SECTION 2 – ENVIRONMENTAL MONITORING PROGRAM

I. Estimates of Radiation Dose to Man

1. Pathways to Man - Calculation Models

The radiation doses to man as a result of BVPS operations were calculated for both gaseous and liquid effluent pathways using computer codes for the ARERAS/MIDAS computer system. These computer codes are equivalent to NRC computer codes XOQDOQ2, GASPAR, and LADTAP. Dose factors listed in the ODCM are used to calculate doses from radioactive noble gases in discharge plumes. BVPS effluent data, based on sample analysis were used as the radionuclide activity input.

All liquid and gaseous effluent radionuclides listed in the Annual Radioactive Effluent Release Report were used as input source terms to the computer codes.

All batch and continuous gaseous effluent releases were included in the dose assessment calculations. The release activities are based on laboratory analysis. Meteorological data collected by the BVPS Meteorology System was also used as input to the computer codes. The usage factors were obtained from the BVPS Final Environmental Statements or Regulatory Guide 1.109, except when more recent or specific data was available.

All radioactive liquid effluents are released by batch mode after analysis by gamma spectrometry. Each batch is diluted by cooling tower blowdown water prior to discharge into the Ohio River via the main outfall (River Mile 35.0). The actual data from these analyses are tabulated and used as the radionuclide source term input to the computer code. The usage factors were obtained from the BVPS Final Environmental Statements or Regulatory Guide 1.109, except when more recent or specific data was available.

The total population doses were evaluated for all liquid and gaseous effluent pathways up to 50 miles. For these evaluations, a total population of approximately 4 million people was used. An estimate of the populations are listed in the BVPS-2 UFSAR Section 2.1.3.1 for 0-10 miles and Section 2.1.3.2 for 10-50 miles.

2. Results of Calculated Population Dose to Man - Liquid Effluent Releases

During the report period, the calculated dose to the entire population within 50 miles of the plant is presented in Table 2-4 for BVPS liquid effluent releases. Also shown in the Table 2-6 is a comparison to natural radiation exposure.

3. Results of Calculated Population Dose to Man – Gaseous Effluent Releases

During the report period, the calculated dose to the entire population within 50 miles of the plant is presented in Table 2-5 for BVPS airborne effluent releases. Also shown in the Table 2-6 is a comparison to natural radiation exposure. The doses include the contribution of all pathways.

SECTION 2 – ENVIRONMENTAL MONITORING PROGRAM

4. Conclusions

Based upon the estimated dose to individuals from the natural background radiation exposure in Tables 2-4 and 2-5, the incremental increase in total body dose to the 50-mile population from the operation of BVPS - Unit 1 and 2, is less than **0.0000025%** of the annual background dose.

The calculated doses to the public from the operation of BVPS - Unit 1 and 2, are below ODCM annual limits and resulted in only a small incremental dose to that which area residents already received as a result of natural background. The doses constituted no meaningful risk to the public.

**Table 2-4: Calculated Population Dose to Man
Liquid Effluent Releases**

0-50 mile Population Dose from BVPS Liquid Effluent Releases		
	Man-millirem	Largest Isotope Contributor
Total Dose	141	Tritium
Average Dose (per Individual)	0.0000351	Tritium

Comparison of Individual Dose BVPS Liquid Effluent Releases Versus Natural and Medical Radiation Exposure	
	Millirem
BVPS Liquid Effluent Release Dose	0.0000351
Radiation Exposure	620

**Table 2-5: Calculated Population Dose to Man
Gaseous Effluent Releases**

0-50 mile Population Dose from BVPS Gaseous Effluent Releases		
	Man-millirem	Largest Isotope Contributor
Total Dose	41	Tritium
Average Dose (per Individual)	0.0000103	Tritium

Comparison of Individual Dose BVPS Gaseous Effluent Releases Versus Natural and Medical Radiation Exposure	
	Millirem
BVPS Gaseous Effluent Release Dose	0.0000103
Radiation Exposure	620

SECTION 2 – ENVIRONMENTAL MONITORING PROGRAM

Table 2-6: Natural and Medical Radiation Exposures

TYPICAL DOSE TO INDIVIDUALS

FROM RADIATION EXPOSURE [a]

Ubiquitous background	=	311 millirem / year	
Internal, inhalation			228 millirem / year
Internal, ingestion			29 millirem / year
External, space			33 millirem / year
External, terrestrial			21 millirem / year
Medical	=	300 millirem / year	
CT			147 millirem / year
Nuclear medicine			77 millirem / year
Interventional fluoroscopy			43 millirem / year
Conventional radiography			33 millirem / year
Consumer	=	13 millirem / year	
Industrial, security, educational, research	=	0.3 millirem / year	
Occupational	=	0.5 millirem / year	
Average Individual	**=**	**620 millirem / year**	
(Total from all sources shown above)			

(a) NCRP Report No. 160: Ionizing Radiation Exposure of the Population of the United States." *Journal of Radiological Protection J. Radiol. Prot.* 29.3 (2009)

SECTION 3 – LAND USE CENSUS

A. **Land Use Census Overview:** A Land Use Census was conducted June 1 through September 1, 2015 to comply with:

- Offsite Dose Calculation Manual procedure 1/2-ODC-3.03, *"Controls for RETS and REMP Programs"*, Attachment R, Control 3.12.2, and Surveillance Requirement 4.12.2.1

- BVPS REMP procedure 1/2-ENV-04.02, *"Milch Animal Sampling Location Determination & ODCM Procedure 1/2-ODC-3.03, Control 3.12.2 Action Statements a and b Compliance Determination"*

The Land Use Census indicated that no changes were required in the current sampling locations, and no changes were required to the methodology used for determination of offsite dose from plant releases. A numerical summary of the Land Use Census results are provided in Table 3-1. The following information is also provided to clarify the Land Use Census as documented in letter NPD3NRE:1125, dated December 23, 2015:

B. **Nearest Residence:** The location has not changed since the previous census. The nearest inhabited residence is at **209 Ferry Hill Road, Shippingport, PA** (0.4 miles, E).

C. **Nearest Garden >500 sqft**: The location has not changed since the previous census. The closest garden location is at the **Pringle Residence**, 1221 Virginia Ave., Midland, PA (1.0 miles, in the NW Sector). The previous sampling location at the **Cox Residence**, 238 State Route 168, Hookstown, PA (0.760 miles, in the SSW Sector) was available for sampling cabbage this year but does not meet all the requirements of NUREG-1301 **Ref (h)**.

D. **Nearest Dairy Cow:** The location has changed since the previous census. **Searight Dairy**, 948 McCleary Road, RD 1, Hookstown, PA (2.097 miles, SSW) closed in 2014. Therefore, the closest milking cow location is **Brunton Dairy**, 3681 Ridge Road, Aliquippa, PA (6.158 miles, SE).

E. **Nearest Doe Goat:** The location has not changed since the previous census. The closest location is the **Covert Residence**, 930 Pine Street, Hookstown, PA (1.900 miles, SW).

SECTION 3 – LAND USE CENSUS

F. **Projection for 2015 Dairy Cow Sampling Locations:** Using a linear regression analysis of deposition parameters (D/Q), Dairy Cow sampling locations were determined to remain at the same locations used in 2015:
   - **Brunton Dairy**, 3681 Ridge Road, Aliquippa, PA (6.158 miles SE)
   - **Windsheimer Dairy**, 20 Windsheimer Lane, Burgettstown, PA (10.476 miles SSW)

G. **Projection for 2015 Doe Goat Sampling Locations:** The linear regression analysis also indicated that there will be a Doe Goat sampling location in 2015. The Doe Goat sampling location for 2015 may be as follows if Goat Milk continues to be available from this site:
   - **Covert Residence**, 930 Pine Street, Hookstown PA (1.900 miles, SW)

H. **D/Q for Milch Animal Locations:** None of the 2015 milch animal sampling locations experienced a >20% increase in D/Q. Therefore, a Special Report per ODCM procedure 1/2-ODC-3.03, Attachment R, Control 3.12.2 Action "a" and/or Action "b" was not required.

I. **D/Q for Offsite Dose Determination:** There was no adverse effect on the current ODCM methodology used for offsite dose determination from effluent releases. Specifically, the analysis of D/Q did not yield any valid locations where the offsite dose could have increased >20% of the offsite dose previously calculated using current ODCM methodology. Therefore, a Special Report per ODCM Control 3.12.2 Action "a" and/or Action "b" is not required.

J. **D/Q Historical Comparison:** There is no adverse trend in D/Q when comparing 2000 to 2015 data to the ODCM default D/Q values. This validates that there is no adverse effect on the current ODCM methodology used for offsite dose determination from effluent releases. Specifically, the analysis of D/Q did not yield any valid locations where the offsite dose could have increased >20% of the offsite dose previously calculated using current ODCM methodology. Therefore, a change in ODCM receptor location and/or a change to meteorology at the current ODCM receptor location are not required.

SECTION 3 – LAND USE CENSUS

Table 3-1

Location of Nearest Residences, Gardens, Dairy Cows and Doe Goats

SECTOR	RESIDENCES	GARDENS	DAIRY COWS	DOE GOATS
	0 to 5 miles (miles)	0 to 5 miles (miles)	0 to 5 miles (miles)	0 to 5 miles (miles)
N	1.584	1.584	None	None
NNE	1.661	1.8	None	None
NE	0.4	3.3	None	None
ENE	0.603	1.047	None	None
E	**0.4** [b]	2.1	None	3.402
ESE	0.850	1.713	None	None
SE	1.583	1.3	None [a]	None
SSE	1.102	None	None	None
S	1.399	1.5	None	None
SSW	0.760	2.215 [b]	None	None
SW	1.453	1.453	None	**1.900**
WSW	1.394	2.5	None	None
W	2.204	None	None	None
WNW	2.742	2.8	None	None
NW	0.885	1.0	None	None
NNW	0.902	2.4	2.442	None

[a] Although there are no Dairy Cows within 5 miles in this sector, a large local dairy located at 6.158 miles is included in the milk sampling program.

[b] **Distances shown in Bold print are the nearest location for that receptor.**

SECTION 4 - SPLIT SAMPLE PROGRAM and SPIKE SAMPLE INTER-LABORATORY COMPARISON PROGRAM

A. **Split Sample Program (Inter-Laboratory Comparison, Part 1 of 2):** BVPS participates in a split sample program with the Pennsylvania Department of Environmental Protection (PADEP) in support of their nuclear power plant monitoring program.

- BVPS provided split samples to PADEP throughout the report period. The shared media and number of locations were typically comprised of milk (1), surface water (3), sediment (1), fish (1), and food crops (2).
- PADEP has co-located continuous air particulate & air iodine sample stations with four (4) of the BVPS locations.
- PADEP has co-located TLDs with twenty-four (24) of the BVPS TLDs.

B. **Spike Sample Program (Inter-Laboratory Comparison, Part 2 of 2):** BVPS participates in a spike sample program with an Independent Laboratory. This program is used to independently verify sample analyses performed by the BVPS Contractor Laboratory.

- **Acceptance Criteria:** The NRC criteria listed in NRC Inspection Procedure 84750, 03/15/94, Inspection Guidance 84750-03 is used as acceptance criteria for comparisons of results of spiked samples between the Contractor Lab and the Independent Lab. These comparisons are performed by dividing the comparison standard (Independent Lab result) by its associated uncertainty to obtain the resolution. The comparison standard value is multiplied by the ratio values obtained from the following table to find the acceptance band for the result to be compared. However, in such cases in which the counting precision of the standard yields a resolution of less than 4, a valid comparison is not practical, and therefore, not performed.

NRC Criteria	
Resolution	**Ratio**
< 4	--
4 - 7	0.50 - 2.00
8 - 15	0.60 - 1.66
16 - 50	0.75 - 1.33
51 - 200	0.80 - 1.25
> 200	0.85 - 1.18

SECTION 4 - SPLIT SAMPLE PROGRAM and SPIKE SAMPLE INTER-LABORATORY COMPARISON PROGRAM

Participation in an Inter-Laboratory Comparison Program is required by BVPS Unit 1 and 2 Offsite Dose Calculation Manual procedure 1/2-ODC-3.03 Attachment S Control 3.12.3. For the report period, the requirement was met by the Contractor Lab analyzing NIST traceable spiked samples supplied by an Independent Lab.

During the report period, BVPS used (Environmental, Inc., Midwest Laboratory – Northbrook, IL) as the Contractor Laboratory, and (Eckert & Ziegler Analytics – Atlanta, GA) as the Independent Laboratory.

The spiked samples included air particulate filter papers, charcoal cartridges, water samples, and milk samples. The samples were submitted by the Independent Laboratory to the Contractor Laboratory for analysis. The "spiked to" values were used for calculating comparison Acceptance Criteria.

- **Spiked Milk & Water Samples:** The spiked sample results (i.e. the BVPS criteria) for each calendar quarter are reported in Table 4-1 through Table 4-4, respectively. The following summary is provided:

  - A total of forty-eight (48) gamma spectrometry radionuclide analyses were performed by the Contractor Laboratory on four (4) milk samples.

  - A total of forty-eight (48) gamma spectrometry radionuclide analyses were performed by the Contractor Laboratory on four (4) water samples.

  - A total of four (4) chemical analyses for I-131 were performed by the Contractor Laboratory on four (4) milk samples.

  - A total of four (4) I-131 analyses were performed by the Contractor Laboratory on four (4) water samples.

  - A total of four (4) tritium analyses were performed by the Contractor Laboratory on four (4) water samples.

  - Comparison of results of the spiked milk and water samples showed acceptable agreement with the NRC acceptance criteria. All one hundred eight (108) analyses met the NRC acceptance criteria.

SECTION 4 - SPLIT SAMPLE PROGRAM and SPIKE SAMPLE INTER-LABORATORY COMPARISON PROGRAM

- **Spiked Filter Paper and Charcoal Cartridge Samples:** The spiked sample results for each calendar quarter are reported in Table 4-1 through Table 4-4, respectively. The following summary is provided:

  - Gross Beta (cesium-137) analyses were performed by the Contractor Laboratory on two (2) filter paper samples.

  - Iodine-131 analyses were performed by the Contractor Laboratory on two (2) charcoal cartridge samples.

  - Comparison of results of the spiked filter paper and charcoal cartridge samples showed acceptable agreement with the NRC acceptance criteria. One sample, 1st quarter for filter paper, gross beta (cesium-137), failed the acceptance criteria. The vendor laboratory was immediately notified of the failure and asked to re-preform the analyses, if necessary. The vendor re-analyzed the sample and the result was within the acceptable criteria. The vendor provided a corrected report and the analysis met the acceptance criteria. This issue was documented in Condition Report 2015-06857. All four (4) analyses performed by the Contractor Laboratory met the NRC acceptance criteria.

C. Conclusions

- **Results of Split Sample Program:**

  The split sample program is coordinated by the state, and the results are not included in this report.

- **Results of Spike Sample Program:**

  Based on the Inter-Laboratory comparison data, BVPS considers all analyses provided throughout the report period by the Contractor Laboratory to be acceptable with respect to both accuracy and measurement. A comparison of the data is provided in the following tables. All analyses for the 2015 report period were within the NRC Acceptance Criteria.

SECTION 4 - SPLIT SAMPLE PROGRAM and SPIKE SAMPLE INTER-LABORATORY COMPARISON PROGRAM

Table 4-1

Inter-Laboratory Comparison Program Spiked Samples – 1st Quarter

Sample Date, Type and Identification No.	Resolution	Resolution	Required Ratio Band	Ratio Env Inc: Analytics	Comparison
03/19/15 **Water** Ind Lab: E11167 Con. Lab: SPW-1133	Sr-89	60	0.80 - 1.25	0.91	AGREEMENT
	Sr-90	60	0.80 - 1.25	0.96	AGREEMENT
	I-131	60	0.80 - 1.25	0.94	AGREEMENT
	I-131	60	0.80 - 1.25	0.98	AGREEMENT
	Ce-141	60	0.80 - 1.25	0.98	AGREEMENT
	Cr-51	60	0.80 - 1.25	1.04	AGREEMENT
	Cs-134	60	0.80 - 1.25	0.94	AGREEMENT
	Cs-137	60	0.80 - 1.25	1.03	AGREEMENT
	Co-58	60	0.80 - 1.25	1.00	AGREEMENT
	Mn-54	60	0.80 - 1.25	1.03	AGREEMENT
	Fe-59	60	0.80 - 1.25	1.06	AGREEMENT
	Zn-65	60	0.80 - 1.25	0.88	AGREEMENT
	Co-60	60	0.80 - 1.25	0.98	AGREEMENT
03/19/15 **Water** Ind. Lab: E11165 Con. Lab: SPW-1137	H-3	60	0.80 - 1.25	0.97	AGREEMENT
03/19/15 **Milk** Ind. Lab: E11166 Con. Lab: SPMI-1134	Sr-89	60	0.80 - 1.25	0.87	AGREEMENT
	Sr-90	60	0.80 - 1.25	0.88	AGREEMENT
	I-131	60	0.80 - 1.25	0.88	AGREEMENT
	I-131	60	0.80 - 1.25	0.99	AGREEMENT
	Ce-141	60	0.80 - 1.25	1.10	AGREEMENT
	Cr-51	60	0.80 - 1.25	0.99	AGREEMENT
	Cs-134	60	0.80 - 1.25	0.98	AGREEMENT
	Cs-137	60	0.80 - 1.25	1.06	AGREEMENT
	Co-58	60	0.80 - 1.25	1.01	AGREEMENT
	Mn-54	60	0.80 - 1.25	1.05	AGREEMENT
	Fe-59	60	0.80 - 1.25	1.06	AGREEMENT
	Zn-65	60	0.80 - 1.25	1.08	AGREEMENT
	Co-60	60	0.80 - 1.25	0.99	AGREEMENT
03/19/15 **Filter Paper** Ind. Lab: E11168 Con. Lab: SPAP-1135	Cs-137 (Gross Beta)	60	0.80 - 1.25	1.09	AGREEMENT
03/19/15 **Charcoal Cartridge** Ind. Lab: E11169 Con. Lab: SPCH-1136	I-131	60	0.80 - 1.25	0.95	AGREEMENT

SECTION 4 - SPLIT SAMPLE PROGRAM and SPIKE SAMPLE INTER-LABORATORY COMPARISON PROGRAM

Table 4-2

Inter-Laboratory Comparison Program Spiked Samples – 2nd Quarter

Sample Date, Type and Identification No.	Resolution	Resolution	Required Ratio Band	Ratio Env Inc: Analytics	Comparison
06/11/15 Water Ind Lab: E11225 Con. Lab: SPW-2941	Sr-89	60	0.80 - 1.25	0.92	AGREEMENT
	Sr-90	60	0.80 - 1.25	0.98	AGREEMENT
	I-131	60	0.80 - 1.25	0.92	AGREEMENT
	I-131	60	0.80 - 1.25	1.02	AGREEMENT
	Ce-141	60	0.80 - 1.25	LLD*	AGREEMENT
	Cr-51	60	0.80 - 1.25	1.02	AGREEMENT
	Cs-134	60	0.80 - 1.25	0.93	AGREEMENT
	Cs-137	60	0.80 - 1.25	1.01	AGREEMENT
	Co-58	60	0.80 - 1.25	0.97	AGREEMENT
	Mn-54	60	0.80 - 1.25	1.07	AGREEMENT
	Fe-59	60	0.80 - 1.25	1.10	AGREEMENT
	Zn-65	60	0.80 - 1.25	1.02	AGREEMENT
	Co-60	60	0.80 - 1.25	1.00	AGREEMENT
06/11/15 Water Ind. Lab: E11224 Con. Lab: SPW-2939	H-3	60	0.80 - 1.25	0.97	AGREEMENT
06/11/15 Milk Ind. Lab: E11226 Con. Lab: SPMI-2940	Sr-89	60	0.80 - 1.25	0.87	AGREEMENT
	Sr-90	60	0.80 - 1.25	0.83	AGREEMENT
	I-131	60	0.80 - 1.25	0.96	AGREEMENT
	I-131	60	0.80 - 1.25	1.03	AGREEMENT
	Ce-141	60	0.80 - 1.25	LLD*	AGREEMENT
	Cr-51	60	0.80 - 1.25	0.99	AGREEMENT
	Cs-134	60	0.80 - 1.25	0.92	AGREEMENT
	Cs-137	60	0.80 - 1.25	1.04	AGREEMENT
	Co-58	60	0.80 - 1.25	1.01	AGREEMENT
	Mn-54	60	0.80 - 1.25	1.05	AGREEMENT
	Fe-59	60	0.80 - 1.25	1.05	AGREEMENT
	Zn-65	60	0.80 - 1.25	0.97	AGREEMENT
	Co-60	60	0.80 - 1.25	1.02	AGREEMENT

