WBN2Public Resource

From: Boyd, Desiree L [dlboyd@tva.gov]
Sent: Monday, May 02, 2011 8:14 AM
To: Epperson, Dan; Poole, Justin; Raghavan, Rags; Milano, Patrick; Campbell, Stephen
Cc: Crouch, William D; Hamill, Carol L; Boyd, Desiree L; Bryan, Robert H Jr
Subject: TVA letter to NRC_04-29-11_IPS Flow Response
Attachments: 04-29-11_IPS Flow Response_Final.pdf

Please see attached TVA letter that was sent to the NRC today.

Thank You,

~*~*~*~*~*~*~*~*~*~*~*~*~*~*~*~

Désireé L. Boyd
WBN 2 Licensing Support
Sun Technical Services
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423-365-8764
~*~*~*~*~*~*~*~*~*~*~*~*~*~*~*~

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Subject: TVA letter to NRC_04-29-11_IPS Flow Response
Sent Date: 5/2/2011 8:13:48 AM
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April 29, 2011

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555-0001

Watts Bar Nuclear Plant, Unit 2	10 CFR 51.50
NRC Docket No. 50-391	10 CFR 51.92

Subject: Watts Bar Nuclear Plant (WBN) Unit 2 - Intake Pumping Station Water Velocity – Response to Request for Additional Information

This letter responds to a staff verbal request for additional information (RAI) regarding the Intake Pumping Station Flow Rates used for environmental reviews. This RAI was clarified during an April 15, 2011, phone call.

Enclosure 1 provides the response to the RAI. Enclosure 2 provides revised TVA study "Fish Impingement at Watts Bar Nuclear Plant Intake Pumping Station Cooling Water Intake Structure during March 2010 through March 2011," dated April 2011.

There are no new commitments made in this letter. If you have any questions, please contact Bill Crouch at (423) 365-2004.

I declare under penalty of perjury that the foregoing is true and correct. Executed on the 29th day of April, 2011.

Respectfully,

David Stinson
Watts Bar Unit 2 Vice President

<u>Enclosures</u>:

1. Response to IPS Water Velocity RAI

2. Fish Impingement at Watts Bar Nuclear Plant Intake Pumping Station Cooling Water Intake Structure during March 2010 through March 2011, Revised April 2011

cc (Enclosures):

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ENCLOSURE 1

Response to IPS Water Velocity RAI

Tennessee Valley Authority - Watts Bar Nuclear Plant - Unit 2, Docket No. 50-391

The NRC noted that different flow rates associated with the intake pumping station (IPS) were being used in the following:

- the value in the Environmental Impact Statement (Reference 2, Section 5.4.2) ,
- the value for the fish impingement studies (Reference 3, Table 1 pg. 10), and
- the value being used for state permits (Reference 4, pg 4).

TVA agrees that there were different bases for the numbers (nominal vs. maximum flows, nominal vs. minimum seasonal pool level, etc.). It has been concluded that using a single basis is feasible and is not unduly conservative. Reference 1 was revised to provide the basis for the water velocity values. The information shown below was developed using the new basis.

Dual Unit Operation

	Summer pool (681 ft above mean sea level)	**Winter pool (677 ft above mean sea level)**
Intake entrance velocity	0.17 fps	0.18 fps
Approach velocity (in front of screen)	0.4 fps	0.37 fps
Through-screen velocity	0.62 fps	0.67 fps
Flow rates used for developing velocities	73 cfs	68 cfs
Total Intake Pumping Station Flow	134 cfs	113 cfs

The values in the table are more representative of upper limit values than the nominal values typically used for such reports. Specifically, the flow rates are based on the maximum number of pumps in service from operational data, and pool elevations are set at the lower bound for the time of year based on historical pool level data. The IPS is designed with two independent bays. One bay has more pumps than the other and thus a higher flow rate. The flow values used to determine the velocities are based on the bay with more pumps. The velocities shown are applicable to either one or two unit operation.

TVA is preparing an amended page to the National Pollutant Discharge Elimination System (NPDES) permit request to send to the Tennessee Department of Environment and Conservation that includes the 0.67 feet per second (fps) through screen velocity shown above. The Environmental Impact Statement (Reference 2) includes a value of 0.4 fps for the velocity near the intake pumping station openings. This value is not being changed as it is consistent with the values shown above. The values shown above were used in the April revision of Reference 3 being submitted with this response.

