TVA TENNESSEE VALLEY AUTHORITY

1101 Market Street, BR 2C, Chattanooga, Tennessee 37402

Sent Via Electronic Transmittal

January 27, 2025

Mr. Vojin Janjić (Water.Permits@tn.gov)
Division of Water Resources
Tennessee Department of Environment
and Conservation (TDEC)
Davy Crockett Tower, 9th Floor
500 James Roberston Parkway
Nashville, Tennessee 37243

Dear Mr. Janjić:

TENNESSEE VALLEY AUTHORITY (TVA) – SEQUOYAH NUCLEAR PLANT (SQN) – NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) PERMIT NO. TN0026450 – APPLICATION FOR RENEWAL

Enclosed is the NPDES renewal application package for SQN consisting of EPA Form 1, site map, Form 2C, flow schematic, and NPDES permit address form. Historical sampling data was compiled from September 2020 to August 2024. TVA would appreciate consideration of the following in the renewed permit.

Outfall 101

1. In accordance with Part I Section 8 Narrative Requirements, enclosed is the study to confirm the calibration of the numerical model for the thermal discharge from SQN Outfall 101. There was no significant change in the model performance compared to the previous calibration.
2. Enclosed is a summary of the Reasonable Potential Evaluation and toxicity test results since 2014 showing the last 20 studies. As discussed in the enclosure, TVA requests that the current monitoring limit be replaced with an IC_{25} = 58.2%, which is consistent with the Technical Support Document for effluents demonstrating No Reasonable Potential.
    a. In 2015, TVA received approval to use UV treatment on the effluent during Whole Effluent Toxicity testing for Fathead Minnows and requests that the approved treatment is referenced in the reissued permit. Enclosed is a copy of the 2015 approval.
3. TVA requests continuation of the 316(a) Alternate Thermal Limit (ATL) as incorporated in the current permit. Based on the results summarized in the enclosed Reservoir Fish Assemblage Index Report, TVA believes that thermal discharges from SQN have not had a negative effect on the balanced indigenous fish population in Chickamauga Reservoir. Enclosed is a copy of the most recent report for biological monitoring of the Tennessee River near SQN discharge during summer and autumn 2022.

IE25
NRR

4. Based on compliance reliability, TVA requests the monitoring frequency for pH at Outfall 101 be reduced from once per week to once per month.

Biocide/Corrosion Treatment Plan (B/CTP)

As required by Part IV, Section D of the permit, enclosed is the current B/CTP. There are no changes to the B/CTP since the approved 2020 B/CTP submittal.

Clean Water Act Section 316(b) Impingement

In accordance with 40 CFR § 125.95(c), TVA submitted a letter to Tennessee Department of Environment and Conservation (TDEC) on July 25, 2022 requesting reduced application information required in permit TN0026450 on the basis that the source water, intake structure, cooling water system, and operating conditions remain substantially unchanged from the information submitted with the permit application on June 29, 2018 and upon which TDEC's BTA determination for entrainment was made. TDEC responded to TVA in a letter on July 27, 2022, granting a waiver for the required cooling water intake structure and waterbody application information to be submitted with the next renewal permit application.

Prior to the above waiver, on January 27, 2021, in accordance with Part I.A.7. of the facility NPDES permit and 40 CFR § 122.21(r)(6), TVA submitted its chosen method of compliance for impingement controls for both SQN's essential raw cooling water intake (ERCW) and condenser circulating water (CCW) intake. The ERCW intake withdraws water at less than 0.5 foot per second; therefore, TVA chose to comply with the option at 40 CFR 125.94(c)(3), to operate the cooling water intake structure with maximum through-screen intake velocity of 0.5 foot per second. Enclosures were provided including an engineering work record with associated references demonstrating the through-screen intake velocity at the ERCW intake is less than 0.5 foot per second.

In the same letter, TVA chose to comply with the option at 40 CFR 125.94(c)(5) by installing and operating modified traveling screens (MTWS) at the CCW intake structure. Included was a compliance schedule to complete the design, procurement, installation, and optimization of the MTWS at the CCW intake structure. Due to specific installation challenges around planned unit outages, the SQN project team has had to modify the original timeline. The updated schedule below, provided by the project team to align with planned unit outages, accurately reflects the current and expected completion milestones of the remainder of the project. Because this is TVA's first MTWS project which could lead to slight schedule changes in the future based on lessons learned, TVA requests that this the timeline is not incorporated into the permit but is utilized for informational purposes only.