*LLD: Lower Limit of Detection

SECTION 4 - SPLIT SAMPLE PROGRAM and SPIKE SAMPLE INTER-LABORATORY COMPARISON PROGRAM

Table 4-3

Inter-Laboratory Comparison Program Spiked Samples – 3rd Quarter

Sample Date, Type and Identification No.	Resolution	Resolution	Required Ratio Band	Ratio Env Inc: Analytics	Comparison
09/10/15 Water Ind Lab: E11323 Con. Lab: SPW-4979	Sr-89	60	0.80 - 1.25	0.88	AGREEMENT
	Sr-90	60	0.80 - 1.25	0.97	AGREEMENT
	I-131	60	0.80 - 1.25	0.94	AGREEMENT
	I-131	60	0.80 - 1.25	1.01	AGREEMENT
	Ce-141	60	0.80 - 1.25	1.01	AGREEMENT
	Cr-51	60	0.80 - 1.25	1.02	AGREEMENT
	Cs-134	60	0.80 - 1.25	0.90	AGREEMENT
	Cs-137	60	0.80 - 1.25	1.02	AGREEMENT
	Co-58	60	0.80 - 1.25	1.01	AGREEMENT
	Mn-54	60	0.80 - 1.25	1.05	AGREEMENT
	Fe-59	60	0.80 - 1.25	1.07	AGREEMENT
	Zn-65	60	0.80 - 1.25	1.03	AGREEMENT
	Co-60	60	0.80 - 1.25	1.02	AGREEMENT
09/10/15 Water Ind. Lab: E11322 Con. Lab: SPW-4978	H-3	60	0.80 - 1.25	1.00	AGREEMENT
09/10/15 Milk Ind. Lab: E11324 Con. Lab: SPMI-4980	Sr-89	60	0.80 - 1.25	0.84	AGREEMENT
	Sr-90	60	0.80 - 1.25	0.90	AGREEMENT
	I-131	60	0.80 - 1.25	0.91	AGREEMENT
	I-131	60	0.80 - 1.25	1.03	AGREEMENT
	Ce-141	60	0.80 - 1.25	1.00	AGREEMENT
	Cr-51	60	0.80 - 1.25	1.08	AGREEMENT
	Cs-134	60	0.80 - 1.25	0.91	AGREEMENT
	Cs-137	60	0.80 - 1.25	1.03	AGREEMENT
	Co-58	60	0.80 - 1.25	1.01	AGREEMENT
	Mn-54	60	0.80 - 1.25	1.06	AGREEMENT
	Fe-59	60	0.80 - 1.25	1.06	AGREEMENT
	Zn-65	60	0.80 - 1.25	1.04	AGREEMENT
	Co-60	60	0.80 - 1.25	1.03	AGREEMENT
09/10/15 Filter Paper Ind. Lab: E11325A Con. Lab: SPAP-4981	Cs-137 (Gross Beta)	60	0.80 - 1.25	1.05	AGREEMENT
09/10/15 Charcoal Cartridge Ind. Lab: E11326 Con. Lab: SPCH-4982	I-131	60	0.80 - 1.25	0.97	AGREEMENT

SECTION 4 - SPLIT SAMPLE PROGRAM and SPIKE SAMPLE INTER-LABORATORY COMPARISON PROGRAM

Table 4-4

Inter-Laboratory Comparison Program Spiked Samples – 4th Quarter

Sample Date, Type and Identification No.	Resolution	Resolution	Required Ratio Band	Ratio Env Inc: Analytics	Comparison
12/03/15 Water Ind Lab: E11388 Con. Lab: SPW-6781	Sr-89	60	0.80 - 1.25	0.87	AGREEMENT
	Sr-90	60	0.80 - 1.25	0.99	AGREEMENT
	I-131	60	0.80 - 1.25	0.85	AGREEMENT
	I-131	60	0.80 - 1.25	0.95	AGREEMENT
	Ce-141	60	0.80 - 1.25	1.00	AGREEMENT
	Cr-51	60	0.80 - 1.25	0.98	AGREEMENT
	Cs-134	60	0.80 - 1.25	0.93	AGREEMENT
	Cs-137	60	0.80 - 1.25	1.05	AGREEMENT
	Co-58	60	0.80 - 1.25	1.01	AGREEMENT
	Mn-54	60	0.80 - 1.25	1.04	AGREEMENT
	Fe-59	60	0.80 - 1.25	1.06	AGREEMENT
	Zn-65	60	0.80 - 1.25	1.06	AGREEMENT
	Co-60	60	0.80 - 1.25	1.01	AGREEMENT
12/03/15 Water Ind. Lab: E11387 Con. Lab: SPW-6780	H-3	60	0.80 - 1.25	0.96	AGREEMENT
12/03/15 Milk Ind. Lab: E11389 Con. Lab: SPMI-6782	Sr-89	60	0.80 - 1.25	0.82	AGREEMENT
	Sr-90	60	0.80 - 1.25	0.91	AGREEMENT
	I-131	60	0.80 - 1.25	0.84	AGREEMENT
	I-131	60	0.80 - 1.25	1.00	AGREEMENT
	Ce-141	60	0.80 - 1.25	1.01	AGREEMENT
	Cr-51	60	0.80 - 1.25	0.99	AGREEMENT
	Cs-134	60	0.80 - 1.25	0.93	AGREEMENT
	Cs-137	60	0.80 - 1.25	1.05	AGREEMENT
	Co-58	60	0.80 - 1.25	1.00	AGREEMENT
	Mn-54	60	0.80 - 1.25	1.04	AGREEMENT
	Fe-59	60	0.80 - 1.25	1.07	AGREEMENT
	Zn-65	60	0.80 - 1.25	1.05	AGREEMENT
	Co-60	60	0.80 - 1.25	0.99	AGREEMENT

SECTION 5 – CORRECTIONS TO PREVIOUS RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT(S)

Corrections to Previous Radiological Environmental Operating Report(s): There are no corrections to previous reports at this time.

Enclosure B
L-16-125

2015 Annual Environmental Operating Report (Non-Radiological)
(Report follows)

RTL# A9.630F

FIRSTENERGY NUCLEAR OPERATING COMPANY
BEAVER VALLEY POWER STATION

2015 ANNUAL ENVIRONMENTAL OPERATING REPORT
NON-RADIOLOGICAL
UNITS NO. 1 AND 2
LICENSES DPR-66 AND NPF-73

BEAVER VALLEY POWER STATION
ENVIRONMENTAL & CHEMISTRY SECTION

Technical Report Approval

2015 ANNUAL ENVIRONMENTAL OPERATING REPORT

(Non-Radiological)

UNITS NO. 1 AND 2

LICENSES DPR-66 AND NPF-73

Prepared by: Cameron L. Lange *(Via E-mail)* **Date:** 2-26-16

Reviewed by: Courtney F. Casto Courtney F. Casto **Date:** 4-6-16

Reviewed by: Robert R. Winters Robert R. Winters **Date:** 4-6-16

Approved by: Donald J. Salera Donald J. Salera **Date:** 4-6-16

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1.0 EXECUTIVE SUMMARY

1.1 INTRODUCTION

This report is submitted in accordance with Section 5.4.1 of Appendix B: To Facility Operating License No. NPF-73, Beaver Valley Power Station Unit 2, Environmental Protection Plan (Non-Radiological). Beaver Valley Power Station (BVPS) is operated by FirstEnergy Nuclear Operating Company (FENOC). The Objectives of the Environmental Protection Plan (EPP) are to:

- Verify that the facility is operated in an environmentally acceptable manner, as established by the Final Environmental Statement-Operating License Stage (FES-OL) and other Nuclear Regulatory Commission (NRC) environmental impact assessments,

- Keep plant operations personnel appraised of changes in environmental conditions that may affect the facility,.

- Coordinate NRC requirements and maintain consistency with other Federal, State, and local requirements for environmental protection, and

- Keep the NRC informed of the environmental effects of facility construction and operation and of actions taken to control those effects.

To achieve the objectives of the EPP, both FENOC and BVPS have written programs and procedures to comply with the EPP, protect the environment, and comply with governmental requirements primarily including the US Environmental Protection Agency (EPA) and the Pennsylvania Department of Environmental Protection (PADEP) requirements. Water quality matters identified in the Final Environmental Statements-Operating License Stage (FES-OL) are regulated under the National Pollutants Discharge Elimination System (NPDES) Permit No. PA0025615. Waste is regulated under EPA Identification No. PAR000040485. Attachment 10.1 contains a listing of permits and certificates for environmental compliance.

The BVPS programs and procedures include pre-work and pre-project environmental evaluations, operating procedures, pollution prevention and response programs procedures and plans, process improvement and corrective action programs, and human performance programs. Technical and managerial monitoring of tasks, operations, and other activities are performed. Any identified challenges, concerns, or questions are captured in the FENOC Problem Identification and Resolution Program with a Condition Report. Condition Reports include investigations, cause determinations, and corrective actions.

During 2015, BVPS continued an Aquatic Monitoring Program to evaluate its potential impact on the New Cumberland Pool of the Ohio River and to provide information on potential impacts to BVPS operation from macrofoulers such as Asian clams and zebra mussels.

1.2 SUMMARY AND CONCLUSIONS

There were no significant environmental events during 2015. During 2015, no significant changes to operations that could affect the environment were made at Beaver Valley Power Station. ***As in previous years, results of the BVPS environmental programs did not indicate any adverse environmental impacts from station operation.***

1.3 ANALYSIS OF SIGNIFICANT ENVIRONMENTAL CHANGE

During 2015, no significant changes were made at BVPS to cause significant negative affect on the environment.

1.4 AQUATIC MONITORING PROGRAM

The 2015 Beaver Valley Power Station (BVPS) Units 1 and 2 Non-Radiological Monitoring Program consisted of an Aquatic Program that included surveillance and field sampling of the Ohio River's aquatic life in the vicinity of the station. The Aquatic Program is an annual program conducted to provide baseline aquatic resources data, to assess the impact of the operation of BVPS on the aquatic ecosystem of the Ohio River, and to monitor for potential impacts of biofouling organisms (*Corbicula* and zebra mussels) on BVPS operations. This is the 40^{th} year of operational environmental monitoring for Unit 1 and the 29^{th} year for Unit 2. As in previous years, the results of the program did not indicate any adverse environmental impact to the aquatic life in the Ohio River associated with the operation of BVPS.

The results of the 2015 benthic macroinvertebrate survey conducted in May and September indicated a normal community structure exists in the Ohio River both upstream and downstream of the BVPS. These benthic surveys are a continuation of a Fate and Effects Study conducted from 1990 through 1992 for the PADEP to assess the ecosystem impacts of molluscicides including Betz Clamtrol CT-1, CT-2, and Nalco H150M that have been used to control biofouling organisms at BVPS. To date the results of the benthic studies have not indicated any impacts of operation at the BVPS including the use these biocides on the benthic community below the BVPS discharge.

Substrate was probably the most important factor influencing the distribution and abundance of the benthic macroinvertebrates in the Ohio River near BVPS. The generally soft muck-type substrate along the shoreline found in 2015 and previous years was conducive to segmented worm (oligochaete) and midge fly larvae (chironomid) proliferation. Increased water clarity due at least in part to the establishment of zebra mussels was noted during 2015. This has increased the amount of submerged aquatic vegetation at Stations 1, 2B and 3. The presence of submerged aquatic vegetation can increase the number of species of macroinvertebrates, especially chironomids (midge flies) that use them as a primary food source and a place to avoid predators. Sixty-one (61) macroinvertebrate taxa were identified during the 2015 monitoring program. In 2015, no new taxa were added to the cumulative list of macroinvertebrates collected near BVPS (Table 5.2). Also, no state or Federal threatened or endangered macroinvertebrate species were collected during 2015.

In May and in September oligochaetes were the most frequently collected group of macroinvertebrates. ***There were no major differences in the community structure between control and non-control stations that could be attributed to operation of BVPS. The overall community structure has changed little since pre-operational years, and program results did not indicate that BVPS operations were affecting the benthic community of the Ohio River.***

The fish community of the Ohio River near the BVPS was sampled in May (spring), July (summer), September (fall) and November (winter) of 2015 with electrofishing and seining. Since monitoring began in the early 1970's, the number of identified fish taxa has increased from 43 to 78 for the New Cumberland Pool.

In 2015, 435 fish representing 20 taxa were collected (i.e., handled) during BVPS surveys by electrofishing and seining. This was 245 more fish but the same number of taxa that were collected in 2014. This increase was due largely to the large number of juvenile gizzard shad that were collected in fall and winter by electrofishing. All taxa collected in 2015 were previously encountered at BVPS. A total, of 419 fish, representing 17 taxa, was collected by electrofishing in 2015 compared to 186 fish representing 17 taxa in 2014. The number of fish collected in 2015 was considerably more than the total number collected in 2011 (151 fish), the last time electrofishing was collected at night. The number of species collected was, however, fewer than in 2011 when 22 species were encountered. A total of 16 fish representing five (5) taxa was collected by seines in 2015 (Table 5.10) compared to 48 fish representing eight (8) taxa in 2014.

Benthivores (bottom feeders including suckers and buffalo) and forage species (e.g. gizzard shad and emerald shiners) were generally collected in the highest numbers in 2015. The numbers of forage fish were much greater in 2015, due to the large number of juvenile gizzard shad collected in the fall and winter. Variations in annual catch were probably attributable to normal fluctuations in the population size of the forage species and the predator populations that rely on them. Forage species, such as gizzard shad and emerald shiner with high reproductive potentials, frequently respond to changes in natural environmental factors (competition, food availability, cover, and water quality) with large fluctuations in population size. This, in turn, influences their appearance in the sample populations during annual surveys. Spawning/rearing success due to abiotic factors is usually the determining factor of the size and composition of a fish community.

The annual catch rate in 2015 (2.56 fish per minute) was higher than any of the previous three years, when catch rates were 0.86 fish per minute in 2014, 0.53 in 2013 and 0.59 in 2012. The greater electrofishing rate in 2015 was due to the relatively large number of juvenile gizzard shad that were in fall and winter. Gizzard shad are schooling fish so multiple individuals are generally collected when present. They display high year to year fluctuations in abundance due to spawning success and over winter mortality. The gizzard shad collected in fall and winter likely were spawned in spring and early summer 2015 and became large enough to be collected by electrofishing.

Little difference in the species composition of the catch was observed between the control (Station 1) and non-control (Stations 2A, 2B and 3) stations. Habitat preference and availability

were probably the most important factors affecting where and when fish were collected. ***Results from the 2015 fish surveys indicated that a normal community structure for the Ohio River exists near BVPS based on species composition and relative abundance. In 2015, there was no indication of negative impact to the fish community in the Ohio River from the operation of BVPS.***

The monthly reservoir Ponar samples collected in Units 1 and 2 cooling towers and the four samples collected at the intake during 2015 indicated that *Corbicula* were present in the Ohio River and entering the station. In 2015, 13 settled live *Corbicula* were collected from the Unit 1 cooling tower reservoir during monthly reservoir ponar sampling. In 2015, nine (9) live settled *Corbicula* was collected from the Unit 2 cooling tower reservoir. ***The overall low numbers of live Corbicula collected in the sample collected outside the intake and cooling towers in 2015, compared to levels in the 1980's, likely reflects a natural decrease in the density of Corbicula in the Ohio River near BVPS, although an increased density of live settled individuals and juveniles collected in the cooling towers may indicate that the population is beginning to increase again. Continued monitoring of Corbicula densities is recommended.***

In 1995, live zebra mussels were collected for the first time by divers in the BVPS main intake and auxiliary intake structures during scheduled cleanings. They have been found in the BVPS every year since. Overall, both the number of observations and densities of settled mussels in 2015 were consistent to those recorded in 2008-2014, and much higher than the preceding five years. Although densities of settled mussels are low compared to other populations such as the Lower Great Lakes, densities comparable to those in the Ohio River are more than sufficient to cause problems in the operation of untreated cooling water intake systems. ***Whether the population of zebra mussels in this reach of the Ohio River will remain the same or increase cannot be determined. In any case, the densities of mussels that presently exist are more than sufficient to impact the BVPS, if continued prudent monitoring and control activities are not conducted.***

2.0 ENVIRONMENTAL PROTECTION PLAN NON-COMPLIANCES

There were no Environmental Protection Plan non-compliances identified in 2015.

3.0 CHANGES INVOLVING UNREVIEWED ENVIRONMENTAL QUESTIONS

No Unreviewed Environmental Questions were identified in 2015. Therefore, there were no changes involving an Unreviewed Environmental Question.

4.0 NON-ROUTINE ENVIRONMENTAL REPORT

There were no non-routine environmental reports in 2015.

5.0 AQUATIC MONITORING PROGRAM

This section of the report summarizes the Non-Radiological Environmental Program conducted for the BVPS Units 1 and 2; Operating License Numbers DPR-66 and NPF-73. This is a non-mandatory program, because on February 26, 1980, the NRC granted BVPS's request to delete all of the Aquatic Monitoring Program, with the exception of the fish impingement program (Amendment No. 25), from the Environmental Technical Specifications (ETS). In 1983, BVPS was permitted to also delete the fish impingement studies from the ETS program of required sampling along with non-radiological water quality requirements. However, in the interest of providing an uninterrupted database, BVPS has continued the Aquatic Monitoring Program.

The objectives of the 2015 environmental program were:

- To monitor for any possible environmental impact of BVPS operation on the benthic macroinvertebrate and fish communities in the Ohio River;

- To evaluate the presence, growth, and reproduction of macrofouling *Corbicula* sp. (Asiatic clam) and zebra mussels (*Dreissena* spp.) at BVPS;

- To provide a low level sampling program to continue an uninterrupted environmental database for the Ohio River near BVPS, pre-operational to present; and

- Keep plant operations appraised of any of changes in environmental conditions that may affect the facility.

These objectives have assisted facility personnel in the past. For instance, in the facility's Significant Operating Experience Report (SOER 07-2, October 2008) relative to "Intake Cooling Water Blockage" this Aquatic Monitoring Program was credited as a means of addressing "Changing Environmental Conditions" by looking "for changes in quantity of clam and mussel activity by monitoring the veliger (commonly known as larvae) density in the river and mussel settlement density."

5.1 SITE DESCRIPTION

BVPS is located on an approximately 453-acre tract of land on the south bank of the Ohio River in the Borough of Shippingport, Beaver County, Pennsylvania. The Shippingport Atomic Power Station once shared the site with BVPS before being decommissioned. Figure 5.1 is a plan view of BVPS. The site is approximately 1 mile (1.6 km) from Midland, Pennsylvania; 5 miles (8 km) from East Liverpool, Ohio; and 25 miles (40 km) from Pittsburgh, Pennsylvania. The population within a 5-mile (8 km) radius of the plant is approximately 18,000. The Borough of Midland, Pennsylvania has a population of approximately 3,500.

The station is situated at Ohio River Mile 34.8 (Latitude: 40° 36' 18"; Longitude: 80° 26' 02") at a location on the New Cumberland Pool that is 3.1 river miles (5.3 km) downstream from Montgomery Lock and Dam and 19.6 miles (31.2 km) upstream from New Cumberland Lock

and Dam. The Pennsylvania-Ohio-West Virginia border is 5.2 river miles (8.4 km) downstream from the site. The river flow is regulated by a series of dams and reservoirs on the Beaver, Allegheny, Monongahela, and Ohio Rivers and their tributaries.

The study site lies along the Ohio River in a valley, which has a gradual slope that extends from the river at an elevation of 665 ft. (203 m) above mean sea level; to an elevation of 1,160 ft. (354 m) along a ridge south of BVPS. The plant entrance elevation at the station is approximately 735 ft. (224 m) above mean sea level.

BVPS Units 1 and 2 have a thermal rating of 2,900 megawatts (MW). Units 1 & 2 have a design electrical rating of 974 MW and 1,009 MW, respectively. The circulating water systems for each unit are considered a closed cycle system with continuous overflow, using a cooling tower to minimize heat released to the Ohio River. Commercial operation of BVPS Unit 1 began in 1976 and Unit 2 began operation in 1987.

5.2 STUDY AREA

The environmental study area was established to assess potential impacts and consists of four sampling stations, each having a north and south shore (Figure 5.1). Station 1 is located at River Mile (RM) 34.5, approximately 0.3 miles (0.5 km) upstream of BVPS and is the control station. Station 2A is located approximately 0.5 miles (0.8 km) downstream of the BVPS discharge structure in the main channel. Station 2B is located in the back channel of Phillis Island; also 0.5 miles downstream of the BVPS discharge structure. Station 2B is the principal non-control station because the majority of discharges from BVPS Units 1 and 2 are released to this back channel. Station 3 is located approximately two miles (3.2 km) downstream of BVPS and only rarely is influenced by the BVPS discharge. Significant erosion of Phillis Island has occurred over the past four years, which has affected sampling Stations 2A and 2B. Also evident at all locations has been the establishment of submerged aquatic vegetation due to increased water clarity, likely caused by the establishment of the zebra mussel (*Dreissena polymorpha*) in the Ohio River system.

5.3 METHODS

CB&I Environmental & Infrastructure, Incorporated (CB&I), formally known as Shaw Environmental, Incorporated, was contracted to perform the 2015 Aquatic Monitoring Program as specified in BVBP-ENV-001-Aquatic Monitoring (procedural guide). This procedural guide references and describes in detail the field and laboratory procedures used in the various monitoring programs, as well as the data analysis and reporting requirements. These procedures are summarized according to task in the following subsections. Sampling was conducted according to the schedule presented in Table 5.1.

5.3.1 Benthic Macroinvertebrate Monitoring

The benthic macroinvertebrate monitoring program consisted of river bottom sampling using a Ponar grab sampler at four stations on the Ohio River. Prior to 1996, duplicate sampling occurred at Stations 1, 2A, and 3, while triplicate sampling occurred at Station 2B (i.e., one sample at each shoreline and mid-channel) (Figures 5.1 and 5.2). In 1996, a review of the sampling design indicated that sampling should be performed in triplicate at each station to conform to standardized EPA procedures. Therefore, starting in 1996, triplicate samples were taken at Stations 1, 2A, and 3, as in 1995, with triplicate samples also collected at each shore and mid-channel location at Station 2B. A petite Ponar dredge was used to collect these samples, replacing the standard Ponar dredge used in prior studies.