ENCLOSURE 1

Response to IPS Water Velocity RAI

Tennessee Valley Authority - Watts Bar Nuclear Plant - Unit 2, Docket No. 50-391

References:

1. TVA Calculation EPMRCP052992, R2, “Sizing of Traveling Water Screen”

2. NUREG 0498 – “Final Environmental Statement Relative to the Operation of Watts Bar Nuclear Plants Nos. 1 and 2,” dated May 1978

3. Watts Bar Nuclear Plant (WBN) Unit 2 – Additional Information Related To U.S. Nuclear Regulatory Commission (NRC) Environmental Review (TAC NO. MD8203), Enclosure 1, “Fish Impingement at Watts Bar Nuclear Plant Intake Pumping Station Cooling Water Intake Structure during March 2010 through March 2011”

4. TVA Letter to Dr. Richard Urban, PhD, “Tennessee Valley Authority (TVA) – Watts Bar Nuclear Plant (WBN) – NPDES Permit No. TN0020168 – Permit Modification Request – Addition of Unit 2 Operation,” dated August 17, 2010

ENCLOSURE 2

Fish Impingement at Watts Bar Nuclear Plant Intake Pumping Station Cooling Water Intake Structure during March 2010 through March 2011, Revised April 2011

Tennessee Valley Authority - Watts Bar Nuclear Plant - Unit 2, Docket No. 50-391

Fish Impingement at Watts Bar Nuclear Plant Intake Pumping Station Cooling Water Intake Structure during March 2010 through March 2011

TENNESSEE VALLEY AUTHORITY

ENVIRONMENTAL STEWARDSHIP AND POLICY

Revised April 2011

Changes made from the previous version of this document:

In the previous version of this document, values provided for intake velocity (in front of screen), through-screen velocity, and average flow rate were derived using certain preliminary assumptions (e.g., summer and winter water levels, number of intake pumping station pumps in service) regarding operation of Units 1 and 2. Since issuance of the prior version, TVA recognized the need for consistency in these values and in response developed a standard set of assumptions for two-unit operation which will be used for the calculation of the velocities and flow rate in future relevant studies and documents. In addition, the updated values are more conservative in that they are representative of upper limit values rather than the nominal values typically used for such reports. Specifically, the average flow rates are based on the maximum number of intake pumping station pumps in service and Chickamauga Reservoir pool elevations are set at the lower bound for the time of year based on historical data. Because the differences between the preliminary and current standard assumptions were minor, use of the new standard values resulted in only small differences between resultant impingement values in the previous and updated versions of this report. Velocity and flow rate values derived using the current standard assumptions are reflected in this updated version.

Additional changes included in this updated version include:

- In the previous version, "Intake velocity (in front of screen)" was used to identify velocity at the entrance to the IPS. In the updated version, this was changed to "intake opening velocity (at entrance to IPS)" to more clearly describe the location being measured

- In this updated version, "Screen approach velocity (in front of screen)" and corresponding values were added to characterize the velocity in the IPS channel in front of the screen. These values had not been included in the previous version.

- In the previous version, values for intake opening velocity (at entrance to IPS), through-screen velocity, average flow rate, and percent hydraulic entrainment were separated by operation of Unit 1 only and both Units 1 and 2. In this updated version, the aforementioned values, along with screen approach velocity (in front of screen), were separated by summer and winter pool elevations and by operation of Unit 1 only and both Units 1 and 2.

Table of Contents

List of Figures

List of Tables

List of Acronyms and Abbreviations

CCW	**Condenser Cooling Water**
CWA	**Clean Water Act**
EPA	**Environmental Protection Agency**
EPRI	**Electric Power Research Institute**
FPS	**Feet Per Second**
GPM	**Gallons Per Minute**
IPS	**Intake Pumping Station**
MSL	**Mean Sea Level**
MW	**Megawatts**
NPDES	**National Pollutant Discharge Elimination System**
RFAI	**Reservoir Fisheries Assemblage Index**
TRM	**Tennessee River Mile**
TVA	**Tennessee Valley Authority**
VS	**Vital Signs**
WBH	**Watts Bar Hydroelectric Plant**
WBN	**Watts Bar Nuclear Plant**

Introduction

Tennessee Valley Authority (TVA) is conducting additional monitoring during 2010–2011 in Chickamauga Reservoir to estimate annual impingement mortality of fish in the vicinity of Watts Bar Nuclear Plant (WBN) due to the proposed operation of WBN Reactor Unit 2 at the Plant site. The National Pollutant Discharge Elimination System (NPDES) Permit No. TN0020168 for WBN is subject to compliance with the Federal Clean Water Act (CWA). Section 316(b) of the CWA requires the location, design, construction, and capacity of cooling water intake structures to reflect the best technology available for minimizing adverse environmental impacts. A potential impact associated with cooling water intake structures is impingement of aquatic organisms. Impingement occurs when fish and shellfish are trapped against intake screens by the force of cooling water withdrawal. Impingement data were collected during March 2010 through March 2011 to update baseline data collected during the same period 1996 through 1997 (both sampling periods during operation of Unit 1) and to assess potential impingement impacts from the proposed operation of WBN Unit 2. This report presents annual impingement data collected from the Condenser Cooling Water (CCW) intake screens during March 2010 through March 2011.

Plant Description

WBN is located on the right descending (west) bank of upper Chickamauga Reservoir at Tennessee River Mile (TRM) 528 approximately 1.9 miles downstream of Watts Bar Hydroelectric Dam (WBH; TRM 529.9) and one mile downstream of the idled Watts Bar Fossil Plant (Figure 1). Commercial operation of WBN Unit 1 began on May 27, 1996 and is designed for a net electrical output of 1,160 megawatts (MW; gross electrical output of 1,218 MW).