Milestone Activity	Conceptual Start	Conceptual Complete
Establish Project	Complete	Complete
Select TWS Vendor	Complete	Complete
Fish Return Modeling	Complete	Complete
Engineering Scoping and Design	May 2021	February 2025
Order TWS Assemblies and spares	Complete	Complete
Constructability Review	December 2021	February 2025
Prepare Unit 1 Modifications Work Plan	December 2021	January 2025
Receive Unit 1 TWS Assemblies	Complete	Complete
Prepare Unit 2 Modifications Work Plan	June 2022	April 2025
Install Unit 1 TWS	January 2025	October 2025
Receive Unit 2 TWS Assemblies	Complete	Complete
Install Unit 2 TWS	June 2025	February 2025
Develop Performance Optimization Study Plan	January 2026	August 2026
Implement Performance Optimization Study	October 2026	October 2028
Complete Performance Optimization Study Report	November 2028	April 2029
Submit Performance Optimization Study to TDEC		April 30, 2029

If you have questions or need additional information, please contact Callan Pierson by email at cpierson@tva.gov.

Sincerely,

Paul Pearman

Paul Pearman
Senior Manager
Water Permits, Compliance, and Monitoring

Enclosure

cc (Electronic Distribution w/ Enclosures):

Ms. Jennifer Innes (Jennifer.Innes@tn.gov)
Program Manager
Chattanooga Environmental Field Office
Division of Water Resources
1301 Riverfront Parkway, Suite #206
Chattanooga, Tennessee 37402

Ms. Sarah Terpstra (sarah.terpstra@tn.gov)
Division of Water Resources
Tennessee Department of Environment
and Conservation (TDEC)
Davy Crockett Tower, 9th Floor
500 James Robertson Parkway
Nashville, Tennessee 37243

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555

EPA Identification Number	NPDES Permit Number	Facility Name	OMB No. 2040-0004 Expires 07/31/2026
TN5640020504	TN0026450	Sequoyah Nuclear Plant (SQN)	

Form 1 NPDES

EPA

U.S. Environmental Protection Agency
Application for NPDES Permit to Discharge Wastewater

GENERAL INFORMATION

SECTION 1. ACTIVITIES REQUIRING AN NPDES PERMIT (40 CFR 122.21(F) AND (F)(1))

Activities Requiring an NPDES Permit

1.1 Applicants *Not Required* to Submit Form 1

1.1.1	Is the facility a new or existing publicly owned treatment works or has your permitting authority directed you to submit Form 2A? If yes, STOP. Do NOT complete Form 1. Complete Form 2A. If the facility is also a treatment works treating domestic sewage, you must also complete Form 2S. ☑ No	1.1.2	Is the facility a sludge-only facility (i.e., a facility that does not discharge wastewater to surface waters)? If yes, STOP. Do NOT complete Form 1. Complete Form 2S. ☑ No

1.2 Applicants *Required* to Submit Form 1

1.2.1	Is the facility a concentrated animal feeding operation or a concentrated aquatic animal production facility? ☐ Yes → Complete Form 1 ***and*** Form 2B. ☑ No	1.2.2	Is the facility an **existing** manufacturing, commercial, mining, or silvicultural **facility** that **is currently discharging process wastewater**? ☑ Yes → Complete Form 1 ***and*** Form 2C. ☐ No
1.2.3	Is the facility a **new** manufacturing, commercial, mining, or silvicultural **facility** that has **not yet commenced to discharge**? ☐ Yes → Complete Form 1 ***and*** Form 2D. ☑ No	1.2.4	Is the facility a **new or existing** manufacturing, commercial, mining, or silvicultural **facility** that **discharges only nonprocess wastewater**? ☐ Yes → Complete Form 1 ***and*** Form 2E. ☑ No
1.2.5	Is the facility a **new or existing facility** whose discharge is composed entirely of **stormwater associated with industrial activity** or whose discharge is composed of **both stormwater and non-stormwater**? ☐ Yes → Complete Form 1 ***and*** Form 2F unless exempted by 40 CFR 122.26(b)(14)(x) or (b)(15). ☑ No	1.2.6	Is the facility a new or existing **treatment works treating domestic sewage** that discharges wastewater to surface waters? ☐ Yes → Complete Form 1, Form 2S, ***and*** any other applicable forms, as directed by your permitting authority. ☑ No