In 2015, benthic macroinvertebrate sampling was conducted as scheduled in May and September. For each 2015 field effort, 18 benthic samples were collected and processed in the laboratory. All field procedures and data analyses were conducted in accordance with the procedural guide. The contents of each Ponar grab sample were gently washed through a U.S. Standard No. 30 sieve and the retained contents were placed in a labeled bottle and preserved in ethanol. In the laboratory, rose bengal stain was added to aid in sorting and identifying the benthic organisms. Macroinvertebrates were sorted from each sample, identified to the lowest taxon practical and counted. Mean density (number/m^2) for each taxon was calculated for each replicate. Four indices used to describe the benthic community were calculated: Shannon-Weiner diversity index, evenness (Pielou, 1969), species richness, and the number of taxa. These estimates provide an indication of the relative quality of the macroinvertebrate community.

5.3.2 Fish Monitoring

Fish sampling was conducted in 2015 to provide a continuous baseline of data and to detect possible changes that may have occurred in the fish populations in the Ohio River near BVPS. Fish population surveys have been conducted in the Ohio River near BVPS annually from 1970 through 2015. These surveys have resulted in the collection of 73 fish species and five different hybrids.

Adult fish surveys were successfully conducted as scheduled in May, July, September, and November 2015. During each survey, fish were scheduled to be sampled at four stations (Stations 1, 2A, 2B and 3) (Figure 5.3). Prior to 2011, all electrofishing was conducted at night. From 2011 to present, due to damage to the onsite boat launch, the crew was required to launch the boat from the Lock 57 Community Park Boat Launch located near Glasgow Pennsylvania. The launch was only open until one hour after dark, so it was necessary to conduct electrofishing efforts during the day. Electrofishing was completed at all stations and months. Seining was scheduled to be performed at Station 1 (north shore) and Station 2B (south shore of Phillis Island) to sample species that are generally under-represented in electrofishing catches (e.g., young-of-the-year fish and small cyprinids). In 2014, severe erosion to the shoreline at Station 2B required relocating the seining location about 200 meters west. This habitat at the new

location was comparable to the former site, prior to the erosion. The new location is also influenced by the BVPS discharge, so is a comparable non-control site. This site was also used in 2015, although further erosion was evident. All seining efforts were successfully completed.

Electrofishing was conducted using a boat-mounted electroshocker. A Smith-Root Type VI A variable voltage, pulsed-DC electrofishing unit powered by a 5-kW generator was used. The voltage selected depended on water conductivity and was adjusted to provide constant amperage (4-6 amps) of the current through the water. The north and south shoreline areas at each station were shocked for at least 10 minutes of unit "on" time (approximately five minutes along each shore) during each survey.

When large schools of fish of a single non-game species such as gizzard shad and shiners were encountered during electrofishing efforts, all of the stunned fish were not netted and retrieved onboard the boat. A few fish were netted for verification of identity, and the number of observed stunned fish remaining in the water was estimated. The size range of the individual fish in the school was also estimated and recorded. This was done in an effort to expedite sample processing and cover a larger area during the timed electrofishing run. Regardless of the number of individuals, all game fish were boated when observed.

Fish seining was performed during the day at Station 1 (control) and Station 2B (non-control) (Figure 5.3) during each of the four 2015 BVPS fishery surveys. A 30-ft long bag seine made of 1/4-inch nylon mesh netting was used to collect fish located close to shore in 1 to 4 ft. of water. Three seine hauls were performed at both Station 1 (north shore) and Station 2B (south shore of Phillis Island) during each survey.

Fish collected during electrofishing and seining efforts were processed according to standardized procedures. All captured game fishes were identified to species, counted, measured for total length (nearest 1 mm), and weighed (nearest 1 g for fish less than or equal to 1000 g and the nearest 5 g for all other fish). Non-game fishes were counted, and a random subsample of lengths was taken. Live fish were returned to the river immediately after processing was completed. All fish that were unidentifiable or of questionable identification and were obviously not on the endangered or threatened species list were placed in plastic sample bottles, preserved, labeled and returned to the laboratory for identification. Any species of fish that had not previously been collected at BVPS was retained for the voucher collection. Any threatened or endangered species (if collected) would be photographed and released.

5.3.3 *Corbicula* Density Determinations for Cooling Tower Reservoirs

The *Corbicula* Monitoring Program at BVPS includes sampling the circulating river water and the service water systems of the BVPS (intake structure and cooling towers). The objectives of the ongoing Monitoring Program are to evaluate the presence of *Corbicula* at BVPS, and to evaluate the potential for and timing of infestation of the BVPS. This program is conducted in conjunction with a program to monitor for the presence of macrofouling zebra mussels (see Section 5.3.5).

Corbicula enter the BVPS from the Ohio River by passing through the water intakes, and eventually settle in low flow areas including the lower reservoirs of the Units 1 and 2 cooling towers. The density and growth of these *Corbicula* were monitored by collecting monthly samples from the lower reservoir sidewalls and sediments. The sampler used on the sidewalls consisted of a D-frame net attached behind a 24-inch long metal scraping edge. This device was connected to a pole long enough to allow the sampler to extend down into the reservoir area from the outside wall of the cooling tower. Sediments were sampled with a petite Ponar dredge.

Cooling tower reservoir sampling was historically conducted once per month. Beginning in December 1997, it was decided to forego sampling in cold water months since buildup of *Corbicula* does not occur then. Monthly sampling has been maintained throughout the warmer water months of the year. In 2015, sampling began in March and ended in November.

In 2015, once each month (March through November), a single petite Ponar grab sample was scheduled to be taken in the reservoir of each cooling tower to obtain density and growth information on *Corbicula* present in the bottom sediment. The samples collected from each cooling tower were returned to the laboratory and processed. Samples were individually washed, and any *Corbicula* removed and rinsed through a series of stacked U.S. Standard sieves that ranged in mesh size from 1.00 mm to 9.49 mm. Live and dead clams retained in each sieve were counted and the numbers were recorded. The size distribution data obtained using the sieves reflected clam width, rather than length. Samples containing a small number of *Corbicula* were not sieved; individuals were measured and placed in their respective size categories. A scraping sample of about 12 square feet was also collected at each cooling tower during each monthly sampling effort. This sample was processed in a manner consistent with the petit Ponar samples. All samples were successfully collected except in Cooling Tower 2 in October due to a unit outage.

5.3.4 *Corbicula* Juvenile Monitoring

The *Corbicula* juvenile study was designed to collect data on *Corbicula* spawning activities and growth of individuals entering the intake from the Ohio River. From 1988 through 1998, clam cages were deployed in the intake forebay to monitor for *Corbicula* that entered the BVPS.

Observational-based concerns that the clam cages would quickly clog with sediment during high sediment periods and, as a result, would not effectively sample for *Corbicula*, led to an evaluation of an alternate sampling technique. From April through June 1997, a study was conducted to compare the results of the clam cage samplers to a petite ponar dredge technique to determine *Corbicula* presence and density in the BVPS intake bays. It was hypothesized that using a Ponar sampler to collect bottom sediments and analysis of those sediments would provide a more representative sample of *Corbicula* settlement and growth rates, and had the added benefit of not requiring confined space entry to conduct the sampling. Results of the study confirmed this hypothesis.

During the 1998 sampling season, at the request of BVPS personnel, all clam cages were

removed after the May collection. Monthly petite ponar grabs from the forebay in the intake building continued thereafter. Samples were processed in the same manner as Cooling Tower samples (Section 5.3.3).

From 2002 to present, because of site access restrictions, sampling with the petite ponar has been moved to the Ohio River directly in front of the Intake Structure Building. Collections are presently scheduled to be made in conjunction with the fisheries sampling (May, July, September, and November). During each sampling month two Ponar grabs are taken approximately 20 feet offshore of the intake building. These grab samples are processed in the same manner as when they were collected from within the Intake Structure Building.

5.3.5 Zebra Mussel Monitoring

The Zebra Mussel Monitoring Program includes sampling the Ohio River and the circulating river water system of the BVPS.

The objectives of the Monitoring Program were:

(1) To identify if zebra mussels were in the Ohio River adjacent to BVPS and provide early warning to operations personnel as to their possible infestation;

(2) To provide data as to when the larvae were mobile in the Ohio River and insights as to their vulnerability to potential treatments; and

(3) To provide data on their overall density and growth rates under different water temperatures and provide estimates on the time it requires these mussels to reach the size and density that could impact the plant.

The zebra mussel sampling for settled adults was historically conducted once per month, yearlong. Beginning in December 1997, it was decided to forego sampling in the colder water months of each year, since buildup of zebra mussels and growth of the individuals that are present, does not occur then. Monthly sampling has been maintained throughout the balance of the year. In 2015, sampling occurred from March through November.

A pump sample for zebra mussel veligers was collected at the barge slip location monthly from April through October in 1996 and 1997. The scope of the sampling was expanded in 1998 to also include the intake structure. In June 1998, the Emergency Outfall and Emergency Outfall Impact Basin locations were also added. Additional pump samples were collected from the cooling towers of Unit 1 and Unit 2 in October 1998. In 2015 veliger sampling began in April and was conducted monthly through October.

At the Intake Structure and Barge Slip the following surveillance techniques were used:

- Wall scraper sample collections on a monthly basis (March through November) from the barge slip and the riprap near the intake structure to detect attached adults; and

- Pump sample collections from the barge slip and outside the intake structure, to detect the planktonic early life forms (April through October).

At each of the cooling towers the following techniques were used:

- Monthly reservoir scraper sample collections in each cooling tower (March through November); and

- Pump samples in April through October to detect planktonic life forms.

At the Emergency Outfall and the Splash Pool the following techniques were used:

- Monthly scraper sample collections in each (March through November); and

- Pump samples in each from April through October to detect planktonic life forms.

5.3.6 Reports

Each month, activity reports that summarized the activities that took place the previous month were prepared and submitted. These reports included the results of the monthly *Corbicula*/zebra mussel monitoring including any trends observed and any preliminary results available from the benthic and fisheries programs. The reports addressed progress made on each task, and reported any observed biological activity of interest.

5.4 RESULTS OF THE AQUATIC MONITORING PROGRAM

The following sections summarize the findings for each of the program elements. Sampling dates for each of the program elements are presented in Table 5.1.

5.4.1 Benthic Macroinvertebrate Monitoring Program

Benthic surveys were performed in May and in September 2015. Benthic samples were successfully collected using a petite ponar grab sampler at Stations 1, 2A, 2B, and 3 (Figure 5.2). Triplicate samples were taken off the south shore at Stations 1, 2A, and 3. Sampling at Station 2B, in the back channel of Phillis Island, consisted of triplicate petite Ponar grabs at the south side, middle, and north side of the channel (i.e., Sample Stations 2B1, 2B2, and 2B3, respectively).

Substrate type is an important factor in determining the composition of the benthic community.

The habitats in the vicinity of BVPS are the result of damming, channelization, and river traffic. Shoreline habitats at the majority of sampling locations were generally in depositional areas that consisted of soft substrates composed of mixes of sand, silt, and detritus. One exception was along the north shoreline of Phillis Island at Station 2A where hard-pan clay overlain with a thin layer of fine sand dominated. The other distinct habitat, hard substrate (gravel and cobble), was located in mid-channel in the back channel of Phillis Island. The hard substrate was probably the result of channelization and ongoing scouring by river currents. In general, the substrates found at each sampling location have been consistent from year to year.

Increased water clarity due at least in part to the establishment of zebra mussels was noted during 2015. This has increased the amount of submerged aquatic vegetation at Stations 1, 2B and 3. The presence of submerged aquatic vegetation can increase the number of species of macroinvertebrates, especially chironomids (midge flies) that use them as a primary food source. Also zebra mussel filtering moves much of the available nutrients from the water column to the bottom, which also can affect the type and density of macroinvertebrates present in the project area.

Sixty-one (61) macroinvertebrate taxa were identified during the 2015 monitoring program (Tables 5.2 and 5.3), which was one more than was identified in 2014. A mean density of 1,037 macroinvertebrates/m^2 was collected in May and 3,902/m^2 in September (Table 5.4). As in previous years, the macroinvertebrate assemblage during 2015 was dominated by burrowing organisms typical of soft unconsolidated substrates. Oligochaetes (segmented worms), mollusks (clams and snails) and chironomid (midge fly) larvae were abundant (Table 5.4). Nineteen (19) taxa of chironomids and 19 taxa of oligochaetes were collected. This is the two more chironomid taxa, but five (5) fewer oligochaete taxa than collected in 2014. Eleven (11) taxa of mollusks were also collected in 2015; two more than in 2014. As was the case in 2014, the total mean density of organisms was higher in September than in May.

Thirty-two (32) taxa were present in the May 2015 samples. Fifty-three (53) taxa were present in the September samples (Table 5.3.1 and 5.3.2). Twenty-four (24) of the 61 taxa were present in both May and September. As in 2014, immature tubificid worms were numerically the most abundant organism in both May and September 2015.

The macrofouling Asiatic clam (*Corbicula*) has been observed in the Ohio River near BVPS from 1974 to present. Macrofouling zebra mussels were first collected in the BVPS benthic samples in 1998. Adult zebra mussels, however, were detected in 1995 and 1996 by divers in the BVPS main and auxiliary intake structures during scheduled cleaning operations. Zebra mussel veligers, adults and juveniles were collected during the 1997-2015 sampling programs (see Sections 5.4.5 Zebra Mussel Monitoring Program). Both live adult *Corbicula* and adult zebra mussels were collected in benthic macroinvertebrate samples in 2015. *Corbicula* and zebra mussels were collected in both May and September samples. Zebra mussels were the third most abundant taxa collected in the September samples.

No new taxa of macroinvertebrates were collected near BVPS in 2015 (Table 5.2). Also no state or Federal threatened or endangered macroinvertebrate species were collected during 2015.

In the May 2015 samples, oligochaetes accounted for the highest mean density of macroinvertebrates (518/m^2 or 50 percent of the total density) (Table 5.4). Oligochaetes also were the dominant taxon in May 2014. Chironomids were the second most abundant species in May (399/m^2 or 38 percent of the total density). Mollusks (74/m^2 or seven percent of the total) and organisms other than oligochaetes, chironomids and mollusks ("others") (46/m^2 or four percent) were both present in May.

In September 2015 samples, oligochaetes also accounted for the highest mean density of macroinvertebrates (1,656/m^2 or 42 percent of the total density) (Table 5.4). Chironomids had the next highest mean density in September 2015 (1,362/m^2 or 35 percent of the total density), followed by mollusks (714/m^2 or 18 percent) and the "others" category (170/m^2 or four percent).

In May 2015, the highest density of macroinvertebrates (1,935/m^2) occurred at Station 3. Oligochaetes were over twice as abundant at Station 3 as any other location. In September, the highest density of macroinvertebrates occurred at Station 2B1 (7,267/m^2). This was due to a high density of mollusks, principally zebra mussels that were collected (2,322/m^2) at this location. In May the lowest mean density of organisms was 272/m^2, which occurred at Station 2B3. In September, the lowest mean density of organisms occurred at Station 2B2 (1,118/m^2).

For a comparison of the control to non-control stations, Station 1 was designated the control station, because it is always out of the influence of the BVPS discharge and Station 2B (mean density of Station 2B1, 2B2, and 2B3) was designated as the non-control station, since it is the station most regularly subjected to BVPS's discharge. Stations 3 and 2A may be under the influence of the plume under certain conditions, but it is unlikely that they are regularly influenced by BVPS.

The mean density of macroinvertebrates in the non-control station was approximately 50 percent higher (979/m^2) than that of the control station (673/m^2) in May (Table 5.5). The relatively higher densities of chironomids and mollusks, at the non-control station, contributed to the majority of this difference. A similar difference occurred in 2014.

Similarly, in September the density of macroinvertebrates present at the non-control station (4,343/m^2) was approximately 50 percent higher than at the control station (2,924/m^2). As in May, the relatively higher densities of chironomids and mollusks at the non-control station contributed to the majority of this difference. Differences were within the expected range of variation for natural populations of macroinvertebrates and likely not due to any impact of plant operation.

Indices that describe the relative diversity, evenness, and richness of the macroinvertebrate population structure among stations and between control and non-control sites were calculated. A higher Shannon-Weiner diversity index indicates a relatively better structured assemblage of organisms, while a lower index generally indicates a lower quality or stressed community. Evenness is an index that estimates the relative contribution of each taxon to the community assemblage; the closer to 1.00, the healthier the community. The community richness is another estimate of the quality of the macroinvertebrate community with a higher richness number indicating a healthier community.

The Shannon-Weiner diversity indices in May 2015 collections ranged from 0.56 at Station 1 to 0.93 at Stations 2B1 and 2B2 (Table 5.6). In May, evenness ranged from 0.64 at Station 3 to 0.88 at Station 2B3. Richness greatest at Station 3 (3.67) and lowest at Station 1 (1.30). In general, the indices were higher in May 2015 than in 2014. This is due in part to the relatively lower density of immature tubificids present in 2015 and the greater density of tubificids that were mature enough to identify. In 2014, 65 percent of the individuals collected in May were immature tubificids while in 2015 they contributed to only 30 percent of the May total. This resulted in a greater number of taxa present in 2015. This difference in maturation rate of oligochaetes was likely due to natural annual differences and not related to any effect of plant operations.

The Shannon-Weiner diversity of the macroinvertebrate community (0.70 to 1.05), evenness (0.58 to 0.76) and richness (3.76 to 5.71) in September 2015 were generally higher than in May. There was also an increase in the number of taxa present at each station in September compared to that station in May. Relatively high numbers of taxa are frequently present in early fall due to the increased numbers of aquatic stages of insects, especially chironomids, as well as the ability to identify many of the tubificids that are lumped together when immature to lower taxonomic levels. A comparable increase in indices values in September compared to May was also observed in each year from 2010 through 2015.

In May 2015, the number of taxa was lower in the control station (Station 1) than in the non-control stations (2B1, 2B2, 2B3) (6 in the control versus 8, 16 and 15 in the non-controls). The diversity, evenness and richness indices were also lower at the control station than the non-controls (Table 5.6). In September 2015 the indices at the control stations were, in general, comparable to the non-control stations. Similar trends were apparent in the previous five study years and were likely due to natural variations in the local populations at these locations. No impacts of the BVPS on the benthic community, as measured by differences between control and non-control zones, were evident in either May or September.

Substrate was probably the most important factor controlling the distribution and abundance of the benthic macroinvertebrates in the Ohio River near BVPS. Soft substrates that generally existed along the shoreline are conducive to oligochaete, chironomid, and mollusk habitation and limit species of macroinvertebrates that require a more stable bottom. There was an apparent change in the chironomid community throughout the study zone, as evidenced by their increased densities and the type of species present. This is likely due to an increase in the submerged vegetation noted along the shoreline. Vegetation provides an ideal habitat for many chironomid species that use it for grazing on the surficial phytoplankton and a place to avoid predators. This change in the chironomid community is not caused by BVPS operations.

The density of macroinvertebrates in May and September 2015 fell within the range of densities of macroinvertebrates collected at BVPS in previous years (Table 5.7). ***Although the species of chironomids and their relative densities may have increased slightly due to increased light penetration caused by zebra mussels and the subsequent increase in submerged aquatic vegetation in the nearshore area, the overall macroinvertebrate community structure has changed little since pre-operational years. Any changes have occurred at both control and non-control sites, so the available evidence does not indicate that BVPS operations have***

affected the benthic community of the Ohio River.

5.4.2 Fish Sampling Program

In 2015, 435 fish representing 20 taxa were collected (i.e., handled) during BVPS surveys by electrofishing and seining (Table 5.8). This was 245 more fish, but the same number of taxa as collected in 2014. All taxa collected in 2015 were previously encountered at BVPS. By far the most common species in the 2015 BVPS surveys that were collected by electrofishing and seining combined were gizzard shad (81.6% of the total catch), followed by smallmouth buffalo (4.6%) emerald shiner (2.8%), longnose gar (2.5%), golden redhorse sucker (1.6%) and smallmouth bass (1.6%). None of the remaining 15 species contributed to more than one percent of the total handled catch. The most frequently observed, but not handled fish in 2015 juvenile gizzard shad (Table 5.15). Game fish collected in 2015 included channel catfish, bluegill, smallmouth bass, walleye, spotted bass, pumpkinseed, rock bass, and flathead catfish. Game fish represented 4.1% of the total handled catch.

A total of 419 fish, representing 17 taxa, was collected by electrofishing in 2015 (Table 5.9) compared to 186 fish representing 17 species in 2014. The number of fish collected in 2015 was considerably more than the total number collected in 2011 (151 fish), the last time electrofishing was conducted at night. The number of species collected was, however, fewer than in 2011 when 22 species were encountered. The increased catch was due to the large number of gizzard shad juveniles that were collected during the fall and winter electrofishing efforts. In general electrofishing at night has been demonstrated to be more productive than during the day in riverine systems. Movements of many species of fish into shallower water at night to feed, makes them more susceptible to the electrofishing technique. This may have contributed to the fewer number of species collected in 2014. Gizzard shad (84.7% of the total) was by far the most abundant species in the electrofishing catch. Smallmouth buffalo (4.8%), longnose gar (2.6%), golden redhorse sucker (1.8%) and smallmouth bass (1.4%) were the only other species that contributed to greater than one percent of the catch. Fish observed and not collected in the 2015 electrofishing study are presented in Table 5.15.

A total of 16 fish representing five (5) taxa was collected by seines in 2015 (Table 5.10) compared to 48 fish representing eight (8) taxa in 2014. The most abundant taxa collected in 2015 were emerald shiner, representing 75% of the total catch. The other four species were each represented by single individual. One bluegill and one juvenile smallmouth bass the only game species collected during seining efforts.