Cooling water flows from Chickamauga Reservoir through the plant intake channel to the intake pumping station (IPS) located approximately 1.9 miles downstream of Watts Bar Dam at TRM 528 (Figure 1). WBN Unit 1 and proposed Unit 2 use closed-cycle cooling such that the cooling water withdrawn at the intake pumping station is to make-up for evaporation of cooling tower blowdown. The intake channel leading to the pumping station has a cross-sectional area of approximately 1,650 ft^2 at a Chickamauga Reservoir summer pool elevation of 681 ft mean sea level (msl), and 3,150 ft^2 at a winter pool elevation of 677 ft msl. The IPS includes four gated openings containing a combined gross flow area of approximately 360 ft^2, producing an intake opening velocity (at entrance of IPS) of 0.17 fps at summer pool and 0.18 fps at winter pool. The approach screen velocity (in front of screen) at summer and winter pools is 0.40 and 0.37 fps, respectively. At the traveling water screens, the combined unobstructed through-screen area of the flow corresponding to the gated openings is reduced to approximately 140 ft^2, producing an average through-screen velocity of 0.62 fps at summer pool and 0.67 fps at winter pool. The average flowrate at the IPS for WBN Unit 1 only is approximately 73 cubic feet per second (cfs) at summer pool and 68 cfs at winter pool. Percent hydraulic entrainment for Unit 1 only at summer and winter pools is 0.3% of the long-term average river flow (about 27,000 cfs) past the plant. With the operation of both Unit 1 and proposed Unit 2, the average flow rate at the IPS at summer pool is expected to be 134 cfs, or 0.5% of the long-term average river flow past the plant. At winter pool, the average flow rate with operation of both Unit 1 and proposed Unit 2 is expected to be 113 cfs, or 0.4% of the long term average river flow (Table 1).

Methods and Analysis

Impingement

Impingement data presented in this report represent weekly samples collected from March 26, 2010 through March 17, 2011. Quality Assurance/Quality Control procedures for impingement sampling (TVA 2004) were followed to ensure sampling was consistent with historical impingement monitoring methods used during 1996 through 1997.

Impinged fish were collected after each routinely scheduled weekly 24-hour screen washes. TVA's Biological and Water Resources (B&WR) crew removed impinged fish that were washed into a fish collection basket (Figure 1). Fish were sorted from debris, identified, separated into 25-mm (1-in) length classes, enumerated, and weighed. Any fish collected alive were returned to the reservoir after processing. Incidental numbers of fish which appeared to have been dead for more than 24 hours (i.e., exhibiting pale gills, cloudy eyes, fungus, or partial decomposition) were not included in the sample. Data recorded by one member of the B&WR crew was checked and verified (signed) by the other for quality control.

Estimated weekly and annual impingement rates were calculated by extrapolating impingement rates from 24-hr samples [i.e., 24-hr sample x 7 days (weekly) x 52 weeks (annual)].

Fish Community Assessment - RFAI

The health of the fish community in the vicinity of WBN, with Unit 1 operating, was assessed using a standardized index. Prior to 2000, WBN was operating under a 316(a) Alternative Thermal Limit (ATL) that had been continued with each permit renewal based on studies conducted in the mid-1970s. In 1999, EPA Region IV began requesting additional data in conjunction with NPDES permit renewal applications to verify that a "Balanced Indigenous Population" (BIP) of fish and shellfish was being maintained at TVA's thermal plants with ATLs. TVA proposed that its existing Vital Signs (VS) monitoring program, supplemented with additional fish and benthic macroinvertebrate community monitoring upstream and downstream of thermal plants with ATLs, was appropriate for that purpose. The VS monitoring program began in 1990 in the Tennessee River System. This program was implemented to evaluate ecological health conditions in major reservoirs as part of TVA's stewardship role. One of five indicators used in the VS program to evaluate reservoir health is the Reservoir Fish Assemblage Index (RFAI) methodology. RFAI has been thoroughly tested on TVA and other reservoirs and published in peer-reviewed literature (Jennings, et al., 1995; Hickman and McDonough, 1996; McDonough and Hickman, 1999).

TVA initiated a study to evaluate fish communities in areas immediately upstream and downstream of WBN during 1999–2010 using RFAI multi-metric evaluation techniques. This report presents the results of autumn RFAI data collected in the vicinity and downstream of WBN during autumn 1999–2010 to illustrate the health and stability of the fish community in Chickamauga Reservoir (TVA, 2011).

