes of this project, successful mitigation is proposed to be achieved when observation of shallow groundwater, surface water, and soil moisture indicates that wetland hydrologic conditions within the Area of Effect mimic baseline conditions. Acceptable tolerances for groundwater elevations during pumping are proposed to be less than three inches difference between seasonally observed baseline water surface elevations from the same time period during pre-construction. Acceptable tolerances for stream flow depth are proposed to be less than two inches difference between seasonally observed flow depth during pumping and baseline conditions; however field judgment may need to be exercised during summer months when baseline conditions may indicate little to no flow. Acceptable seasonal ranges for each monitoring location will be established as part of the pre-construction monitoring work.

Makeup water to be used for mitigation will be supplied by the dewatering pumps and routed to an on-site settling basin to remove any entrained sediment. If wetland or streamflow observations indicate a reduction in flow requiring mitigation, water will be directly introduced to the affected stream channel or wetland via a temporary irrigation system. A schematic of the pumping and irrigation system is provided in Figure 3.

5.1 Mitigation Water Supply

Pumped groundwater from the construction dewatering operation will be discharged into the first cell of a two-cell holding pond. Each cell has the capacity to hold twenty-four hours of pumped water at the anticipated pumping rate. The total pond capacity is equal to two days of pumping volume. Overflow from the pond will be conveyed via a temporary swale to the downstream end of Wetland 11, from there it will be conveyed to Tributary 1 of Walker Run via a proposed culvert. The dewatering pumping rate will be approximately 0.7 cfs, so impacts to the existing downstream channels are not anticipated. The pond depth will be six to eight feet, and water will be drawn from the bottom to minimize thermal impacts.

5.2 Irrigation System

A temporary irrigation system will be installed with sprinkler heads on the east side of Wetland 11 and on the north side of Wetland 12. In addition, piping will be in place to supplement stream flow to the Tributary 1 of Walker Run and Tributary 2, as needed. The irrigation system will consist of four zones such that supplemental flow can be added to either wetland or stream independently based on the needs identified by the construction phase monitoring. Daily monitoring results will be compared to established seasonal baseline ranges and the irrigation system will be activated if actual conditions are below the acceptable ranges.

5.3 Maintenance of Baseline Conditions

As discussed in Section 4.1, establishment of baseline hydrologic conditions in on-site streams and wetlands is being completed to provide a reference condition towards which mitigation activities may be targeted. This baseline provides a multi-year, all-seasons reference to guide mitigation actions, including provision of makeup water to the affected areas.

Critical to the effectiveness of preventing adverse impacts to wetlands is ensuring mitigation activities correctly mimic baseline conditions. Continued monitoring of wetlands within the area of effect using the same monitoring points/devices and similar monitoring equipment is proposed to evaluate the success of mitigation actions and to serve as a positive feedback system to dictate changes in the type, extent, and duration of mitigation.

6. References:

- Construction Dewatering Design, Bell Bend Nuclear Power Plant, UniStar Nuclear Energy, Report No. SL-009655, Revision 2. Sargent & Lundy, LLC. November 23, 2010.
- Evaluation of Temporary Construction Dewatering Strategies, Proposed Bell Bend Nuclear Power Plant, Berwick, Pennsylvania. Weaver Boos Consultants North Central, LLC. October 20, 2010.
- *Wetlands, 2nd Ed.* William J. Mitsch and James G. Gosselink, 1993.