A total of 30 fish representing 13 species was captured during the May (spring) 2015 sampling event (Table 5.11). All of them were collected during electrofishing. Golden redhorse sucker was the most abundant species and represented 23.3% of the electrofishing catch, followed in abundance by longnose gar (representing 20.0% of the total catch), freshwater drum (10.0%), smallmouth bass (10.0%), shorthead redhorse sucker (6.7%), and smallmouth buffalo (6.7%). No other species contributed to more than five (5) percent of the May electrofishing catch. No fish were collected in the seines. Flathead catfish, rock bass, smallmouth bass, spotted bass and

walleye were the game species collected in May.

A total of 15 fish representing six (6) species was captured during the July (summer) 2015 sampling event (Table 5.12). All of the fish were collected during electrofishing efforts. Gizzard shad and longnose gar were the most abundant species and represented 60.0% and 13.3% of the catch, respectively. Every other fish species was represented by a single individual. No fish were collected in the seines. Smallmouth bass, pumpkinseed and flathead catfish were the only game species collected in July.

During the September (fall) 2015 sampling event, 291 fish representing four (4) taxa were collected. All of the fish were collected during electrofishing efforts (Table 5.13). Gizzard shad were the most abundant species and contributed to 98.3 percent on the total. Two pumpkinseed, two longnose gar and one bluegill were the only other fish collected.

During the November (winter) 2015 sampling event, 99 fish representing 11 taxa were collected. A total of 83 fish representing seven (7) species was collected during electrofishing efforts (Table 5.13). Gizzard shad and smallmouth buffalo were the most abundant species collected by electrofishing and contributed to 72.3% and 20.5% of the total catch, respectively. Smallmouth bass (2.4% of the total) was the only other species that more than one individual was collected. A total of 16 fish representing five (5) species were the only fish collected by seining. Emerald shiners (75% of the seine catch were the only species that more than one individual was collected. November was the only month that seining efforts collected any fish. Game species collected in November included bluegill, channel catfish and smallmouth bass.

Electrofishing catch rates are presented in Tables 5.16, 5.17, 5.18, and 5.19 for fish that were boated and handled during the 2012 through 2015 surveys by season (FENOC 2013, 2014 and 2015). In 2015, the annual catch rate was 2.56 fish per minute. In 2015, the greatest seasonal catch rate occurred in fall (September) when the catch rate was 7.11 fish per minute. Gizzard shad were collected at a rate of 6.99 fish per minute in fall, so were the reason for this atypically high catch rate. The lowest catch rate occurred in summer (July) with a rate of 0.37 fish per electrofishing minute.

The annual catch rate in 2015 (2.56 fish per minute) was higher any of the previous three years, when catch rates were 0.86 fish per minute in 2014, 0.53 in 2013 and 0.59 in 2012. The greater electrofishing rate in 2015 was due to the relatively large number of juvenile gizzard shad that were in fall and winter. Gizzard shad are schooling fish, so multiple individuals are generally collected when present. They display high year to year fluctuations in abundance due to spawning success and the extent of over winter mortality. The gizzard shad collected in fall and winter likely were spawned in spring and early summer 2015 and became large enough to be collected by electrofishing. Large numbers of small gizzard shad were also noted during the summer electrofishing effort, but were too small to be netted. The 2015 catch rates in fall and winter were the highest of the four years. The highest spring and catch rates over the four years occurred in 2014. Over the four years, the highest seasonal catch rate occurred in fall 2015 (7.11 fish per minute), which was due to the large number of juvenile gizzard shad present.

The results of the electrofishing sampling effort in 2015 (Table 5.9) did not indicate any major

differences in species composition between the control station (1) and the non-control Stations 2A, 2B, and 3. In both, gizzard shad was the most abundant species. A greater number of fish representing more species was captured at non-control stations than control station. This was most likely due to the extra effort expended at non-control stations versus control station. There are three non-control stations and only one control station so there was three times the effort at the non-control stations. In 2015, there was 5.5 times as many fish collected at the non-control stations with three times the effort. In 201, similar numbers of individuals and species were collected by seines at the control station compared to the non-control station, where sampling effort is equal (Table 5.10).

In 2015, species composition remained comparable among stations. Common taxa collected in the 2015 surveys by all methods included gizzard shad, redhorse sucker species, smallmouth buffalo, and smallmouth bass. Little difference in the species composition of the catch and relative composition was observed between the control (1) and non-control stations (2A, 2B and 3). Habitat preference and availability were probably the most important factors affecting where and when different species of fish are collected.

The results of the 2015 fish surveys indicated that there is a normal community structure in the Ohio River in the vicinity of BVPS based on species composition and relative abundance of fish observed during the surveys. Benthivores (bottom feeders including suckers and buffalo) and forage species (e.g. gizzard shad and emerald shiners) were generally collected in the highest numbers. The numbers of forage fish were greater than those present in the previous three years, due largely to the large number of juvenile gizzard shad collected. Variations in annual catch were probably attributable to normal fluctuations in the population size of the forage species and the predator populations that rely on them. Forage species, such as gizzard shad, minnow species and shiner species that have high reproductive potentials, frequently respond to changes in natural environmental factors (competition, food availability, cover, and water quality) with large fluctuations in population size. This, in turn, influences their appearance in the sampled populations during annual surveys. Spawning/rearing success due to abiotic factors is usually the determining factor of the size and composition of a fish community.

In addition, differences in electrofishing catch rate can be attributed to environmental conditions that prevail during sampling efforts. High water, increased turbidity, waves, and swift currents that occur during electrofishing efforts in some years can affect the collection efficiency in any given month. In 2015, as in the previous three years, increased water clarity was apparent during all months sampled. A direct result of the increased clarity was the abundance of rooted submerged aquatic vegetation throughout the study reach. The amount of rooted vegetation in 2015 was much more than in any other year sampled. This increase in vegetation is likely the result of an increased photic zone due to zebra mussels filtering organic and inorganic particulates from the water and redistributing them to the benthic layer. The presence of rooted vegetation and increased water clarity can change the distribution of many of the fish species present in the study reach.

Results from the 2015 fish surveys indicated that a normal community structure for the Ohio River exists near BVPS based on species composition and relative abundance. In 2015, there was no indication of negative impact to the fish community in the Ohio River from the

operation of BVPS.

5.4.3 *Corbicula* Monitoring Program

In 2015, 13 settled live *Corbicula* were collected from the Unit 1 cooling tower reservoir during monthly reservoir ponar sampling (Table 5.20 and Figure 5.5). They ranged in size from 1.00 mm to greater than 9.50 mm. Eleven dead *Corbicula* that were between 2.00 mm and 9.49 mm were also collected. The seasonal average density of settled live *Corbicula* was 62/m^{2}, which was about twice the density of *Corbicula* in the Unit 1 cooling tower in 2014. Settled live *Corbicula* were collected in all sampled months except April, October and November. The highest density occurred in April when a density of 129 *Corbicula*/m^2 was present. No *Corbicula* were collected in the scraping samples. *Corbicula* juveniles were also collected in monthly pump samples collected in the Unit 1 cooling tower reservoir in June and August.

In 2015, nine (9) live settled *Corbicula* were collected from the Unit 2 cooling tower reservoir (Table 5.21 and Figure 5.6). They were between 1.00 mm to greater than 9.50 mm in size, which indicates that some settled prior to 2015. Three dead *Corbicula* were also collected during 2015. These were between 2.00 mm and 6.29 mm and likely represented a number of year classes. The season average density of settled live *Corbicula* was 48/m^2 that was slightly higher than in 2014. The highest density of settled *Corbicula* occurred in September when a density of 129 *Corbicula*/m^2 was present. No *Corbicula* were collected in the scraping samples. *Corbicula* juveniles were also collected in monthly pump samples collected in the Unit 2 cooling tower reservoir in June, August and September.

In 2015, BVPS continued its *Corbicula* control program, which included the use of a molluscicide to prevent the proliferation of *Corbicula* within BVPS. BVPS was granted permission by the PADEP to use a molluscicide to target the Unit 1 river water system and the Unit 2 service water system.

In 1990 through 1993, the molluscicide applications focused on reducing the *Corbicula* population throughout the entire river water system of each BVPS plant (Units 1 and 2). In 1994 and 1995, the applications targeted the internal water systems; therefore, the molluscicide concentrations in the cooling towers were reduced during applications. Consequently, adult and juvenile *Corbicula* in the cooling towers often survived the applications. Reservoir sediment samples taken after molluscicide applications represent mortality of *Corbicula* in the cooling tower only and do not reflect mortality in BVPS internal water systems.

The monthly reservoir sediment samples and pump samples collected in Units 1 and 2 Cooling Towers in recent years demonstrated that *Corbicula* were entering and colonizing the reservoirs. Only 22 live and six dead settled *Corbicula* were collected in the cooling towers in 2015; however, their presence in the cooling tower pump samples indicates that they still are available for establishment in the cooling towers. The recent decrease of *Corbicula* at the BVPS returns densities to levels more consistent with densities in the Ohio River in the mid-1990's, but well below those present during the 1980's. Whether the relatively low density of *Corbicula* in 2015 is indicative of permanent lower levels in the environment or due to natural variability is

uncertain, however, continued monitoring of *Corbicula* densities is recommended.

5.4.4 *Corbicula* Juvenile Monitoring Program

Figure 5.7 presents the abundance and size distribution data for samples collected in the Ohio River near the intake structure by petite ponar dredge in 2015. Sixty (60) live individuals were collected 2015 compared to only 17 in 2014. They ranged in size from the 2.00 mm-3.34 mm size range that were spawned in late 2014 to greater than 9.50 mm that were spawned in prior years. A spring/early-summer spawning period typically occurs in the Ohio River near BVPS each year when preferred spawning temperatures (60-65° F) are reached (Figure 5.8). The offspring from this spawning event generally begin appearing in the sample collections in June. The settled clams generally increase in size throughout the year. The number of individuals collected in 2015 was three to five times greater than in each of the previous four years. This could indicate a slow increase in *Corbicula* numbers in the Ohio River or could be due to normal variability. In any case the densities of *Corbicula* continue to be low relative what was present in the 1980's.

The overall low numbers of live Corbicula collected in the sample collected outside the intake and cooling towers in 2015, compared to levels in the 1980's, likely reflects a natural decrease in the density of Corbicula in the Ohio River near BVPS, although an increased density of live settled individuals and juveniles collected in the cooling towers may indicate that the population is beginning to increase again. Continued monitoring of Corbicula densities is recommended.

5.4.5 Zebra Mussel Monitoring Program

Zebra mussels (Dreissena polymorpha) are exotic freshwater mollusks that have ventrally flattened shells generally marked with alternating dark and lighter bands. They are believed to have been introduced into North America through the ballast water of ocean-going cargo vessels probably from Eastern Europe. They were first identified in Lake St. Clair in 1988 and rapidly spread to other Great Lakes and the Mississippi River drainage system, and have become increasingly abundant in the lower, middle, and upper Ohio River. They use strong adhesive byssal threads, collectively referred to as their byssus, to attach themselves to any hard surfaces (e.g., intake pipes, cooling water intake systems, and other mussels). Responding to NRC Notice No. 89-76 (Biofouling Agent-Zebra Mussel, November 21, 1989), BVPS instituted a Zebra Mussel Monitoring Program in January 1990. Studies have been conducted each year since then.

Zebra mussels were detected in both the pump samples (Figures 5.9 and 5.10) and the substrate samples (Figure 5.11 and 5.12) in 2015. Zebra mussel veliger pump samples were collected from May through October 2015 after not being collected in April. Veligers were collected at all of the six sites that were sampled in 2015. The lack of veligers in April can be attributed to the much colder than usual late winter and early spring that occurred in 2015. Spawning begins as water temperature reach approximately 14^{O} C and peaks at water temperatures of 21^{O} C. Veliger densities usually peak about two weeks after the optimum water temperature for spawning is

reached. Veliger densities then fall off as veligers mature and settle, although female mussels broadcast mature eggs throughout the season. River water temperature in April was 9.4^0 C, which is well below the spawning threshold. Veligers were present at all sampled sites from May through October. A peak in zebra mussel veligers occurred at most sample locations in May. The majority of these veligers were D-form and very recently spawned. This spike was likely due to a large number of mussels spawning at the same time after a delay in spawning due to colder than normal water temperatures. The percentage of mussels capable of setting increased though the rest of the sampling season. Mussel densities in October were very lower which indicated that the majority of mussel have settled and no more veligers were being produce. This is supported by a river water temperature rapidly decreasing between the September and October sampling events.

The greatest density of veligers was present in the sample collected from the Cooling Tower 2 reservoir sample in May (30,500/m^3). This was less than half of the peak density of veligers collected in 2014. It was, however greater than the peak density in 2013 (17,808/m^3) and consistent with that in 2012 (34,628/m^3). The 2015 density is high for the Ohio River.

In 2015, settled zebra mussels were collected only in scrape samples at the Cooling Tower 1 reservoir, the barge slip and the intake structure (Figures 5.11 and 5.12). Those in the Cooling Tower 1 reservoir were on collected in low densities in April. The highest density of settled mussels in any sample collected was at the barge slip (61 mussels/m^2) in August. The mussels collected at the barge slip and intake structure included individuals that were capable of reproducing. The density of collected adult zebra mussels in 2015 was somewhat higher than the densities that occurred in 2014

Overall, both the number of observations and densities of settled mussels in 2015 were consistent to those recorded in 2008-2014, and much higher than the preceding 5 years. Although densities of settled mussels are low compared to other populations such as the Lower Great Lakes, densities comparable to those in the Ohio River are sufficient to cause problems in the operation of untreated cooling water intake systems.

Whether the population of zebra mussels in this reach of the Ohio River will remain the same or increase cannot be determined. In any case, the densities of mussels that presently exist are more than sufficient to impact the BVPS, if continued prudent monitoring and control activities are not conducted.

6.0 ZEBRA MUSSEL AND *CORBICULA* CONTROL ACTIVITIES

In 2015, BVPS continued its *Corbicula* and zebra mussel control program (26th year), which included the use of a molluscicide to prevent the proliferation of *Corbicula* and zebra mussels within BVPS. BVPS was granted permission by the PADEP to use a molluscicide to target the Unit 1 river water system and the Unit 2 service water system.

In 1990 through 1993, the molluscicide applications (CT-1) focused on reducing the *Corbicula* population throughout the entire river water system of each BVPS plant (Units 1 and 2). In 1994 through 2006, the CT-1 or CT-2 (reformulated CT-1) applications targeted zebra mussels and *Corbicula* in the internal water systems; therefore the molluscicide concentrations in the cooling towers were reduced during CT-1 or CT-2 applications. Consequently, adult and juvenile *Corbicula* in the cooling towers often survived the applications. Reservoir sediment samples taken after CT-1 or CT-2 applications represented mortality of *Corbicula* in the cooling tower only and do not reflect mortality in BVPS internal water systems. In 2007 BVPS began using Nalco H150M as the molluscicide. This product, which has the same active ingredients as the CT-2 and CT-2, was applied in the same manner.

In addition to clamicide treatments, preventive measures were taken that included quarterly cleaning of the Intake Bays. The bay cleanings are intended to minimize the accumulation and growth of mussels within the bays. This practice prevents creating an uncontrolled internal colonization habitat.

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TABLES

TABLE 5.1

BEAVER VALLEY POWER STATION (BVPS)
SAMPLING DATES FOR 2015

Study	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Benthic Macroinvertebrate					28				17			
Fish					28		30		17		5	
Corbicula and Zebra Mussel			30	21	28	23	30	28	17	14	5	
Zebra Mussel Veliger				21	28	23	30	28	17	14		

Table 5.2

Systematic List of Macroinvertebrates Collected From 1973 Through 2015 in The Ohio River Near BVPS

Phylum	Class	Family / Sub-Family	Genus and Species	Previous Collections	Collected in 2015	New in 2015
Porifera						
			Spongilla fragilis	X		
Cnidaria						
	Hydrozoa					
		Clavidae				
			Cordylophora lacustris	X		
		Hydridae				
			Craspedacusta sowerbii	X		
			Hydra sp.	X		
Platyhelminthes						
	Tricladida			X		
	Rhabdocoela			X		
Nemertea				X		
Nematoda				X	X	
Entoprocta						
			Urnatella gracilis	X		
Ectoprocta						
			Fredericella sp.	X		
			Paludicella articulata	X		
			Pectinatella sp.	X		
			Plumatella sp.	X		
Annelida						
	Oligochaeta			X	X	
		Aeolosomatidae		X		
		Enchytraeidae		X		
		Naididae		X	X	
			Allonais pectinata	X		
			Amphichaeta leydigi	X		
			Amphichaeta sp.	X		
			Arcteonais lomondi	X	X	
			Aulophorus sp.	X		
			Chaetogaster diaphanus	X		
			C. diastrophus	X		
			Dero digitata	X		
			Dero flabelliger	X		
			D. nivea	X		
			Dero sp.	X		
			Nais barbata	X		
			N. behningi	X		
			N. bretscheri	X		
			N. communis	X		
			N. elinguis	X		
			N. pardalis	X	X	
			N. pseudobtusa	X		
			N. simplex	X		
			N. variabilis	X	X	
			Nais sp.	X		
			Ophidonais serpentina	X		
			Paranais frici	X		
			Paranais litoralis	X		
			Paranais sp.	X		
			Piguetiella michiganensis	X		
			Pristina idrensis	X		
			Pristina longisoma	X		
			Pristina longiseta	X		
			P. osborni	X		
			Pristina sp.	X		
			Pristinella sp.	X		

Table 5.2 (continued)

Systematic List of Macroinvertebrates Collected From 1973 Through 2015 in The Ohio River Near BVPS

Phylum	Class	Family / Sub-Family	Genus and Species	Previous Collections	Collected in 2015	New in 2015
Annelida	Oligochaeta	Naididae	*Pristinella jenkinae*	X	X	
			Pristinella idrensis	X		
			Pristinella sima	X	X	
			Pristina osborni	X	X	
			Ripistes parasita	X		
			Slavina appendiculata	X		
			Specaria josinae	X	X	
			Stephensoniana trivandrana	X		
			Stylaria fossularis	X		
			S. lacustris	X	X	
			Uncinais uncinata	X		
			Vejdovskyella comata	X		
			Vejdovskyella intermedia	X		
			Vejdovskyella sp.	X		
	Tubificida			X		
		Tubificidae		X		
			Aulodrilus limnobius	X		
			A. pigueti	X		
			A. pluriseta	X		
			Aulodrilus sp.	X	X	
			Bothrioneurum vejdovskyanum	X		
			Branchiura sowerbyi	X	X	
			Ilyodrilus templetoni	X		
			Limnodrilus cervix	X		
			L. cervix (variant)	X		
			L. claparedianus	X		
			L. hoffmeisteri	X	X	
			L. maumeensis	X	X	
			L. profundicla	X	X	
			L. spiralis	X		
			L. udekemianus	X		
			Limnodrilus sp.	X		
			Peloscolex multisetosus longidentus	X		
			P. m. multisetosus	X		
			Potamothrix moldaviensis	X		
			Potamothrix sp.	X		
			P. vejdovskyi	X		
			Psammoryctides curvisetosus	X		
			Tubifex tubifex	X		
			Unidentified immature forms:			
			with hair chaetae	X		
			without hair chaetae	X	X	
		Lumbriculidae		X	X	
		Hirudinae		X	X	
		Glossiphoniidae		X		
			Helobdella elongata	X		
			H. stagnalis	X		
			Helobdella sp.	X		
		Erpobdellidae				
			Erpobdella sp.	X		
			Mooreobdella microstoma	X		
		Haplotaxidae				
			Stylodrilus sp.	X		
	Lumbricina			X		
		Lumbricidae		X	X	

Table 5.2 (continued)

Systematic List of Macroinvertebrates Collected From 1973 Through 2015 in The Ohio River Near BVPS

Phylum	Class	Family / Sub-Family	Genus and Species	Previous Collections	Collected in 2015	New in 2015
Arthropoda						
	Acarina			X		
			Oxus sp.	X	X	
	Ostracoda			X		
	Isopoda					
			Asellus sp.	X		
Arthropoda						
	Amphipoda					
		Talitridae				
			Hyalella azteca	X		
		Gammaridae				
			Crangonyx pseudogracilis	X		
			Crangonyx sp.	X		
			Gammarus fasciatus	X		
			Gammarus sp.	X	X	
		Pontoporeiidae				
			Monoporeia affinis	X		
		Corophididae		X		
Decapoda				X		
Collembola				X		
Ephemeroptera				X		
		Heptageniidae		X		
			Stenacron sp.	X		
			Stenonema sp.	X		
		Ephemeridae				
			Ephemera sp.	X		
			Hexagenia sp.	X	X	
			Ephron sp.	X		
		Baetidae				
			Baetis sp.	X		
		Caenidae				
			Caenis sp.	X		
			Serattella sp.	X		
		Tricorythidae				
			Tricorythodes sp.	X		
Megaloptera						
			Sialis sp.	X		
Odonata						
		Gomphidae				
			Argia sp.	X	X	
			Dromogomphus spoliatus	X		
			Dromogomphus sp.	X		
			Gomphus sp.	X		
		Lestidae				
			Lestes sp.	X		
		Libellulidae				
			Libellula sp.	X		
Plecoptera				X	X	
Trichoptera				X	X	
		Hydropsychidae				
			Cheumatopsyche sp.	X		
			Hydropsyche sp.	X		
			Parapsyche sp.	X		
		Hydroptilidae				
			Hydroptila sp.	X		
			Orthotrichia sp.	X		
			Oxyethira sp.	X		
		Leptoceridae				
			Ceraclea sp.	X		
			Oecetis sp.	X	X	
		Polycentropodidae				
			Cyrnellus sp	X		
		Polycentropodidae	*Polycentropus* sp.	X		

Table 5.2 (continued)

Systematic List of Macroinvertebrates Collected From 1973 Through 2015 in The Ohio River Near BVPS