Results and Discussion

Impingement
Weekly impingement sampling at WBN from March 26, 2010 through March 17, 2011, resulted in collection of 1,939 fish, comprising three species (Table 2). Gizzard shad were predominant in the samples (60.4%) followed by threadfin shad (39.5%) and inland silverside (0.1%). Historical impingement monitoring at WBN conducted during March 1996 through March 1997 resulted in the collection of 16 fish representing eight species. Gizzard shad, threadfin shad, bluegill, white crappie and freshwater drum comprised 81.3% of fish impinged during March 1996 through March 1997 monitoring (Table 2). The rate of impingement was highest during January through March 2011 (99.6%). The two largest samples were collected during the second and fourth weeks in February 2011 and contained 618 and 613 fish (extrapolated weekly estimates of 4,326 and 4,291), respectively, comprising 63.5% of the total fish collected for the year (Table 3, Figure 2). Gizzard shad comprised 61.8% and threadfin shad 38.2% of these two samples.

Annual extrapolated estimates of numbers impinged by species for 1996–1997 and 2010–2011 are presented in Table 4. Estimated annual impingement for 2010–2011 (13,573) was significantly higher than that estimated for 1996–1997 (161). The difference in numbers between years was due to larger numbers of gizzard and threadfin shad collected during cold-weather months of January through March 2011. Most (99.9%) of the fish impinged during this period were gizzard and threadfin shad. The timing of this peak impingement period and species composition of fish impinged suggests stress and cold-shock. This is a common and natural phenomenon observed during colder winter months at fossil and nuclear facilities in TVA and other southeastern reservoirs (Loar, 1978; McLean et al., 1980; McLean et al., 1985). Shad are noticeably affected by temperature becoming lethargic and moribund when temperatures fall below 50°F, making them more susceptible to impingement. Shad cannot tolerate drastic temperature changes and typically experience winter die-offs when water temperatures are between 40–55°F, particularly when the change in temperature is quick and drastic (Griffith, 1978 and Fost, 2006). Threadfin and/or gizzard shad typically comprise over 90% of fish impinged on cooling water intake screens of thermal power stations in the Southeastern United States (Loar, 1978). Referenced literature (McLean et al., 1980) has shown that climate-controlled events such as winter shad kills will occasionally occur but populations of the two affected species are able to recover in a relatively short time.

Water temperatures collected at WBN during November 2010 through March 2011 were compared to those during the same period 1996 through1997. Daily water temperatures for December 2010 and January, February, and March 2011 averaged 1.4, 2.3, 1.5 and 3.2°F lower, respectively, than corresponding months in 1996 and 1997. From November 2010 to January 2011, averages of daily water temperatures decreased 17.5°F compared to 11.9°F during the same period in 1996 through 1997 (Table 5; Figure 3). This large and rapid decrease in water temperatures during November 2010 to January 2011 could have stressed shad causing them to become lethargic and moribund. It is likely that cold-stressed shad would possibly require 2-3 weeks of regular exposure to low water temperatures before being collected in samples, as illustrated in Figure 2. Any lethargic or moribund shad in the forebay of Watts Bar Dam would have been vulnerable to passage through the dam during generation. The continued decline of water temperatures into January, consistently low water temperatures in January and February (Figures 2 and 3), and/or passage through the dam could have caused further decline in condition and die-offs increasing their susceptibility to impingement at the WBN IPS. Some fish could actually be impinged after dying but cold temperatures could have delayed decomposition causing them to not be recognized as dead prior to impingement.

Fish Community Assessment - RFAI

In 2010, fish community RFAI scores of 44 ("Good"), 39 ("Fair") and 40 ("Fair") were observed at three sites in Chickamauga Reservoir: in the vicinity of WBN at TRM 529 (near-field), the Transition zone of the reservoir at TRM 490.5 and Forebay of Chickamauga Dam at TRM 482 (far-field), respectively (Table 6). Scores at these three sites were within 6 points of each other and met criteria to be considered similar (TVA, 2011). The RFAI was not used in 1996–1997 so there is not a direct comparison with 2010–2011, but average scores also rated "Good" for 1999–2010 and ranged from 44 to 45 (Table 6).

Summary and Conclusions

Proposed operation of Unit 2, given that both units would only withdraw water through the IPS to provide make-up for evaporation of cooling tower blowdown, would increase average flow rates and percent hydraulic entrainment to values shown in Table 1. It could be assumed that numbers of impinged fish could increase proportionally to average flowrates which would expand numbers impinged by the ratio of 73 to 134 cfs at summer pool or 68 to 113 cfs at winter pool (Table 1). Lethargic, moribund, or dead shad would be drifting without much, if any, maneuverability and could be passively drawn to the IPS. However, considering the unpredictability of the environmental factors which influence cold-shock in shad, it is nearly impossible to estimate numbers of fish that will be impinged at WBN after the addition of Unit 2. Therefore, it is suggested that impingement at the WBN IPS with two-unit operation would be driven more by the severity of cold-shock or winter-kills of shad rather than the projected increase in flow values, given the increased impingement observed during winter 2011 from that of winter 1997 with one-unit operation.