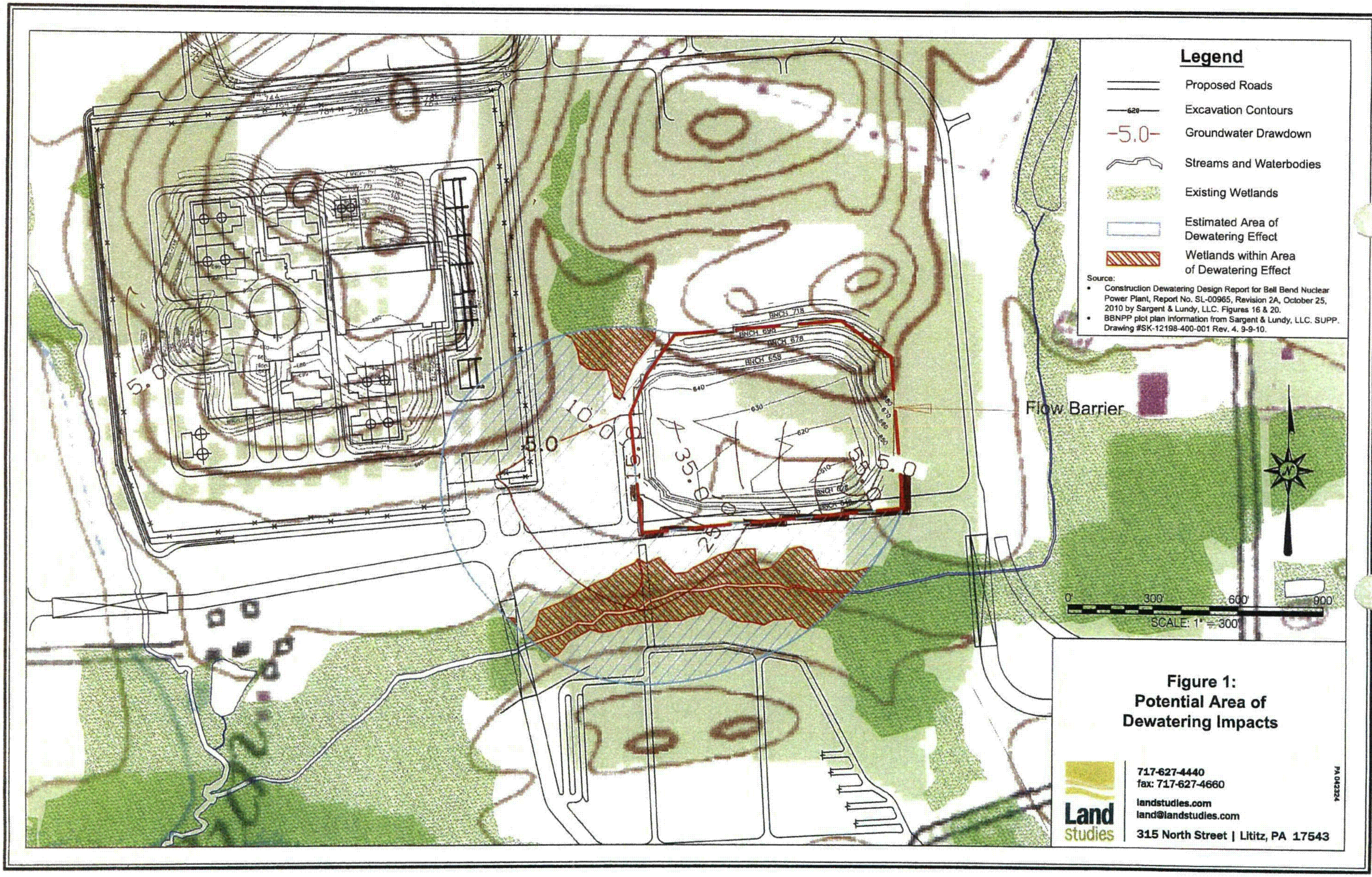

Figure 1: Potential Area of Dewatering Impacts

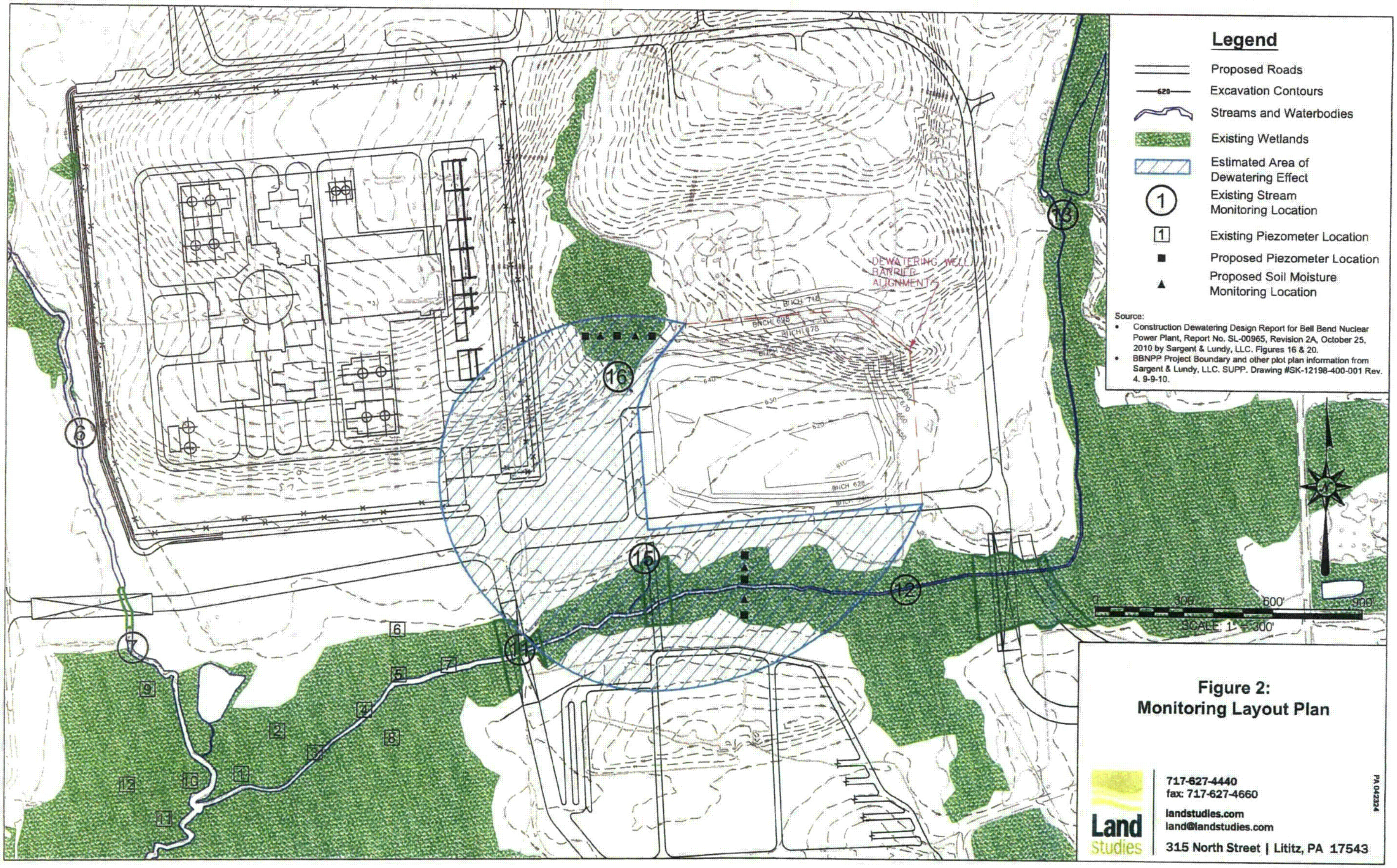

Figure 2: Monitoring Layout Plan

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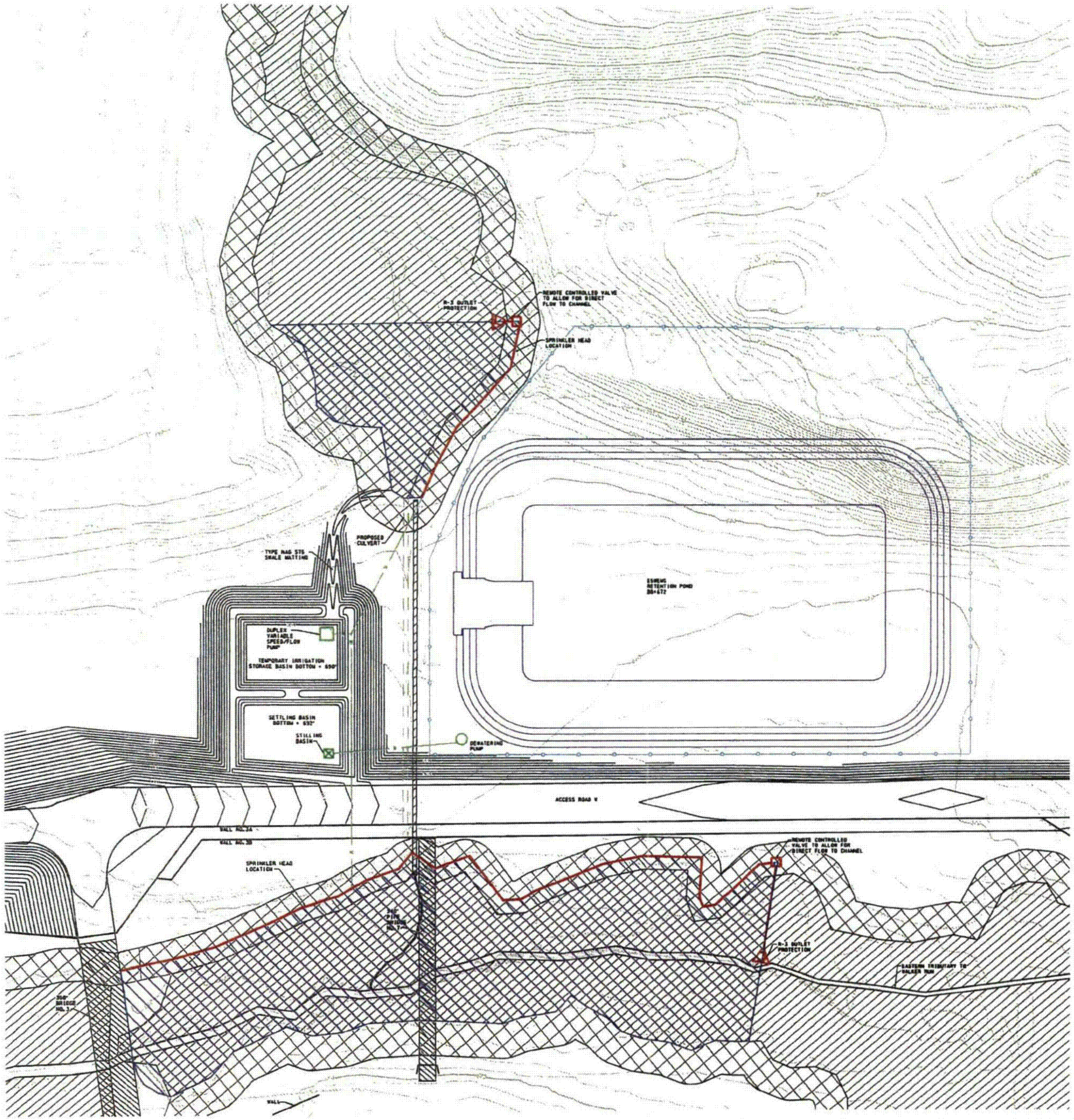

NOTES:

1. EACH BRANCH OF THE IRRIGATION SYSTEM WILL BE CAPABLE OF MITIGATING 350 GPM FROM THE DEWATERING OPERATION BY MEANS OF DIRECT DISCHARGE TO THE STREAM CHANNEL OR SPRAY IRRIGATION OF THE WETLANDS.
2. SPRINKER HEADS WILL BE SPACED 20' APART.