Phylum	Class	Family / Sub-Family	Genus and Species	Previous Collections	Collected in 2015	New in 2015
Coleoptera						
		Hydrophilidae		X		
Coleoptera		Elmidae	*Ancyronyx variegatus*	X		
			Dubiraphia sp.	X	X	
			Helichus sp.	X		
			Optioserus sp.	X	X	
			Stenelmis sp.	X		
		Psephenidae		X		
Diptera						
			Unidentified Diptera	X	X	
		Psychodidae		X		
			Pericoma sp.	X		
			Psychoda sp.	X		
			Telmatoscopus sp.	X		
			Unidentified Psychodidae pupae	X		
		Chaoboridae				
			Chaoborus sp.	X		
		Simuliidae				
			Similium sp.	X		
		Chironomidae		X	X	
		Chironominae		X		
			Tanytarsini pupa	X		
			Chironominae pupa	X	X	
			Axarus sp.	X		
			Chironomus sp.	X	X	
			Cladopelma sp.	X	X	
			Cladotanytarsus sp.	X		
			Cryptochironomus sp.	X	X	
			Cryptotendipes sp.	X		
			Dicrotendipes nervosus	X		
			Dicrotendipes sp.	X	X	
			Glyptotendipes sp.	X		
			Harnischia sp.	X		
			Microchironomus sp.	X		
			Micropsectra sp.	X		
			Microtendipes sp.	X	X	
			Parachironomus sp.	X		
			Paracladopelma sp.	X		
			Paratanytarsus sp.	X		
			Paratendipes sp.	X		
			Phaenopsectra sp.	X	X	
			Polypedilum (s.s.) convictum type	X		
			P. (s.s.) simulans type	X		
			Polypedilum sp.	X	X	
			Pseudochironomis sp.	X	X	
			Rheotanytarsus sp.	X	X	
			Stempellina sp.	X	X	
			Stenochironomus sp.	X		
			Stictochironomus sp.	X		
			Tanytarsus coffmani	X		
			Tanytarsus sp.	X	X	
			Tribelos sp.	X		
			Xenochironomus sp.	X		
		Tanypodinae		X		
			***Tanypodinae* pupae**	X		
			Ablabesmyia sp.	X	X	
			Clinotanypus sp.	X		
			Coelotanypus scapularis	X		
			Coelotanypus sp.	X	X	
			Djalmabatista pulcher	X		
			Djalmabatista sp.	X		
			Procladius sp.	X	X	
			Tanypus sp.	X	X	

Table 5.2 (continued)

Systematic List of Macroinvertebrates Collected From 1973 Through 2015 in The Ohio River Near BVPS

Phylum	Class	Family / Sub-Family	Genus and Species	Previous Collections	Collected in 2015	New in 2015
Diptera		Tanypodinae	*Thienemannimyia* group	X		
			Zavrelimyia sp.	X		
		Orthocladiinae		X		
			Orthocladiinae **pupae**	X		
			Cricotopus bicinctus	X		
			C. (s.s.) trifascia	X		
			Cricotopus (Isocladius)-sylvestris Group	X		
			C. (Isocladius) sp.	X		
			Cricotopus (s.s.) sp.	X		
			Eukiefferiella sp.	X		
			Hydrobaenus sp.	X		
			Limnophyes sp.	X		
			Nanocladius (s.s.) distinctus	X		
			Nanocladius sp.	X		
			Orthocladius sp.	X	X	
			Parametriocnemus sp.	X		
			Paraphaenocladius sp.	X		
			Psectrocladius sp.	X	X	
			Pseudorthocladius sp.	X		
			Pseudosmittia sp.	X		
			Smittia sp.	X		
			Theinemannimyia sp.	X		
		Diamesinae				
			Diamesa sp.	X		
			Potthastia sp.	X		
		Ceratopogonidae		X		
			Probezzia sp.	X	X	
			Bezzia sp.	X		
			Culicoides sp.	X		
		Dolichopodidae		X		
		Empididae		X		
			Clinocera sp.	X		
			Wiedemannia sp.	X		
		Ephydridae		X		
		Muscidae		X		
		Rhagionidae		X		
		Tipulidae		X		
		Stratiomyidae		X		
		Syrphidae		X		
Lepidoptera				X		
Hydracarinidia				X		
			Oxus sp.	X		
Mollusca						
	Gastropoda			X		
		Hydrobiidae		X	X	
		Amnicolinae				
			Amnicola sp.	X	X	
			Aminicola binneyana	X		
			Amnicola limosa	X	X	
			Stagnicola elodes	X		
		Bithynidae				
			Bithynia sp.	X		
	Physacea			X		
		Pleuroceridae				
			Pleurocera acuta	X	X	
			Goniobasis sp.	X		
		Physidae		X		
			Physa sp.	X	X	
			Physa ancillaria	X		
			Physa integm	X		

Table 5.2 (continued)

Systematic List of Macroinvertebrates Collected From 1973 Through 2015 in The Ohio River Near BVPS

Phylum	Class	Family / Sub-Family	Genus and Species	Previous Collections	Collected in 2015	New in 2015
Mollusca	**Physacea**	Ancylidae		X		
			Ferrissia sp.	X	X	
		Planorbidae				
			Gillia atilis	X	X	
			Gyraulus sp.	X		
		Valvatidae		X		
			Valvata perdepressa	X		
			Valvata piscinalis	X		
			Valvata sincera	X	X	
			Valvata sp.	X		
Pelecypoda				X		
	Sphaeriacea			X		
		Corbiculidae				
			Corbicula fluminea	X		
			Corbicula sp.	X	X	
		Sphaeriidae		X		
			Pisidium ventricosum	X		
			Pisidium sp.	X	X	
			Sphaerium sp.	X	X	
			Unidentified immature Sphaeriidae	X		
		Dreissenidae				
			Dreissena polymorpha	X	X	
		Unionidae		X		
			Anodonta grandis	X		
			Anodonta (immature)	X		
			Elliptio sp.	X		
			Quadrula pustulosa	X		
			Unidentified immature Unionidae	X		

TABLE 5.3

BENTHIC MACROINVERTEBRATE COUNTS FOR TRIPLICATE SAMPLES
TAKEN AT EACH SAMPLE STATION FOR MAY AND SEPTEMBER 2015

Scientific name	May							Sept							
	Location						May	Location						Sept	2015
	1	2A	2B1	2B2	2B3	3	Total	1	2A	2B1	2B2	2B3	3	Total	Total
Ablabesmyia sp.	0	0	0	0	0	1	1	0	0	2	0	0	0	2	3
Amnicola sp.	0	0	0	0	0	0	0	0	0	0	0	0	4	4	4
Amnicola limosa	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1
Arcteonais lomondi	0	0	0	0	0	0	0	0	0	5	1	5	0	11	11
Argia sp. (Odonata)	0	0	0	0	0	0	0	0	0	1	0	1	0	2	2
Aulodrilus sp	0	0	0	0	0	0	0	4	0	0	0	0	1	5	5
Branchiura sowerbyi	0	0	0	1	0	3	4	8	0	5	1	4	4	22	26
Chironomid pupae	0	0	4	0	0	2	6	0	0	6	0	2	1	9	15
Chironomidae	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1
Chironomus sp.	0	4	37	14	3	28	86	4	8	11	1	3	9	36	122
Cladopelma sp	0	0	0	0	0	0	0	0	0	2	0	0	0	2	2
Coelotanypus sp.	0	0	0	0	0	0	0	10	0	9	1	7	0	27	27
Corbicula sp.	0	0	0	1	1	5	7	6	1	5	1	2	1	16	23
Cryptochironomus sp.	0	6	2	2	0	5	15	2	30	5	1	7	4	49	64
Dicrotendipes sp.	0	0	0	0	0	0	0	0	0	5	1	1	0	7	7
Diptera	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
Dreissena polymorpha	0	0	0	9	0	0	9	4	24	86	46	3	5	168	177
Dubiraphia sp.	0	0	0	0	0	1	1	1	0	1	0	1	0	3	4
Ferrissia sp.	0	0	0	0	0	0	0	0	3	58	1	1	5	68	68
Gammarus sp.	0	0	0	1	1	2	4	0	2	28	0	2	3	35	39
Gillia atilis	0	0	0	0	0	0	0	0	0	1	1	2	0	4	4
Hexagenia sp.	0	0	0	0	0	0	0	0	0	1	1	1	0	3	3
Hirudinea	0	1	0	0	0	0	1	0	0	0	0	0	1	1	2
Hydrobiidae	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1
Immature tubificid without	21	2	29	11	7	63	133	75	92	116	11	113	131	538	671
Limnodrilus hoffmeisteri	11	0	6	4	2	9	32	13	0	4	0	7	18	42	74
Limnodrilus maumeensis	1	0	0	0	0	0	1	1	0	0	0	0	4	5	6
Limnodrilus profundicola	1	0	0	0	0	0	1	0	0	0	0	0	0	0	1
Lumbriculidae	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1
Microtendipes sp.	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1
Naididae	0	0	4	0	0	0	4	1	0	0	0	0	0	1	5
Nais pardalis	0	16	13	3	1	1	34	0	1	0	0	0	0	1	35
Nais variabilis	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1
Nematoda	12	0	0	3	0	0	15	0	10	4	0	1	2	17	32
Ocetis sp.	0	0	0	0	0	0	0	0	0	2	2	2	0	6	6
Oligochaeta	0	0	0	0	0	0	0	0	0	1	0	4	0	5	5
Optioservus sp.	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1
Orthocladius sp.	0	0	0	0	0	0	0	0	0	0	0	3	0	3	3
Oxus sp. (Hydracarina)	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1
Phaenopsectra sp.	0	4	0	0	0	1	5	0	22	0	0	0	1	23	28
Physa sp.	0	0	0	0	0	0	0	0	0	5	0	0	2	7	7
Pisidium sp.	0	0	2	0	0	1	3	9	2	3	0	6	1	21	24
Pleurocera acuta	0	0	0	2	0	0	2	0	0	0	0	0	0	0	2
Plecoptera	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1
Polypedilum sp.	1	0	3	0	0	3	7	9	57	3	2	3	20	94	101
Pristina osborni	0	0	0	0	0	2	2	11	0	5	0	4	1	21	23
Pristinella jenkinae	0	0	1	0	0	0	1	0	1	0	0	16	6	23	24
Pristinella sima	0	0	1	0	0	0	1	0	0	0	0	0	0	0	1
Probezzia sp.	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1
Procladius sp.	0	0	3	2	0	4	9	28	1	60	4	25	2	120	129
Psectocladius sp.	0	1	0	0	0	0	1	0	0	0	0	0	0	0	1
Pseudochironomis sp.	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1
Rheotanytarsus sp.	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1
Specaria josinae	0	0	0	0	2	2	4	0	0	0	0	0	0	0	4
Sphaerium sp.	0	0	5	0	0	1	6	0	1	0	0	0	0	1	7
Stempellina sp.	0	0	0	0	0	0	0	0	0	0	0	5	0	5	5
Stylaria lacustris	0	0	0	0	0	0	0	10	0	0	0	7	0	17	17
Tanypus sp.	0	0	19	0	0	0	19	0	0	0	0	0	0	0	19
Tanytarsus sp.	0	13	2	1	2	0	18	4	30	67	3	81	5	190	208
Trichoptera	0	0	1	0	0	0	1	0	0	0	0	0	0	0	1
Valvata sincera	0	0	0	0	0	0	0	2	1	3	0	1	0	7	7
Total	47	47	132	54	19	135	434	204	288	507	78	324	232	1633	2067

TABLE 5.4

MEAN NUMBER OF MACROINVERTEBRATES (NUMBER/M²) AND PERCENT COMPOSITION OF OLIGOCHAETES, CHIRONOMIDS, MOLLUSKS, AND OTHER ORGANISMS, 2015 BVPS

May	Station													
	1 (Control)		2A		2B1 (Non-control)		2B2 (Non-control)		2B3 (Non-control)		3		Total Mean	
	$\#/m^2$	%	$\#/m^2$	%	$\#/m^2$	%	$\#/m^2$	%	$\#/m^2$	%	$\#/m^2$	%	$\#/m^2$	%
Oligochaetes	487	72	258	38	774	41	272	35	172	63	1147	59	518	50
Chironomids	14	2	401	60	1004	53	272	35	72	26	631	33	399	38
Mollusks	0	0	0	0	100	5	172	22	14	5	100	5	74	7
Others	172	26	14	2	14	1	58	7	14	5	57	3	46	4
Total	673	100	673	100	1892	100	774	100	272	100	1935	100	1037	100

September	Station													
	1 (Control)		2A		2B1 (Non-control)		2B2 (Non-control)		2B3 (Non-control)		3		Total Mean	
	$\#/m^2$	%	$\#/m^2$	%	$\#/m^2$	%	$\#/m^2$	%	$\#/m^2$	%	$\#/m^2$	%	$\#/m^2$	%
Oligochaetes	1763	60	1362	33	1949	27	186	17	2322	50	2365	71	1656	42
Chironomids	817	28	2136	52	2451	34	186	17	1993	43	602	18	1362	35
Mollusks	301	10	459	11	2322	32	703	63	229	5	258	8	714	18
Others	43	1	172	4	545	7	43	4	100	2	100	3	170	4
Total	2924	100	4129	100	7267	100	1118	100	4644	100	3325	100	3902	100

TABLE 5.5

MEAN NUMBER OF MACROINVERTEBRATES (NUMBER/M^2) AND PERCENT COMPOSITION OF OLIGOCHAETA, CHIRONOMIDAE, MOLLUSCA, AND OTHER ORGANISMS FOR THE CONTROL STATION (1) AND THE AVERAGE FOR NON-CONTROL STATIONS (2B1, 2B2, AND 2B3), 2015 BVPS

May	Control Station (Mean)		Non-Control Station (Mean)	
	#/m^2	%	#/m^2	%
Oligochaeta	487	72	406	41
Chironomidae	14	2	449	46
Mollusca	0	0	95	10
Others	172	26	29	3
TOTAL	673	100	979	100

September	Control Station (Mean)		Non-Control Station (Mean)	
	#/m^2	%	#/m^2	%
Oligochaeta	1763	60	1486	34
Chironomidae	817	28	1543	36
Mollusca	301	10	1085	25
Others	43	1	229	5
TOTAL	2924	100	4343	100

TABLE 5.6

SHANNON-WEINER DIVERSITY, EVENNESS AND RICHNESS INDICES FOR BENTHIC MACROINVERTEBRATES COLLECTED IN THE OHIO RIVER, 2015

	Station					
May	1	2A	2B1	2B2	2B3	3
No. of Taxa	6	8	16	15	8	19
Shannon-Weiner Index	0.56	0.74	0.93	0.93	0.80	0.82
Evenness	0.72	0.82	0.77	0.79	0.88	0.64
Richness	1.30	1.82	3.07	3.51	2.38	3.67

	Station					
September	1	2A	2B1	2B2	2B3	3
No. of Taxa	21	19	32	16	34	24
Shannon-Weiner Index	1.00	0.89	1.05	0.70	0.99	0.80
Evenness	0.76	0.70	0.70	0.58	0.65	0.58
Richness	3.76	3.18	4.98	3.44	5.71	4.22

Table 5.7. Benthic Macroinvertebrate Densities for Stations 1 (Control) and 2B (Noncontrol), BVPS, 1973-2015.

	Preoperational					
	1973		1974		1975	
	1	2B	1	2B	1	2B
May	248	508	1116	2197		
August	99	244	143	541	1017	1124
Mean	**173**	**376**	**630**	**1369**	**1017**	**1124**

	Operational					
	1976		1977		1978	
	1	2B	1	2B	1	2B
May	927	3660	674	848	351	126
August	851	785	591	3474	601	1896
Mean	**889**	**2223**	**633**	**2161**	**476**	**1011**

	Operational					
	1979		1980		1981	
	1	2B	1	2B	1	2B
May	1004	840	1041	747	209	456
Aug/Sept	1185	588	1523	448	2185	912
Mean	**1095**	**714**	**1282**	**598**	**1197**	**684**

	Operational					
	1982		1983		1984	
	1	2B	1	2B	1	2B
May	3490	3026	3590	1314	2741	621
September	2958	3364	4172	4213	1341	828
Mean	**3223**	**3195**	**3881**	**2764**	**2041**	**725**

	Operational					
	1985		1986		1987	
	1	2B	1	2B	1	2B
May	2256	867	601	969	1971	2649
September	1024	913	849	943	2910	2780
Mean	**1640**	**890**	**725**	**956**	**2440**	**2714**

Table 5.7. Benthic Macroinvertebrate Densities for Stations 1 (Control) and 2B (Noncontrol), BVPS, 1973-2015 (Continued).

	Operational					
	1988		1989		1990	
	1	2B	1	2B	1	2B
May	1804	1775	3459	2335	15135	5796
September	1420	1514	1560	4707	5550	1118
Mean	**1612**	**1645**	**2510**	**3274**	**10343**	**3457**

	Operational					
	1991		1992		1993	
	1	2B	1	2B	1	2B
May	7760	6355	7314	10560	8435	2152
September	3588	2605	2723	4707	4693	2143
Mean	**5808**	**4480**	**5019**	**7634**	**6564**	**2148**

	Operational					
	1994		1995		1996	
	1	2B	1	2B	1	2B
May	6980	2349	8083	9283	1987	1333
September	1371	2930	1669	3873	1649	2413
Mean	**4176**	**2640**	**4876**	**6578**	**1814**	**1873**

	Operational					
	1997		1998		1999	
	1	2B	1	2B	1	2B
May	1411	2520	6980	2349	879	1002
September	1944	2774	1371	2930	302	402
Mean	**1678**	**2647**	**4176**	**2640**	**591**	**702**

	Operational					
	2000		2001		2002	
	1	2B	1	2B	1	2B
May	2987	2881	3139	5232	1548	2795
September	3092	2742			8632	14663
Mean	**3040**	**2812**	**3139**	**5232**	**5090**	**8729**

Table 5.7. Benthic Macroinvertebrate Densities for Stations 1 (Control) and 2B (Noncontrol), BVPS, 1973-2015 (Continued).

	Operational					
	2003		2004		2005	
	1	2B	1	2B	1	2B
May	7095	10750	2752	4558	516	1146
September	2193	6464	10062	7604	4773	6435
Mean	**4644**	**8607**	**6407**	**6181**	**2645**	**3791**

	Operational					
	2006		2007		2008	
	1	2B	1	2B	1	2B
May	143	1242	559	912	158	1252
September	229	2199	560	3794	1161	2150
Mean	**186**	**1721**	**560**	**2353**	**660**	**1701**

	Operational					
	2009		2010		2011	
	1	2B	1	2B	1	2B
May	71	1462	1763	2527	115	1700
September	903	1902	1720	1256	874	1233
Mean	**487**	**1682**	**1742**	**1892**	**495**	**1467**

	Operational					
	2012		2013		2014	
	1	2B	1	2B	1	2B
May	71	1462	2107	903	1634	3149
September	903	1902	373	1731	3526	7310
Mean	**487**	**1682**	**1240**	**1317**	**2580**	**5230**

Table 5.7. Benthic Macroinvertebrate Densities for Stations 1 (Control) and 2B (Noncontrol), BVPS, 1973-2015 (Continued).