Historical impingement estimated from WBN during the winter of 1997 was extremely low compared to that observed during the winter of 2011. Colder climatic conditions and probable cold-shock events during winter 2010–2011 appear to be the major factors in the increased impingement. Aside from occasional and uncontrollable cold-shock events, estimated numbers and species composition of impinged fish, low projected maximum flow rate (134 cfs or 0.5% of average river flow) and through-screen velocity (0.67 fps), and "Good" ratings for the adult fish community in Chickamauga Reservoir suggest that proposed operation of two units at WBN will not affect the health and structure of the downstream reservoir fish community.

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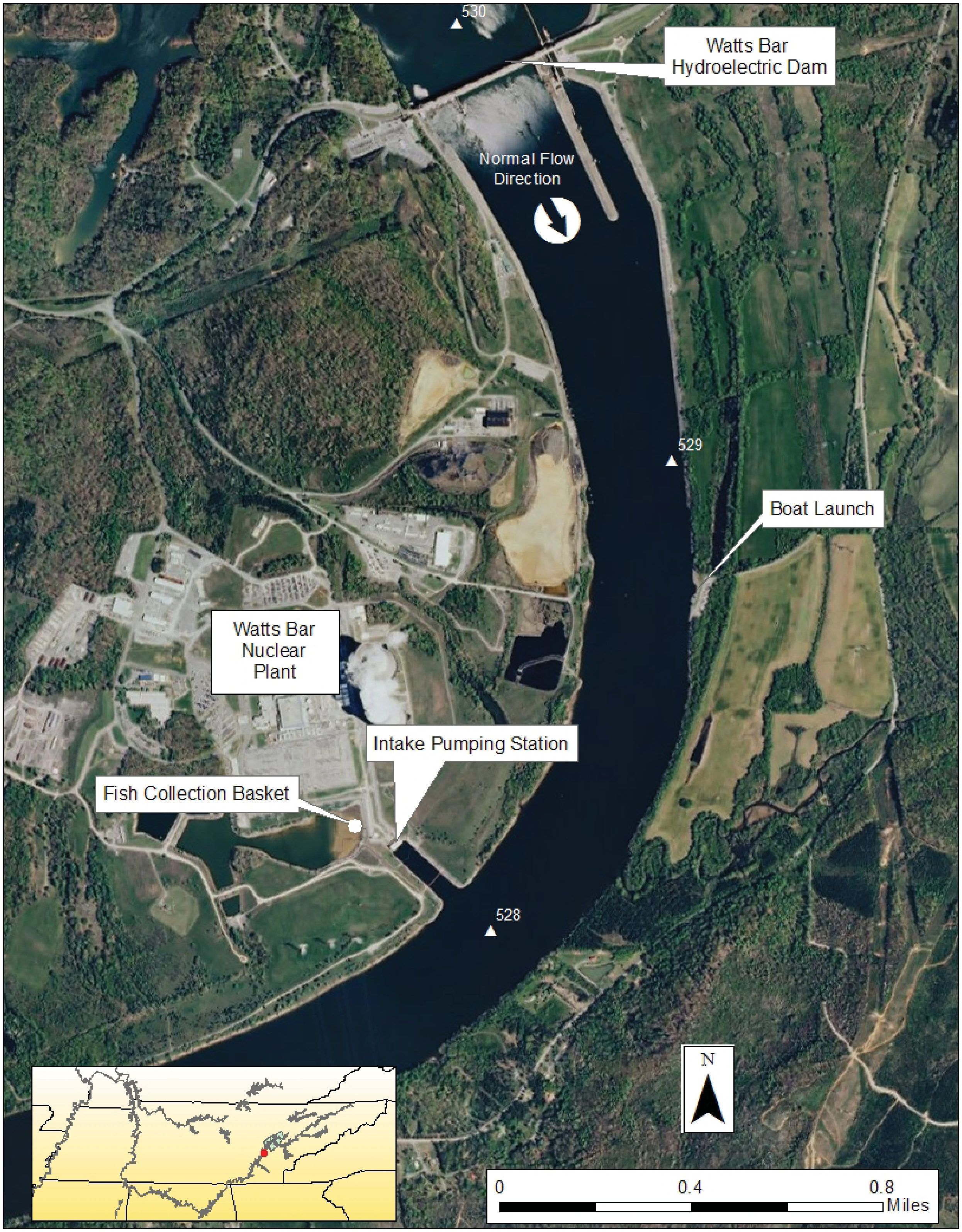

Figure 1. Location of Watts Bar Nuclear Plant, Watts Bar Hydroelectric Dam, Fish Collection Basket, and Intake Pumping Station.