TEAR DROP WETLAND SPRINKLER HEADS WILL BE CAPABLE OF SPRAYING NO LESS THAN 22 GPM.
3. THE EASTERN TRIBUTARY TO WALKER RUN SPRINKLER HEADS WILL BE CAPABLE OF SPRAYING NO LESS THAN 6 GPM.
4. EACH SPRINKLER HEAD WILL HAVE AN OPERATIONAL PRESSURE OF 30-40LBS/SQ-IN.
5. THE DUPLEX VARIABLE SPEED/FLOW PUMP WILL BE CAPABLE OF PUMPED NO LESS THAN 350GPM.
6. THE DEWATERING POND WILL HAVE TWO DAYS OF STORAGE.
7. THE FIRST DAY WILL HAVE THE CAPACITY TO ALLOW THE PUMPED WATER TO SETTLE FOR 24HRS.
8. THE SECOND DAY HAVE THE CAPACITY TO ALL IRRIGATION FOR 24HRS.
9. THE POND HAS AN EMERGENCY SPILL WAY THAT WILL ALLOW UNNECCESSARY WATER TO PASS TO THE STREAM CHANNEL.

LEGEND

- REMOTE CONTROLLED VALVE TO ALLOW FOR DIRECT FLOW TO CHANNEL
- DUPLEX VARIABLE SPEED/FLOW PUMP
- STILLING BASIN
- DEWATERING PUMP
- SPRINKLER SPRAY ZONE
- 50' EXCEPTIONAL VALUE (EV) WETLAND BUFFER
- WETLANDS
- SPRINKLER HEAD LOCATION
- WATER LINE
- FLOW BARRIER
- R-3 OUTLET PROTECTION Do = 1, W = 5, La = 4, 18" THICK

ROCK SIZE DISTRIBUTION TABLE			
	GRADED ROCK SIZE (IN)		
NSA NO.	MAX.	D50	MIN.
R-3	6	3	2

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