	Operational					
	2015					
	1	2B				
May	673	2924				
September	979	4343				
Mean	**826**	**3634**				

TABLE 5.8

TOTAL FISH CATCH; ELECTROFISHING AND SEINE NET COMBINED DURING THE BVPS 2015 FISHERIES SURVEY

Common Name	Scientific Name	Number	Percent
Smallmouth buffalo	*Ictiobus bubalus*	**20**	**4.60**
Bluegill	*Lepomis macrochirus*	**2**	**0.46**
Carp	*Cyprinis carpio*	**1**	**0.23**
Channel catfish	*Ictalurus punctatus*	**1**	**0.23**
Emerald shiner	*Notropis atherinoides*	**12**	**2.76**
Flathead catfish	*Pylodictis olivaris*	**2**	**0.46**
Freshwater drum	*Aplodinotus grunniens*	**4**	**0.92**
Gizzard shad	*Dorosoma cepedianum*	**355**	**81.61**
Goldfish	*Carassius auratus*	**1**	**0.23**
Golden redhorse sucker	*Moxostoma erythrurum*	**7**	**1.61**
Longnose gar	*Lepisosteus osseus*	**11**	**2.53**
Mimic shiner	*Notropis volucellus*	**1**	**0.23**
Pumpkinseed	*Lepomis gibbosus*	**3**	**0.69**
Quillback	*Carpiodes cyprinus*	**1**	**0.23**
Rock bass	*Ambloplites rupestris*	**1**	**0.23**
Shorthead redhorse sucker	*Moxostoma macrolepidotum*	**3**	**0.69**
Smallmouth bass	*Micropterus dolomieu*	**7**	**1.61**
Spotfin shiner	*Notropis spilopterus*	**1**	**0.23**
Spotted bass	*Micropterus punctulatus*	**1**	**0.23**
Walleye	*Sander vitreum*	**1**	**0.23**
Total Fish Collected in 2015		**435**	**100.00**

TABLE 5.9

COMPARISON OF CONTROL VS. NON-CONTROL ELECTROFISHING CATCHES DURING THE BVPS 2015 FISHERIES SURVEY

Common Name	Control	%	Non-control	%	Total fish	%
Smallmouth buffalo	3	4.69	17	4.8	20	4.77
Bluegill			1	0.3	1	0.24
Carp			1	0.3	1	0.24
Channel catfish			1	0.3	1	0.24
Flathead catfish			2	0.6	2	0.48
Freshwater drum	3	4.69	1	0.3	4	0.95
Gizzard shad	45	70.31	310	87.3	355	84.73
Goldfish			1	0.3	1	0.24
Golden redhorse sucker	4	6.25	3	0.8	7	1.67
Longnose gar	4	6.25	7	2.0	11	2.63
Pumpkinseed	1	1.56	2	0.6	3	0.72
Quillback			1	0.3	1	0.24
Rock bass	1	1.56			1	0.24
Shorthead redhorse sucker	1	1.56	2	0.6	3	0.72
Smallmouth bass	2	3.13	4	1.1	6	1.43
Spotted bass			1	0.3	1	0.24
Walleye			1	0.3	1	0.24
Total	64	100.00	355	100.0	419	100.00

TABLE 5.10

COMPARISON OF CONTROL VS. NON-CONTROL SEINE CATCHES DURING THE BVPS 2015 FISHERIES SURVEY

Common Name	Control	%	Non-control	%	Total fish	%
Bluegill	1	11.11	**0**	0.00	1	6.25
Emerald shiner	6	66.67	**6**	85.71	12	75.00
Mimic shiner	1	11.11	**0**	0.00	1	6.25
Smallmouth bass	1	11.11	**0**	0.00	1	6.25
Spotfin shiner	0	0.00	**1**	14.29	1	6.25
Total	**9**	**100.00**	7	**100.00**	**16**	**100.00**

TABLE 5.11

FISH SPECIES COLLECTED DURING THE MAY 2015 (SPRING) SAMPLING OF THE OHIO RIVER IN THE VICINITY OF BVPS

Common Name	Sample locations *						Seine		Electrofishing	
	S-1	S-2	E-1	E-2A	E-2B	E-3	Total	%	Total	%
Smallmouth buffalo			1	1			0	-	2	6.67
Bluegill							0	-	0	0.00
Carp				1			0	-	1	3.33
Channel catfish							0	-	0	0.00
Emerald shiner							0	-	0	0.00
Flathead catfish					1		0	-	1	3.33
Freshwater drum			3				0	-	3	10.00
Gizzard shad							0	-	0	0.00
Goldfish				1			0	-	1	3.33
Golden redhorse sucker			4	2	1		0	-	7	23.33
Longnose gar			1	3	2		0	-	6	20.00
Mimic shiner							0	-	0	0.00
Pumpkinseed							0	-	0	0.00
Quillback					1		0	-	1	3.33
Rock bass			1				0	-	1	3.33
Shorthead redhorse sucker				2			0	-	2	6.67
Smallmouth bass			1		1	1	0	-	3	10.00
Spotfin shiner							0	-	0	0.00
Spotted bass				1			0	-	1	3.33
Walleye				1			0	-	1	3.33
Total	0	0	11	12	6	1	0	-	30	100.00

* Gear = (E) Fish captured by electrofishing; (S) captured by seining

TABLE 5.12

FISH SPECIES COLLECTED DURING THE JULY (SUMMER) 2015 SAMPLING OF THE OHIO RIVER IN THE VICINITY OF BVPS

	Sample locations *						Seine		Electrofishing	
Common Name	S-1	S-2	E-1	E-2A	E-2B	E-3	Total	%	Total	%
Smallmouth buffalo			1				0	-	1	6.67
Bluegill							0	-	0	0.00
Carp							0	-	0	0.00
Channel catfish							0	-	0	0.00
Emerald shiner							0	-	0	0.00
Flathead catfish					1		0	-	1	6.67
Freshwater drum							0	-	0	0.00
Gizzard shad				9			0	-	9	60.00
Goldfish							0	-	0	0.00
Golden redhorse sucker							0	-	0	0.00
Longnose gar			2				0	-	2	13.33
Mimic shiner							0	-	0	0.00
Pumpkinseed						1	0	-	1	6.67
Quillback							0	-	0	0.00
Rock bass							0	-	0	0.00
Shorthead redhorse sucker							0	-	0	0.00
Smallmouth bass						1	0	-	1	6.67
Spotfin shiner							0	-	0	0.00
Spotted bass							0	-	0	0.00
Walleye							0	-	0	0.00
Total	**0**	**0**	**3**	**9**	**1**	**2**	**0**	**-**	**15**	**100.00**

* Gear = (E) Fish captured by electrofishing; (S) captured by seining

TABLE 5.13

FISH SPECIES COLLECTED DURING THE SEPTEMBER (FALL) 2015 SAMPLING OF THE OHIO RIVER IN THE VICINITY OF BVPS

	Sample locations *						Seine		Electrofishing	
Common Name	S-1	S-2	E-1	E-2A	E-2B	E-3	Total	%	Total	%
Smallmouth buffalo							0	-	0	0.00
Bluegill				1			0	-	1	0.34
Carp							0	-	0	0.00
Channel catfish							0	-	0	0.00
Emerald shiner							0	-	0	0.00
Flathead catfish							0	-	0	0.00
Freshwater drum							0	-	0	0.00
Gizzard shad			45	30	43	168	0	-	286	98.28
Goldfish							0	-	0	0.00
Golden redhorse sucker							0	-	0	0.00
Longnose gar			1			1	0	-	2	0.69
Mimic shiner							0	-	0	0.00
Pumpkinseed			1		1		0	-	2	0.69
Quillback							0	-	0	0.00
Rock bass							0	-	0	0.00
Shorthead redhorse sucker							0	-	0	0.00
Smallmouth bass							0	-	0	0.00
Spotfin shiner							0	-	0	0.00
Spotted bass							0	-	0	0.00
Walleye							0	-	0	0.00
Total	**0**	**0**	**47**	**31**	**44**	**169**	**0**	**-**	**291**	**100.00**

* Gear = (E) Fish captured by electrofishing; (S) captured by seining

FISH SPECIES COLLECTED DURING THE NOVEMBER (WINTER) 2015 SAMPLING OF THE OHIO RIVER IN THE VICINITY OF BVPS

	Sample locations *						Seine		Electrofishing	
Common Name	**S-1**	**S-2**	**E-1**	**E-2A**	**E-2B**	**E-3**	**Total**	**%**	**Total**	**%**
Smallmouth buffalo			1	1	15		0	0.00	17	20.48
Bluegill	1						1	6.25	0	0.00
Carp							0	0.00	0	0.00
Channel catfish					1		0	0.00	1	1.20
Emerald shiner	6	6					12	75.00	0	0.00
Flathead catfish							0	0.00	0	0.00
Freshwater drum					1		0	0.00	1	1.20
Gizzard shad				55	1	4	0	0.00	60	72.29
Goldfish							0	0.00	0	0.00
Golden redhorse sucker							0	0.00	0	0.00
Longnose gar						1	0	0.00	1	1.20
Mimic shiner	1						1	6.25	0	0.00
Pumpkinseed							0	0.00	0	0.00
Quillback							0	0.00	0	0.00
Rock bass							0	0.00	0	0.00
Shorthead redhorse sucker			1				0	0.00	1	1.20
Smallmouth bass	1		1		1		1	6.25	2	2.41
Spotfin shiner		1					1	6.25	0	0.00
Spotted bass							0	0.00	0	0.00
Walleye							0	0.00	0	0.00
Total	**9**	**7**	**3**	**56**	**19**	**5**	**16**	**100.00**	**83**	**100.00**

* Gear = (E) Fish captured by electrofishing; (S) captured by seining

TABLE 5.15

ESTIMATED NUMBER OF FISH OBSERVED * DURING ELECTROFISHING OPERATIONS, 2015

Common Name	May	July	Sept	Nov	Total
Bluegill				1	**1**
Freshwater drum	1				**1**
Smallmouth buffalo	1				**1**
Longnose gar		1	1		**2**
Unidentified suckers	2	1			**3**
Unidentified black bass		1		1	**2**
Gizzard shad				200+	**200+**
Total	**4**	**3**	**1**	**200+**	**210+**

* = Not boated or handled

Table 5.16

CATCH PER UNIT EFFORT (CPUE AS FISH/ELECTROFISHING MINUTE) BY SEASON DURING THE BVPS 2012 FISHERIES SURVEY

Season	Effort (min)	Common Name	Number Collected	CPUE (fish/min)
Spring	40.1	Smallmouth buffalo	1	0.0249
		Channel catfish	1	0.0249
		Common carp	1	0.0249
		Gizzard shad	5	0.1247
		Golden redhorse sucker	5	0.1247
		Longnose gar	1	0.0249
		Rock bass	1	0.0249
		Shorthead redhorse sucker	5	0.1247
		Smallmouth bass	3	0.0748
		Season Total	**23**	0.5736
Season	**Effort (min)**	**Common Name**	**Number Collected**	**CPUE (fish/min)**
Summer	40.1	Smallmouth buffalo	5	0.1247
		Common carp	1	0.0249
		Gizzard shad	8	0.1995
		Largemouth bass	1	0.0249
		Smallmouth bass	3	0.0748
		Season Total	**18**	0.4489

Table 5.16 (continued)

CATCH PER UNIT EFFORT (CPUE AS FISH/ELECTROFISHING MINUTE) BY SEASON DURING THE BVPS 2012 FISHERIES SURVEY

Season	Effort (min)	Common Name	Number Collected	CPUE (fish/min)
Fall	40.1	Smallmouth buffalo	4	0.0998
		Black crappie	1	0.0249
		Common carp	2	0.0499
		Freshwater drum	1	0.0249
		Gizzard shad	10	0.2494
		Golden redhorse sucker	3	0.0748
		Largemouth bass	1	0.0249
		Quillback	1	0.0249
		Rock bass	1	0.0249
		Sauger	1	0.0249
		Shorthead redhorse sucker	3	0.0748
		Smallmouth bass	2	0.0499
		Spotted bass	1	0.0249
		White bass	6	0.1496
		Season Total	**37**	0.9227
Season	**Effort (min)**	**Common Name**	**Number Collected**	**CPUE (fish/min)**
Winter	30	Smallmouth buffalo	1	0.0333
		Freshwater drum	1	0.0333
		Golden shiner	1	0.0333
		Shorthead redhorse sucker	3	0.1000
		Smallmouth bass	2	0.0667
		Walleye	1	0.0333
		White bass	1	0.0333
		Season Total	**10**	0.3333
2012	**150.3**		**88**	**0.58550**

Table 5.17

CATCH PER UNIT EFFORT (CPUE AS FISH/ELECTROFISHING MINUTE) BY SEASON DURING THE BVPS 2013 FISHERIES SURVEY

Season	Effort (min)	Common Name	Number Collected	CPUE (fish/min)
Spring	40.4	Smallmouth buffalo	1	0.0248
		Black crappie	1	0.0248
		Bluegill	1	0.0248
		Gizzard shad	1	0.0248
		Golden redhorse sucker	8	0.1980
		Longnose gar	2	0.0495
		Pumpkinseed	1	0.0248
		Quillback	2	0.0495
		River carpsucker	2	0.0495
		Rock bass	1	0.0248
		Shorthead redhorse sucker	10	0.2475
		Smallmouth bass	7	0.1733
		Spotted bass	2	0.0495
		Season Total	**39**	0.9653
Season	**Effort (min)**	**Common Name**	**Number Collected**	**CPUE (fish/min)**
Summer	40.0	Smallmouth buffalo	3	0.0750
		Black crappie	1	0.0250
		Gizzard shad	1	0.0250
		Golden redhorse sucker	3	0.0750
		Sauger	1	0.0250
		Smallmouth bass	2	0.0500
		Season Total	**11**	0.2750

Table 5.17 (continued)

CATCH PER UNIT EFFORT (CPUE AS FISH/ELECTROFISHING MINUTE) BY SEASON DURING THE BVPS 2013 FISHERIES SURVEY

Season	Effort (min)	Common Name	Number Collected	CPUE (fish/min)
Fall	40.4	Bluegill	2	0.0495
		Channel catfish	1	0.0248
		Flathead catfish	1	0.0248
		Freshwater drum	1	0.0248
		Gizzard shad	1	0.0248
		Golden redhorse sucker	2	0.0495
		Longnose gar	1	0.0248
		River carpsucker	1	0.0248
		Smallmouth bass	1	0.0248
		Spotted bass	1	0.0248
		Walleye	1	0.0248
		Season Total	**13**	0.3218
Season	**Effort (min)**	**Common Name**	**Number Collected**	**CPUE (fish/min)**
Winter	40.1	Bluegill	1	0.0249
		Channel catfish	1	0.0249
		Freshwater drum	1	0.0249
		Golden redhorse sucker	6	0.1496
		Rock bass	3	0.0748
		Shorthead redhorse sucker	7	0.1746
		Smallmouth bass	2	0.0499
		Yellow perch	1	0.0249
		Season Total	**22**	0.5486
2013	**160.9**		**85**	**0.52828**

Table 5.18

CATCH PER UNIT EFFORT (CPUE AS FISH/ELECTROFISHING MINUTE) BY SEASON DURING THE BVPS 2014 FISHERIES SURVEY

Season	Effort (min)	Common Name	Number Collected	CPUE (fish/min)
Spring	40.4	Smallmouth buffalo	3	0.0743
		Carp	2	0.0495
		Channel catfish	2	0.0495
		Freshwater drum	2	0.0495
		Gizzard shad	12	0.2970
		Golden redhorse sucker	3	0.0743
		Longnose gar	4	0.0990
		River carpsucker	1	0.0248
		Shorthead redhorse sucker	4	0.0990
		Smallmouth bass	4	0.0990
		Spotted bass	2	0.0495
		Walleye	5	0.1238
		Season Total	**44**	1.0891
Season	**Effort (min)**	**Common Name**	**Number Collected**	**CPUE (fish/min)**
Summer	40.1	Smallmouth buffalo	6	0.1496
		Carp	1	0.0249
		Gizzard shad	14	0.3491
		Longnose gar	1	0.0249
		Shorthead redhorse sucker	3	0.0748
		Smallmouth bass	1	0.0249
		Season Total	**26**	0.6484

Table 5.18 (continued)

CATCH PER UNIT EFFORT (CPUE AS FISH/ELECTROFISHING MINUTE) BY SEASON DURING THE BVPS 2014 FISHERIES SURVEY

Season	Effort (min)	Common Name	Number Collected	CPUE (fish/min)
Fall	40.0	Carp	4	0.1000
		Gizzard shad	26	0.6500
		Largemouth bass	1	0.0250
		Shorthead redhorse sucker	2	0.0500
		Yellow perch	1	0.0250
		Season Total	**34**	0.8500
Season	**Effort (min)**	**Common Name**	**Number Collected**	**CPUE (fish/min)**
Winter	40.0	Smallmouth buffalo	4	0.1000
		Bluegill	1	0.0250
		Carp	6	0.1500
		Gizzard shad	13	0.3250
		Golden redhorse sucker	4	0.1000
		Longnose gar	4	0.1000
		Shorthead redhorse sucker	1	0.0250
		Smallmouth bass	1	0.0250
		Season Total	**34**	0.8500
2014	**160.5**		**138**	**0.85981**

Table 5.19

CATCH PER UNIT EFFORT (CPUE AS FISH/ELECTROFISHING MINUTE) BY SEASON DURING THE BVPS 2015 FISHERIES SURVEY

Season	Effort (min)	Common Name	Number Collected	CPUE (fish/min)
Spring	41.5	Smallmouth buffalo	2	0.0482
		Carp	1	0.0241
		Flathead catfish	1	0.0241
		Freshwater drum	3	0.0723
		Goldfish	1	0.0241
		Golden redhorse sucker	7	0.1687
		Longnose gar	6	0.1446
		Quillback	1	0.0241
		Rock bass	1	0.0241
		Shorthead redhorse sucker	2	0.0482
		Smallmouth bass	3	0.0723
		Spotted bass	1	0.0241
		Walleye	1	0.0241
		Season Total	**30**	0.7229
Season	**Effort (min)**	**Common Name**	**Number Collected**	**CPUE (fish/min)**
Summer	40.7	Smallmouth buffalo	1	0.0246
		Flathead catfish	1	0.0246
		Gizzard shad	9	0.2211
		Longnose gar	2	0.0491
		Pumpkinseed	1	0.0246
		Smallmouth bass	1	0.0246
		Season Total	**15**	0.3686

Table 5.19 (continued)

CATCH PER UNIT EFFORT (CPUE AS FISH/ELECTROFISHING MINUTE) BY SEASON DURING THE BVPS 2015 FISHERIES SURVEY

Season	Effort (min)	Common Name	Number Collected	CPUE (fish/min)
Fall	40.9	Bluegill	1	0.0244
		Gizzard shad	286	6.9927
		Longnose gar	2	0.0489
		Pumpkinseed	2	0.0489
		Season Total	**291**	7.1149
Season	**Effort (min)**	**Common Name**	**Number Collected**	**CPUE (fish/min)**
Winter	40.6	Smallmouth buffalo	17	0.4187
		Channel catfish	1	0.0246
		Freshwater drum	1	0.0246
		Gizzard shad	60	1.4778
		Longnose gar	1	0.0246
		Shorthead redhorse sucker	1	0.0246
		Smallmouth bass	2	0.0493
		Season Total	**83**	2.0443
2015	**163.7**		**419**	**2.55956**

TABLE 5.20

UNIT 1 COOLING RESERVOIR MONTHLY SAMPLING <u>CORBICULA</u> DENSITY DATA FOR 2015 FROM BVPS

Collection Date	Area Sampled (sq ft)	Live or Dead	Count	Maximum Length Range (mm)	Minimum Length Range(mm)	Estimated Number (per sq m)
3/30/2015	0.25	Dead	1	2.00-3.34	2.00-3.34	43
		Live	3	2.00-3.34	1.00-1.99	129
4/21/2015	0.25	Dead	0	---	---	0
		Live	0	---	---	0
5/28/2015	0.25	Dead	2	4.75-6.29	3.35-4.74	86
		Live	2	3.35-4.74	2.00-3.34	86
6/23/2015	0.25	Dead	1	2.00-3.34	2.00-3.34	43
		Live	2	3.35-4.74	2.00-3.34	86
7/30/2015	0.25	Dead	2	2.00-3.34	2.00-3.34	86
		Live	2	4.75-6.29	2.00-3.34	86
8/28/2015	0.25	Dead	2	6.30-9.94	6.30-9.94	86
		Live	3	>9.50	4.75-6.29	129
9/17/2015	0.25	Dead	3	6.30-9.94	4.75-6.29	129
		Live	1	3.35-4.74	3.35-4.74	43
10/14/2015	0.25	Dead	0	---	---	0
		Live	0	---	---	0
11/5/2015	0.25	Dead	0	---	---	0
		Live	0	---	---	0
Unit summary		Dead	11	6.30-9.94	2.00-3.34	53
		Live	13	>9.50	1.00-1.99	62

TABLE 5.21

UNIT 2 COOLING RESERVOIR MONTHLY SAMPLING <u>CORBICULA</u> DENSITY DATA FOR 2015 FROM BVPS

Collection Date	Area Sampled (sq ft)	Live or Dead	Count	Maximum Length Range (mm)	Minimum Length Range(mm)	Estimated Number (per sq m)
3/30/2015	0.25	Dead	1	1.00-1.99	1.00-1.99	43
		Live	2	3.35-4.74	2.00-3.34	86
4/21/2015	0.25	Dead	0	—	—	0
		Live	0	—	—	0
5/28/2015	0.25	Dead	0	—	—	0
		Live	1	2.00-3.34	2.00-3.34	43
6/23/2015	0.25	Dead	1	2.00-3.34	2.00-3.34	43
		Live	1	3.35-4.74	3.35-4.74	43
7/30/2015	0.25	Dead	0	—	—	0
		Live	0	—	—	0
8/28/2015	0.25	Dead	0	—	—	0
		Live	2	>9.50	2.00-3.34	86
9/17/2015	0.25	Dead	1	6.30-9.94	6.30-9.94	43
		Live	3	4.75-6.29	2.00-3.34	129
10/14/2015*	---	Dead	—	—	—	---
		Live	—	—	—	---
11/5/2015	0.25	Dead	0	—	—	0
		Live	0	—	—	0
Unit summary		Dead	3	4.75-6.29	2.00-3.34	16
		Live	9	>9.50	1.00-1.99	48

*Not sampled due to outage

9.0

FIGURES

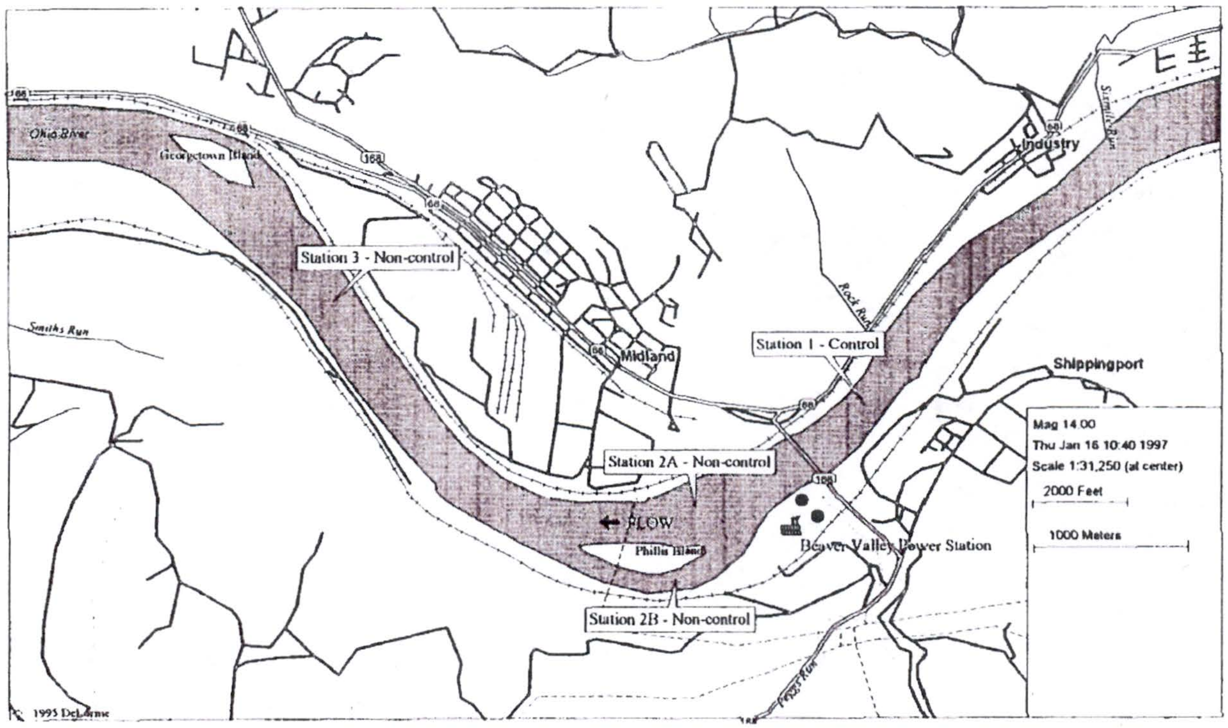


Figure 5.1 2015 Beaver Valley Power Station Aquatic Monitoring Program Sampling Control and Non-Control Sampling Stations