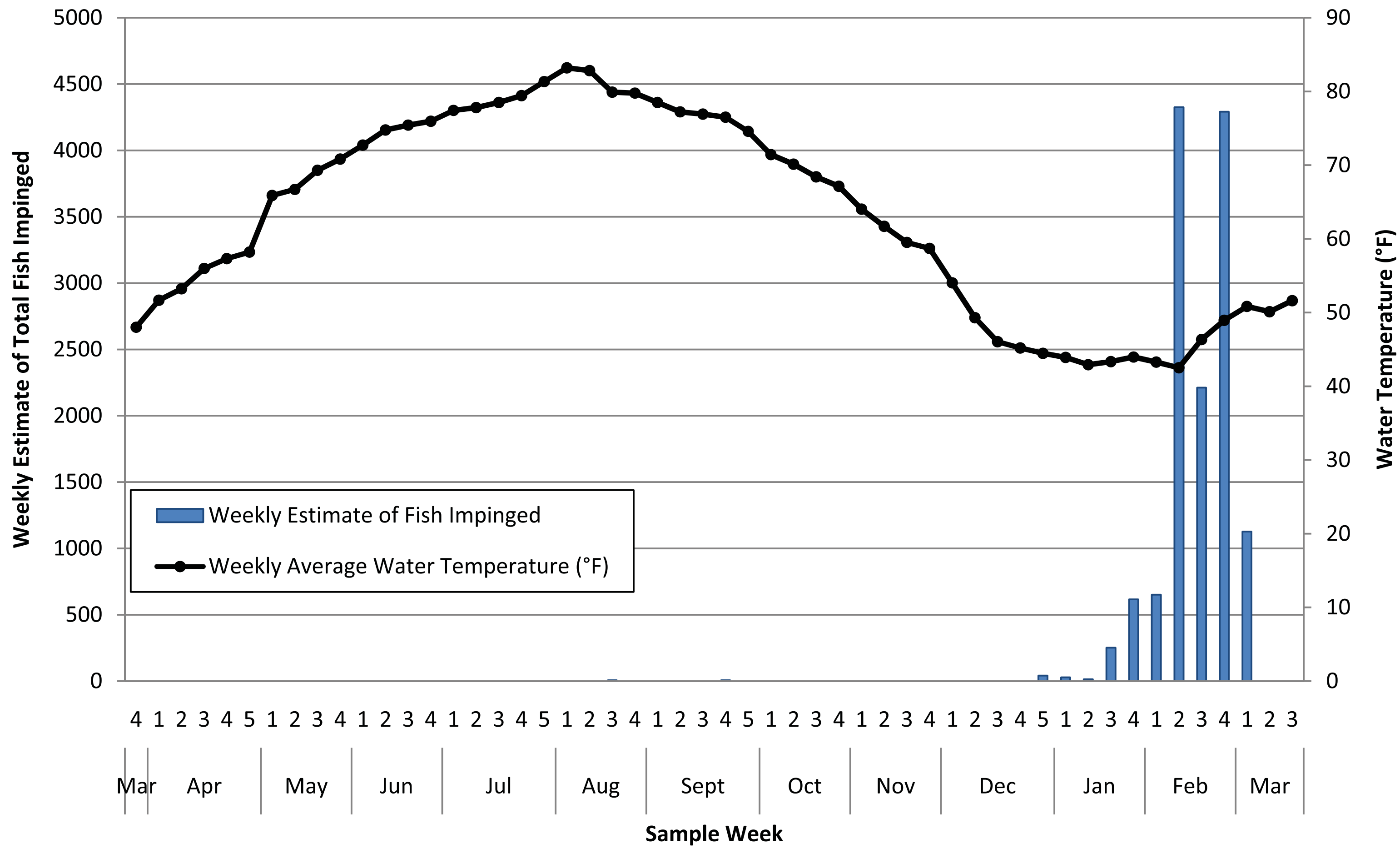

Figure 2. Estimated Weekly Fish Impingement and Weekly Average Water Temperatures (°F) at the WBN Intake Pumping Station, March 26, 2010 Through March 17, 2011.