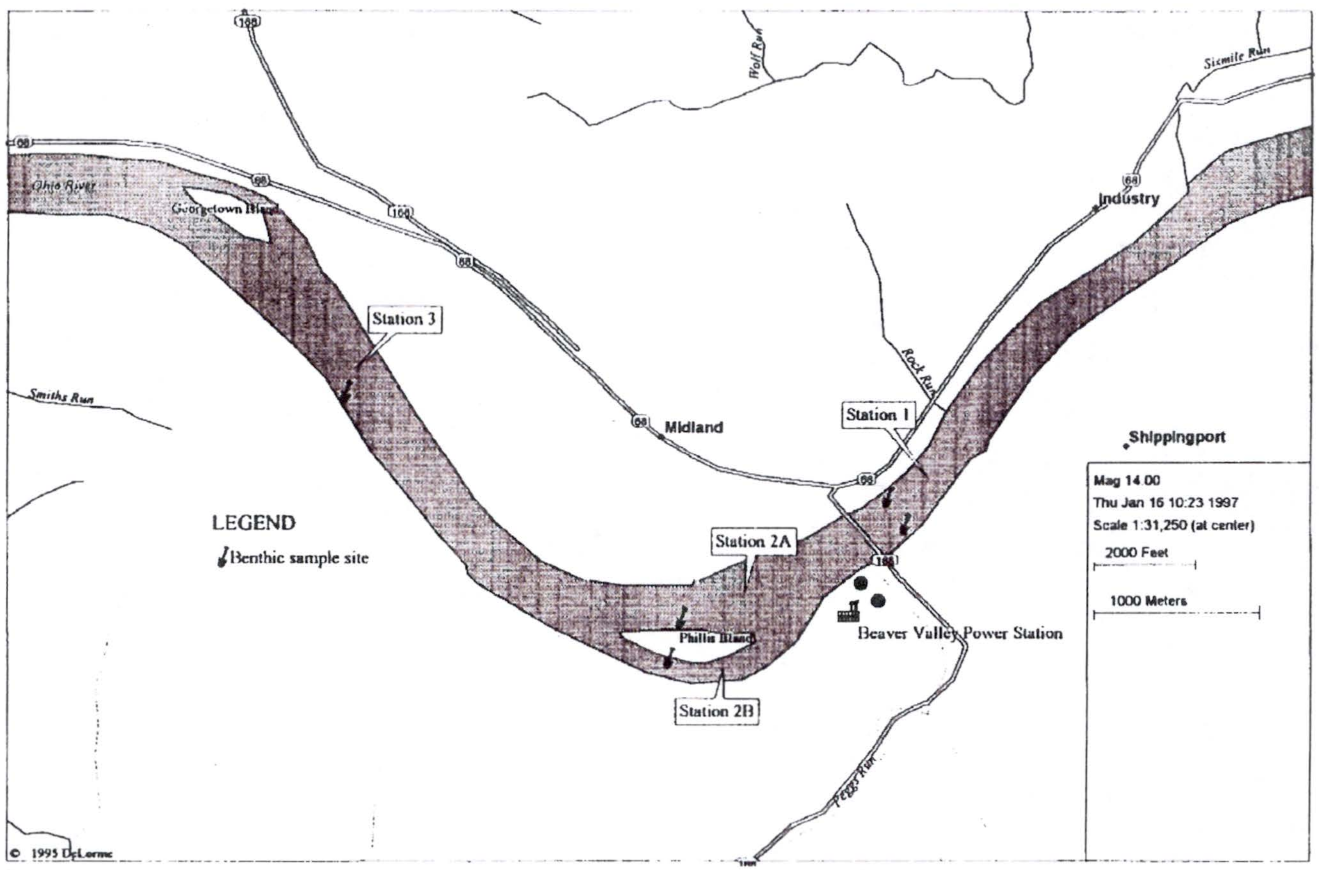


Figure 5.2 Location Map for Beaver Valley Power Station Benthic Organism Survey Sampling Sites for the 2015 Study

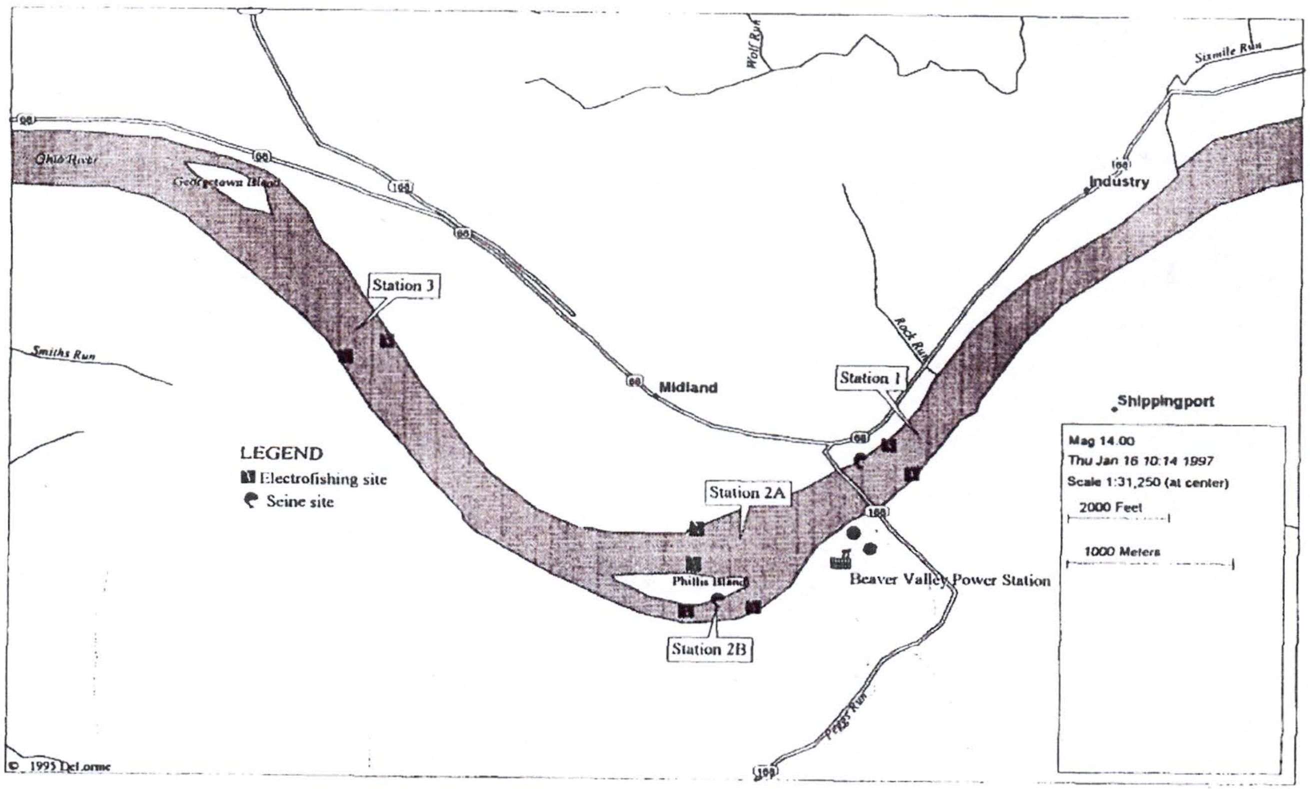


Figure 5.3 Location Map for Beaver Valley Power Station Fish Population Survey Fish Sampling Sites for the 2015 Study

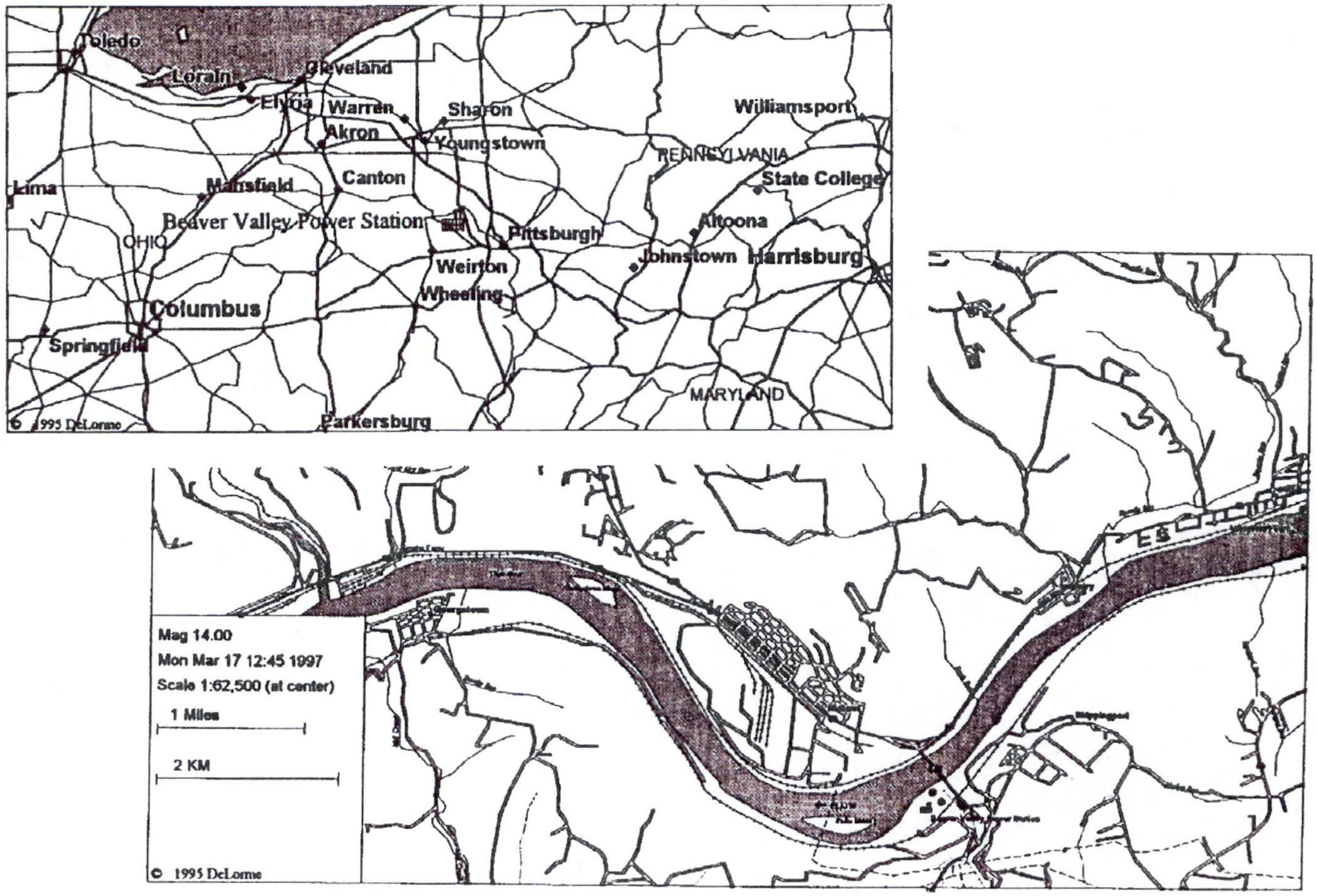
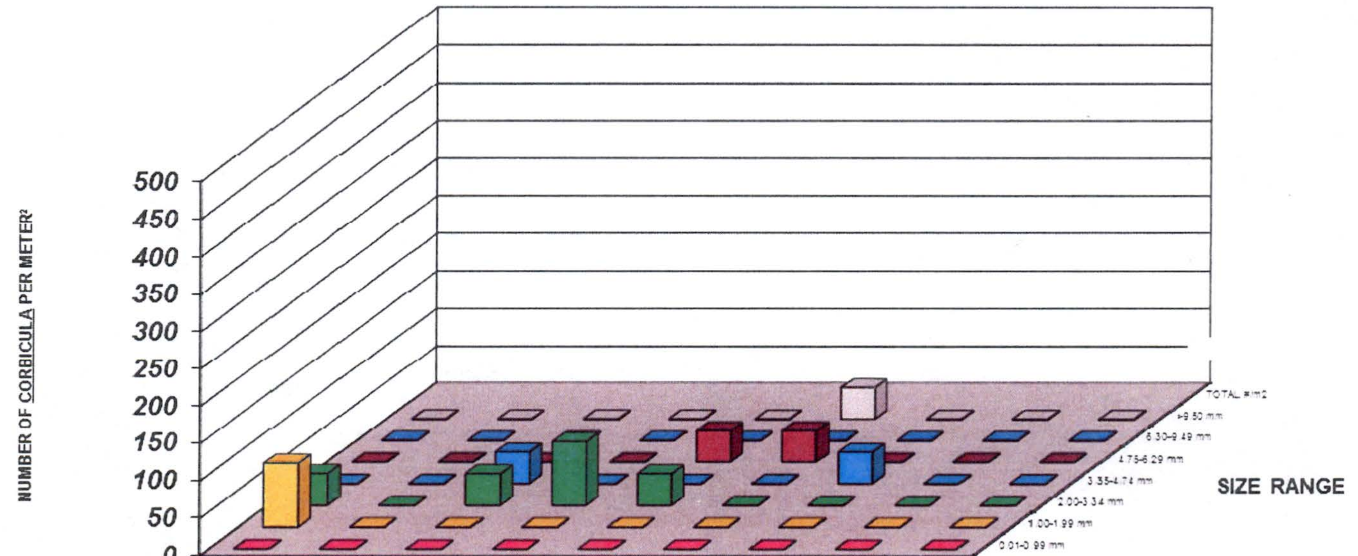


Figure 5.4 Location of Study Area, Beaver Valley Power Station Shippingport, Pennsylvania BVPS

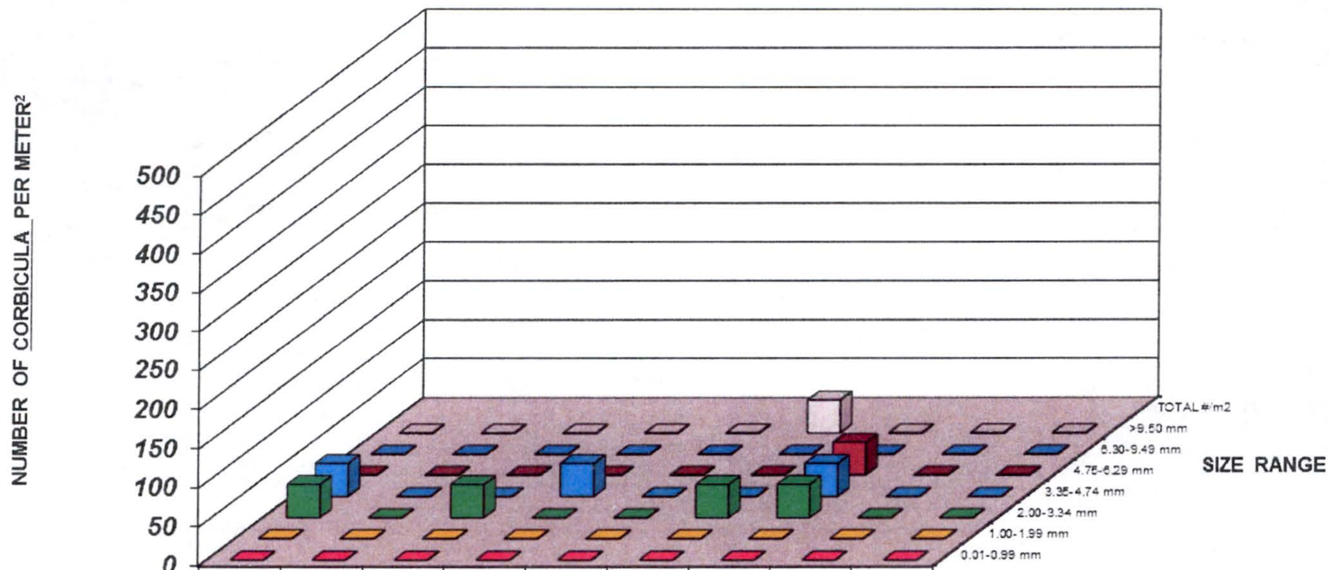
Comparison of live <u>Corbicula</u> clam density estimates among 2015 BVPS Unit 1 cooling tower reservoir events, for various clam shell groups.



	3/30	4/21	5/28	6/23	7/30	8/28	9/17	10/14	11/5
0.01-0.99 mm	0	0	0	0	0	0	0	0	0
1.00-1.99 mm	86	0	0	0	0	0	0	0	0
2.00-3.34 mm	43	0	43	86	43	0	0	0	0
3.35-4.74 mm	0	0	43	0	0	0	43	0	0
4.75-6.29 mm	0	0	0	0	43	43	0	0	0
6.30-9.49 mm	0	0	0	0	0	0	0	0	0
>9.50 mm	0	0	0	0	0	43	0	0	0
TOTAL #/m2	129	0	86	86	86	86	43	0	0

Figure 5.5

Comparison of live Corbicula clam density estimates among 2015 BVPS Unit 2 cooling tower reservoir events, for various clam shell groups.

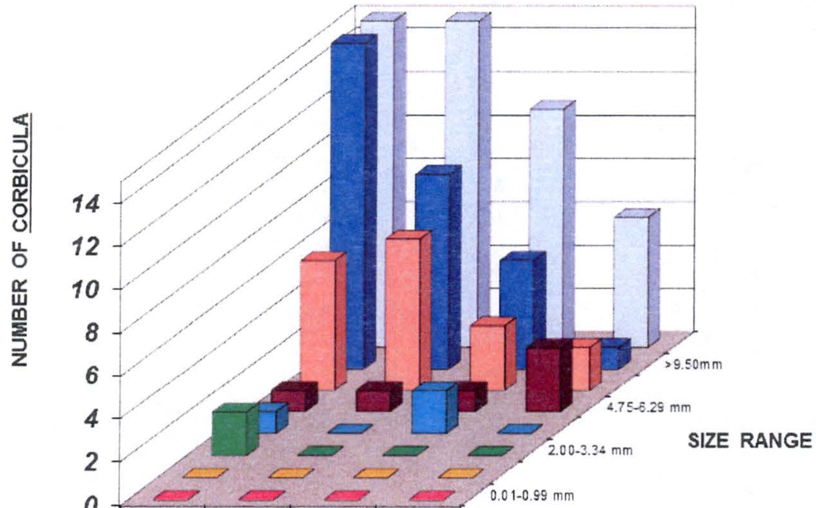


	3/30	4/21	5/28	6/23	7/30	8/28	9/17	10/14*	11/5
0.01-0.99 mm	0	0	0	0	0	0	0	0	0
1.00-1.99 mm	0	0	0	0	0	0	0	0	0
2.00-3.34 mm	43	0	43	0	0	43	43	0	0
3.35-4.74 mm	43	0	0	43	0	0	43	0	0
4.75-6.29 mm	0	0	0	0	0	0	43	0	0
6.30-9.49 mm	0	0	0	0	0	0	0	0	0
>9.50 mm	0	0	0	0	0	43	0	0	0
TOTAL #/m2	86	0	43	43	0	86	129	0	0

Figure 5.6

*No sample; Unit 2 Offline in October

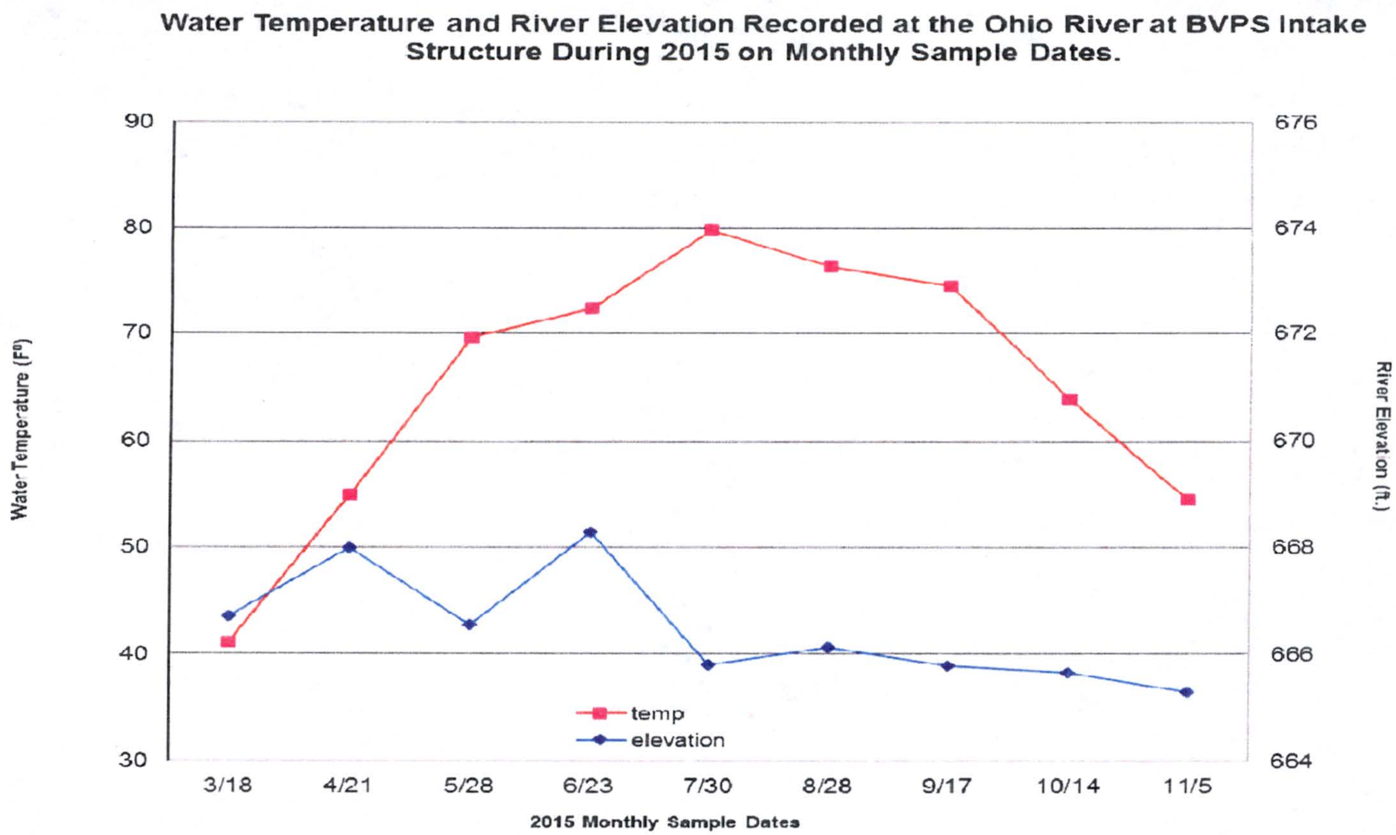
Comparison of live Corbicula clam density estimates among 2015 BVPS Intake Structure sample events, for various clam shell groups.