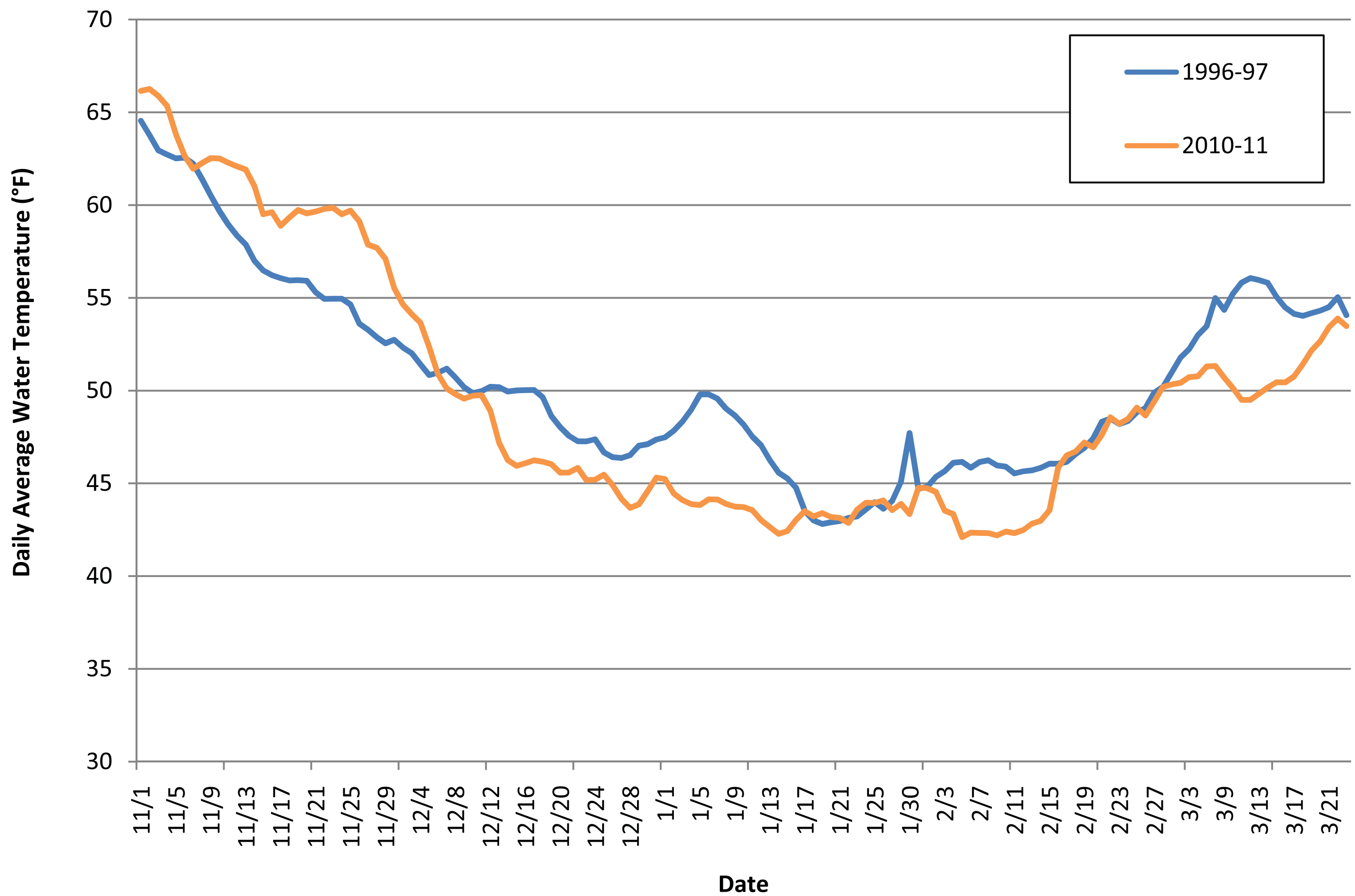

Figure 3. Daily Average Water Temperatures (°F) Collected from Chickamauga Reservoir in the Vicinity of WBN during November 1996 through March 1997 and November 2010 through March 2011.

Table 1. Comparison of Intake Opening, Screen Approach, and Through-Screen Velocities, Average Flow Rates, Percent Hydraulic Entrainment (Percent of River Flow) Past WBN's Intake Pumping Station at Summer and Winter Pool Elevations and during Operation of Unit 1 Only and Expected Values during Operation of Units 1 and 2 Combined.

	Summer Pool (681 msl)		Winter Pool (677 msl)	
	Unit 1 only	**Units 1 and 2 combined**	**Unit 1 only**	**Units 1 and 2 combined**
Intake opening velocity (at entrance of IPS)	0.17 fps	0.17 fps	0.18 fps	0.18 fps
Screen approach velocity (in front of screen)	0.40 fps	0.40 fps	0.37 fps	0.37 fps
Through-screen velocity	0.62 fps	0.62 fps	0.67 fps	0.67 fps
Average flow rates	73 cfs	134 cfs	68 cfs	113 cfs
***Percent hydraulic entrainment**	0.3%	0.5%	0.3%	0.4%

*Percent hydraulic entrainment based on long-term average river flow past WBN of 27,000 cfs.

Table 2. List of Fish Species by Family, Scientific, and Common Name Including Actual Numbers and Percent Composition Collected in Impingement Samples During March 1996 through March 1997 and March 26, 2010 Through March 17, 2011 at TVA's Watts Bar Nuclear Plant.

Family	Scientific Name	Common Name	3/1996 - 3/1997		3/26/2010 - 3/17/2011	
			Total Number Impinged	Percent Composition	Total Number Impinged	Percent Composition
Clupeidae	*Dorosoma cepedianum*	Gizzard shad	4	25.0%	1,172	60.4%
	Dorosoma petenense	Threadfin shad	2	12.5%	766	39.5%
Ictaluridae	*Ictalurus punctatus*	Channel catfish	1	6.3%	---	0.0%
	Pylodictus olivaris	Flathead catfish	1	6.3%	---	0.0%
Centrarchidae	*Lepomis macrochirus*	Bluegill	2	12.5%	---	0.0%
	Lepomis microlophus	Redear sunfish	1	6.3%	---	0.0%
	Pomoxis annularis	White crappie	2	12.5%	---	0.0%
Sciaenidae	*Aplodinotus grunniens*	Freshwater drum	3	18.8%	---	0.0%
Atherinopsidae	*Menidia beryllina*	Inland silverside	---	-	1	0.1%
		Total Number of Fish	**16**		**1,939**	
		Total Number of Species	**8**		**3**	
		Total Number of Sample Days	**52**		**52**	

Table 3. Actual Numbers and Weekly Estimates and Percent of Annual Total of Fish Impinged at Watts Bar Nuclear Plant by Month During March 26, 2010 Through March 17, 2011.

Year	Month	Week	Actual Numbers Impinged	Estimated Weekly Numbers Impinged	Percent of Annual Total
2010	March	4	0	0	0.0%
	April	1	0	0	0.0%
		2	0	0	0.0%
		3	0	0	0.0%
		4	0	0	0.0%
		5	0	0	0.0%
	May	1	0	0	0.0%
		2	0	0	0.0%
		3	0	0	0.0%
		4	0	0	0.0%
	June	1	0	0	0.0%
		2	0	0	0.0%
		3	0	0	0.0%
		4	0	0	0.0%
	July	1	0	0	0.0%
		2	0	0	0.0%
		3	0	0	0.0%
		4	0	0	0.0%
		5	0	0	0.0%
	August	1	0	0	0.0%
		2	0	0	0.0%
		3	1	7	0.1%
		4	0	0	0.0%
	September	1	0	0	0.0%
		2	0	0	0.0%
		3	0	0	0.0%
		4	1	7	0.1%
		5	0	0	0.0%
	October	1	0	0	0.0%
		2	0	0	0.0%
		3	0	0	0.0%
		4	0	0	0.0%
	November	1	0	0	0.0%
		2	0	0	0.0%
		3	0	0	0.0%
		4	0	0	0.0%
	December	1	0	0	0.0%
		2	0	0	0.0%

Table 3. (Continued)

Year	Month	Week	Actual Numbers Impinged	Estimated Weekly Numbers Impinged	Percent of Annual Total
		3	0	0	0.0%
		4	0	0	0.0%
		5	6	42	0.3%
2011	January	1	4	28	0.2%
		2	2	14	0.1%
		3	36	252	1.9%
		4	88	616	4.5%
	February	1	93	651	4.8%
		2	618	4,326	31.9%
		3	316	2,212	16.3%
		4	613	4,291	31.6%
	March	1	161	1,120	8.3%
		2	0	0	0.0%
		3	0	0	0.0%
	Total (Annual)	**52**	**1,939**	**13,573**	**100%**

Table 4. Estimated Annual Numbers and Percent Composition of Fish Impinged by Species at Watts Bar Nuclear Plant During March 1996 Through March 1997 and March 26, 2010 Through March 17, 2011.

Species	3/1996 - 3/1997		3/26/2010 - 3/17/2011	
	Estimated Number	Percent Composition by Number	Estimated Number	Percent Composition by Number
Gizzard shad	41	25.0%	8,204	60.4%
Threadfin shad	20	12.5%	5,362	39.5%
Channel catfish	30	18.8%		0.0%
Flathead catfish	10	6.3%		0.0%
Bluegill	10	6.3%		0.0%
Redear sunfish	20	12.5%		0.0%
White crappie	10	6.3%		0.0%
Freshwater drum	20	12.5%		0.0%
Inland silverside	---	---	7	0.1%
Total	**161**	**100%**	**13,573**	**100%**

Table 5. Comparison of Daily Average Water Temperatures (°F) Collected from Watts Bar Reservoir in the Vicinity of WBN During November 1996 Through March 1997 and November 2010 Through March 2011.

	Daily Average Water Temperatures (°F)		
Period	**1996–1997**	**2010–2011**	**Difference**
November	57.9	61.2	3.3
December	49.2	47.8	-1.4
January	45.9	43.6	-2.3
February	46.8	45.3	-1.5
March	54.3	51.1	-3.2
November – March	50.6	49.7	-0.9
December – January	47.6	45.8	-1.8
December – February	47.4	45.6	-1.8
January – February	46.4	44.4	-2.0

Table 6. Summary of RFAI Scores from Fish Community Sample Sites Located Downstream of Watts Bar Nuclear Plant 1999-2010 as Part of the Vital Signs Monitoring Program in Chickamauga Reservoir.

Station	Location	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Average
Downstream Inflow (Near-Field)	TRM 529.0	42	44	46	48	48	42	42	42	42	44	44	44	**45 (Good)**
Transition (Far-Field)	TRM 490.5	45	46	45	51	42	49	46	47	44	34	41	39	**44 (Good)**
Forebay (Far-Field)	TRM 472.3	45	45	48	46	43	43	46	43	41	41	42	40	**44 (Good)**

RFAI Scores: 12-21 (“Very Poor”), 22-31 (“Poor”), 32-40 (“Fair”), 41-50 (“Good”), or 51-60 (“Excellent”).