	5/28	7/30	9/17	11/5
0.01-0.99 mm	0	0	0	0
1.00-1.99 mm	0	0	0	0
2.00-3.34 mm	2	0	0	0
3.35-4.74 mm	1	0	2	0
4.75-6.29 mm	1	1	1	3
6.30-9.49 mm	6	7	3	2
>9.50mm	16	9	5	1
TOTAL	26	17	11	6

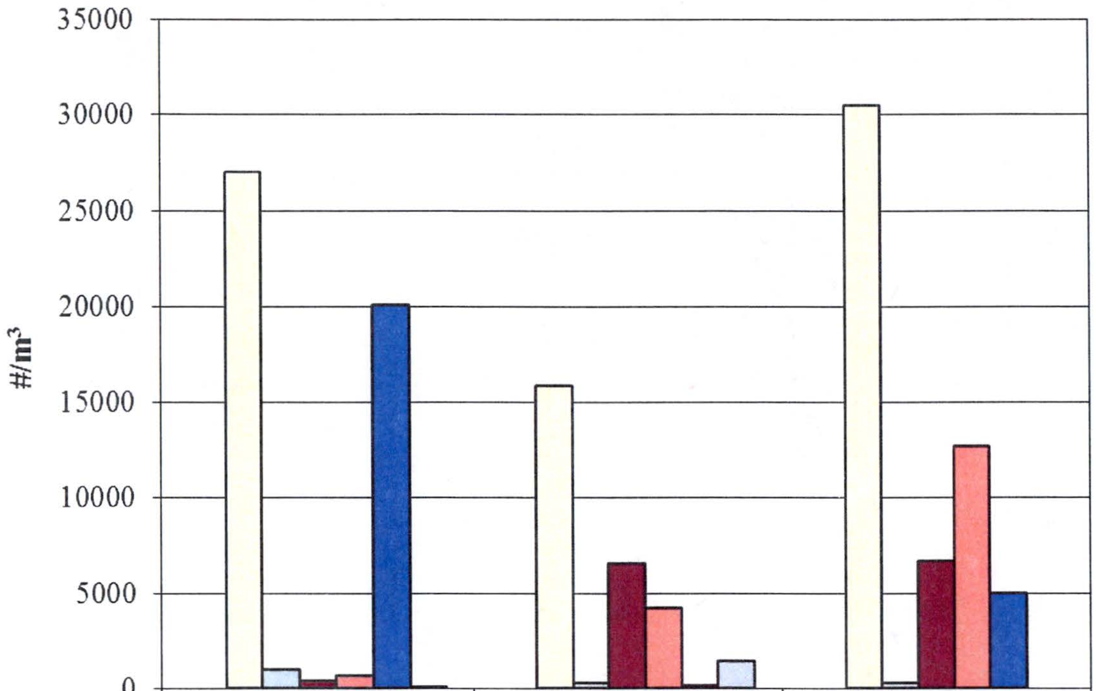
Intake structure bottom samples are collected from the Ohio River at the Intake Building.

Figure 5.7



Water Temperature and River Elevation Recorded at the Ohio River at BVPS Intake Structure During 2015 on Monthly Sample Dates.
Water Temperature (F°)
River Elevation (ft.)
90
80
70
60
50
40
30
676
674
672
670
668
666
664
temp
elevation
3/18
4/21
5/28
6/23
7/30
8/28
9/17
10/14
11/5
2015 Monthly Sample Dates

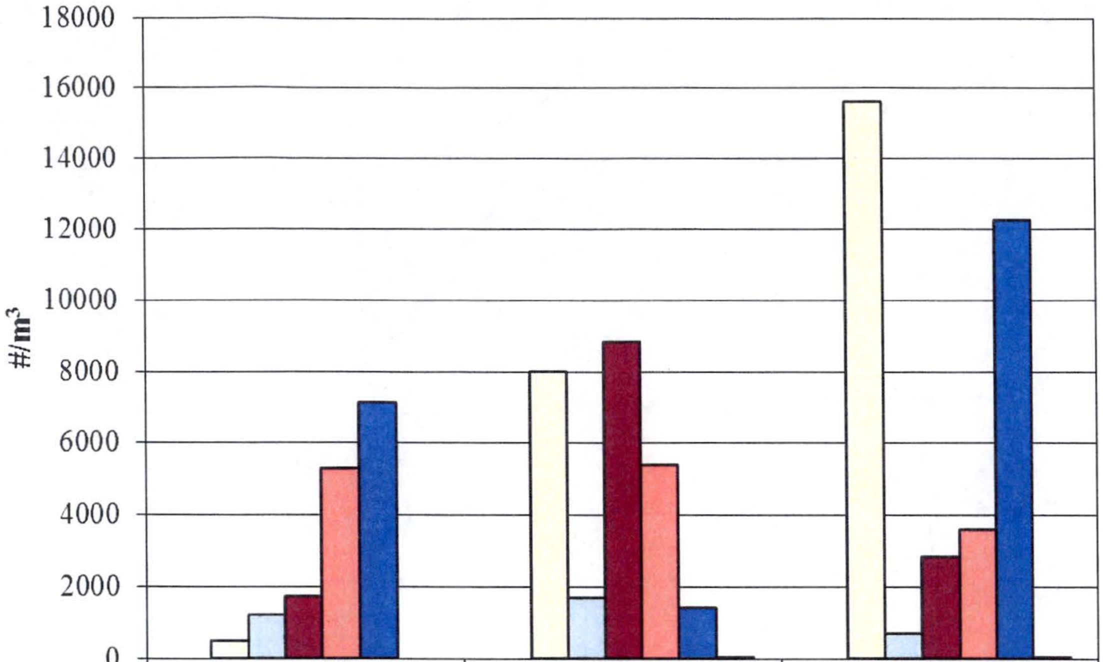
Figure 5.8



	Intake Structure/Open Water	Unit 1 Cooling Tower Reservoir	Unit 2 Cooling Tower Reservoir*
4/21	0	0	0
5/28	27000	15850	30500
6/23	960	300	300
7/30	429	6561	6691
8/28	650	4198	12702
9/17	20100	120	5025
10/14	105	1462	0

Sample location

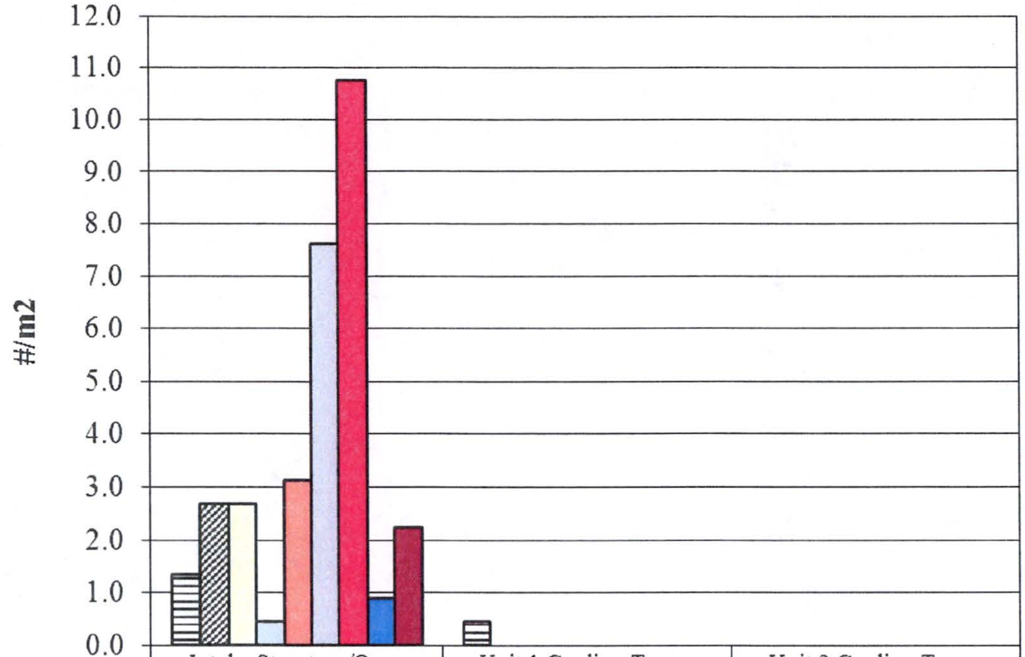
Figure 5.9. Density of zebra mussel veligers collected at Beaver Valley Power Station, 2015.
*Unit 2 Cooling Tower not sampled in October due to outage



	Barge Slip*	Splash Pool	Emergency Outfall Facility**
4/21	0	0	0
5/28	495	8015	15600
6/23	1220	1710	720
7/30	1728	8820	2835
8/28	5290	5415	3625
9/17	7125	1440	12250
10/14	0	13	18

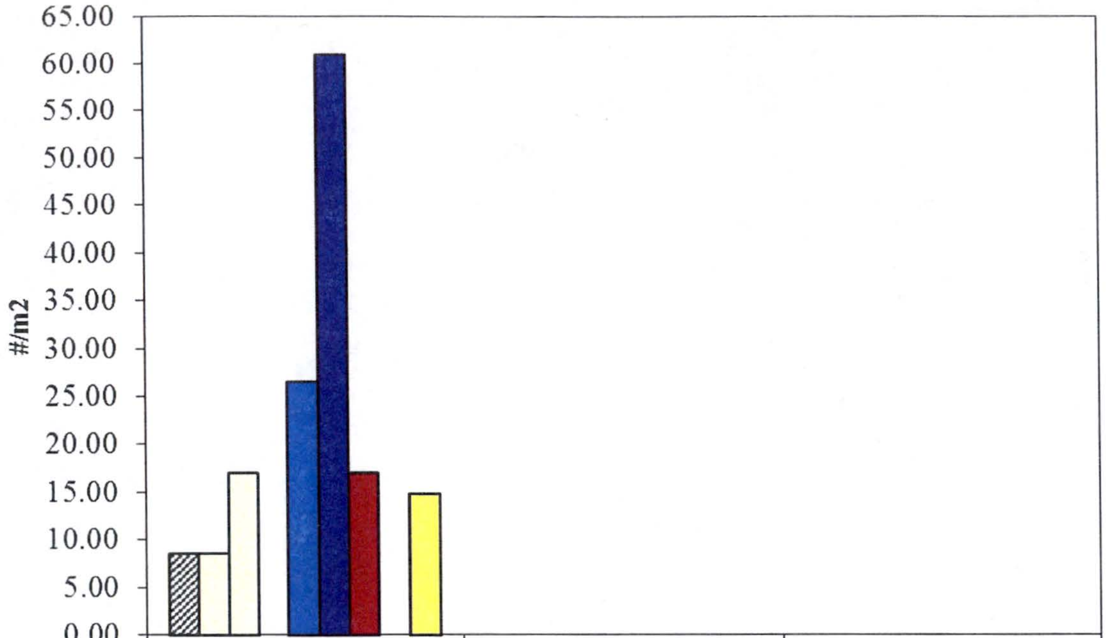
Sample location

Figure 5.10. Density of zebra mussel veligers collected at Beaver Valley Power Station, 2015.
*Barge Slip not sampled in October due to Access Restrictions
**EOB not sampled in April due to Access Restrictions



	Intake Structure/Open Water	Unit 1 Cooling Tower Reservoir	Unit 2 Cooling Tower Reservoir*
3/30	1.3	0.4	0.0
4/21	2.7	0.0	0.0
5/28	2.7	0.0	0.0
6/23	0.4	0.0	0.0
7/30	3.1	0.0	0.0
8/28	7.6	0.0	0.0
9/17	10.8	0.0	0.0
10/14	0.9	0.0	0.0
11/5	2.2	0.0	0.0

Figure 5.11. Density of settled zebra mussels at Beaver Valley Power Station, 2015.
*Unit 2 Cooling tower not sampled in October due to outage



	Barge Slip**	Splash Pool	Emergency Outfall Facility*
3/30	8.52	0.00	0.00
4/21	8.52	0.00	0.00
5/28	17.04	0.00	0.00
6/23	0.00	0.00	0.00
7/30	26.46	0.00	0.00
8/28	60.99	0.00	0.00
9/17	17.04	0.00	0.00
10/14	0.00	0.00	0.00
11/5	14.80	0.00	0.00

Figure 5.12. Density of settled zebra mussels at Beaver Valley Power Station, 2015.
*The EOF was not sampled in March due to Access Restrictions
**The Barge Slip was not sampled in October due to Access Restrictions

10.0

PERMITS

Attachment 10.1: PERMITS & CERTIFICATES FOR ENVIRONMENTAL COMPLIANCE

Registration Number	Regulator/Description	Expiration
PAR000040485	BVPS EPA generator identification Resource Conservation & Recovery Act (RCRA) Identification number for regulated waste activity. Also used by PA DEP to monitor regulated waste activity under the Pennsylvania Solid Waste Management Act (SWMA).	Indefinite
04-02474	BVPS EPA Facility Identification Number for CERCLA/EPCRA/SARA. Used for SARA Tier II reporting and emergency planning.	Indefinite
04-02475	FE Long Term Distribution Center/Warehouse (22) EPA Facility Identification Number for CERCLA/EPCRA/SARA. Used for SARA Tier II reporting and emergency planning.	Indefinite
PA0025615	BVPS NPDES Permit number under US EPA and PA DEP.	12/27/2006 *Continued pending approval of renewal application.*
04-13281	BVPS Unit 1 PA DEP Facility Identification & certificate number for regulated storage tanks.	Indefinite
04-13361	BVPS Unit 2 PA DEP Facility Identification & certificate number for regulated storage tanks.	Indefinite
OP-04-00086	PA DEP State Only Synthetic Minor Permit for emergency auxiliary boilers, emergency diesel generators, paint shop and other miscellaneous sources.	04/28/2020
N/A	PA DEP Open Burning Permit for operation of the BVPS Fire School- annual application and renewal	01/01/2017
042009 450 002RT	US Department of Transportation Hazardous Materials Registration	06/30/2018
200100242	US Army Permit for maintenance dredging (With Encroachment/Submerged Lands Agreement #0477705, this allows maintenance dredging.).	12/31/2021
0477705	Encroachment Permit/Submerged Lands Agreement for construction and maintenance of current barge slip. (With US Army Permit #200100242, this allows maintenance dredging.)	Indefinite
06786A	Encroachment Permit/Submerged Lands Agreement for transmission line over Ohio River @ Mile 34.5	Indefinite
18737	Encroachment Permit/Submerged Lands Agreement for Unit 1 intake and discharge (main combined intake and outfall structures)	Indefinite
0475711	Encroachment Permit/Submerged Lands Agreement for construction and maintenance of Unit 2 auxiliary intake	Indefinite
- End Table -		

APPENDIX A

SCIENTIFIC AND COMMON NAME[1] OF FISH COLLECTED IN THE NEW CUMBERLAND POOL OF THE OHIO RIVER, 1970 THROUGH 2015 BVPS

[1]Nomenclature follows Robins, et al. (1991)

Appendix A

SCIENTIFIC AND COMMON NAME[1] OF FISH COLLECTED IN THE NEW CUMBERLAND POOL OF THE OHIO RIVER, 1970 THROUGH 2015 BVPS

Family and Scientific Name	**Common Name**
Lepisosteidae (gars)	
Lepisosteus osseus	Longnose gar
Hiodontidae (mooneyes)	
Hiodon alosoides	Goldeye
H. tergisus	Mooneye
Clupeidae (herrings)	
Alosa chrysochloris	Skipjack herring
A. pseudoharengus	Alewife
Dorosoma cepedianum	Gizzard shad
Cyprinidae (carps and minnows)	
Campostoma anomalum	Central stoneroller
Carassius auratus	Goldfish
Ctenopharyngodon idella	Grass carp
Notropis spilopterus	Spotfin shiner
Cyprinus carpio	Common carp
C. carpio x C. auratus	Carp-goldfish hybrid
Luxilus chrysocephalus	Striped shiner
Macrhybopsis storeriana	Silver chub
Nocomis micropogon	River chub
Notemigonus crysoleucas	Golden shiner
Notropis atherinoides	Emerald shiner
N. buccatus	Silverjaw minnow
N. hudsonius	Spottail shiner
N. rubellus	Rosyface shiner
N. stramineus	Sand shiner
N. volucellus	Mimic shiner
Pimephales notatus	Bluntnose minnow
P. promelas	Fathead minnow
Rhinichthys atratulus	Blacknose dace
Semotilus atromaculatus	Creek chub
Catostomidae (suckers)	
Carpiodes carpio	River carpsucker
C. cyprinus	Quillback
C. velifer	Highfin carpsucker
Catostomus commersonii	White sucker
Hypentelium nigricans	Northern hogsucker
Ictiobus bubalus	Smallmouth buffalo
I. niger	Black buffalo
Minytrema melanops	Spotted sucker

Appendix A
(Continued)

Family and Scientific Name	Common Name
Moxostoma anisurum	Silver redhorse
M. carinatum	River redhorse
M. duquesnei	Black redhorse
M. erythrurum	Golden redhorse
M. macrolepidotum	Shorthead redhorse
Ictaluridae (bullhead catfishes)	
Ameiurus catus	White catfish
A. furcatus	Blue catfish
A. melas	Black bullhead
A. natalis	Yellow bullhead
A. nebulosus	Brown bullhead
Ictalurus punctatus	Channel catfish
Noturus flavus	Stonecat
Pylodictis olivaris	Flathead catfish
Esocidae (pikes)	
Esox lucius	Northern pike
E. masquinongy	Muskellunge
E. lucius x E. masquinongy	Tiger muskellunge
Salmonidae (trouts)	
Oncorhynchus mykiss	Rainbow trout
Percopsidae (trout-perches)	
Percopsis omiscomaycus	Trout-perch
Cyprinodontidae (killifishes)	
Fundulus diaphanus	Banded killifish
Atherinidae (silversides)	
Labidesthes sicculus	Brook silverside
Percichthyidae (temperate basses)	
Morone chrysops	White bass
M. saxatilis	Striped bass
M. saxatilis x M. chrysops	Striped bass hybrid
Centrarchidae (sunfishes)	
Ambloplites rupestris	Rock bass
Lepomis cyanellus	Green sunfish
L. gibbosus	Pumpkinseed
L. macrochirus	Bluegill
L. microlophus	Redear sunfish
L. gibbosus x L. microlophus	Pumpkinseed-redear sunfish hybrid

Appendix A
(Continued)

Family and Scientific Name	Common Name
Micropterus dolomieu	Smallmouth bass
M. punctulatus	Spotted bass
M. salmoides	Largemouth bass
Pomoxis annularis	White crappie
P. nigromaculatus	Black crappie
Percidae (perches)	
Etheostoma blennioides	Greenside darter
E. nigrum	Johnny darter
E. zonale	Banded darter
Perca flavescens	Yellow perch
Percina caprodes	Logperch
P. copelandi	Channel darter
Sander canadense	Sauger
S. vitreum	Walleye
S. canadense x S. vitreum	Saugeye
Sciaenidae (drums)	
Aplodinotus grunniens	Freshwater drum

[1]Nomenclature follows Robins, et al. (1991)