SECTION 2. NAME, MAILING ADDRESS, AND LOCATION (40 CFR 122.21(F)(2))

Name, Mailing Address, and Location

2.1 Facility Name

TVA Sequoyah Nuclear Plant

2.2 EPA Identification Number

TN5640020504

2.3 Facility Contact

Name (first and last)	Title	Phone number
Thomas B. Marshall	Vice President, SQN	(423) 843-7001

Email address

tbmarshall@tva.gov

Name, Mailing Address, and Location Continued	2.4	**Facility Mailing Address**		
		Street or P.O. box P.O. Box 2000 OPS 4A-SQN		
		City or town Soddy Daisy	State TN	ZIP code 37379
	2.5	**Facility Location**		
		Street, route number, or other specific identifier Sequoyah Access Road		
		County name Hamilton	County code (if known)	
		City or town Soddy Daisy	State TN	ZIP code 37379

SECTION 3. SIC AND NAICS CODES (40 CFR 122.21(F)(3))

SIC and NAICS Codes	3.1	**SIC Code(s)**	**Description** (optional)
		4911	Electric Services
	3.2	**NAICS Code(s)**	**Description** (optional)
		221113	Electric power generation, nuclear

SECTION 4. OPERATOR INFORMATION (40 CFR 122.21(F)(4))

Operator Information	4.1	**Name of Operator**
		Tennessee Valley Authority (TVA)
	4.2	Is the name you listed in Item 4.1 also the owner? ☑ Yes ☐ No
	4.3	**Operator Status**
		☑ Public—federal ☐ Public—state ☐ Other public (specify)______ ☐ Private ☐ Other (specify) ______
	4.4	**Phone Number of Operator**
		(423) 843-7001

Operator Information Continued	4.5	**Operator Address** Street or P.O. Box: P.O. Box 2000 OPS 4A-SQN City or town: Soddy Daisy State: TN ZIP code: 37379 Email address of operator: tbmarshall@tva.gov

SECTION 5. INDIAN LAND (40 CFR 122.21(F)(5))

Indian Land	5.1	Is the facility located on Indian Land? ☐ Yes ☑ No

SECTION 6. EXISTING ENVIRONMENTAL PERMITS (40 CFR 122.21(F)(6))

6.1 Existing Environmental Permits (check all that apply and print or type the corresponding permit number for each)

☑ NPDES (discharges to surface water) TN0026450/ TNR050015	☑ RCRA (hazardous wastes) TN5640020504	☐ UIC (underground injection of fluids)
☑ PSD (air emissions) See attached	☐ Nonattainment program (CAA)	☐ NESHAPs (CAA)
☐ Ocean dumping (MPRSA)	☐ Dredge or fill (CWA Section 404)	☑ Other (specify) DML331050021 (Inert Landfi

SECTION 7. MAP (40 CFR 122.21(F)(7))

Map	7.1	Have you attached a topographic map containing all required information to this application? (See instructions for specific requirements.) ☑ Yes ☐ CAFO—Not Applicable (See requirements in Form 2B.)

SECTION 8. NATURE OF BUSINESS (40 CFR 122.21(F)(8))

Nature of Business	8.1	Describe the nature of your business. Sequoyah Nuclear Plant (SQN) produces electric power by thermonuclear fission.

SECTION 9. COOLING WATER INTAKE STRUCTURES (40 CFR 122.21(F)(9))

Cooling Water Intake Structures	9.1	Does your facility use cooling water? ☑ Yes ☐ No → SKIP to Item 10.1.
	9.2	Identify the source of cooling water. (Note that facilities that use a cooling water intake structure as described at 40 CFR 125, Subparts I and J may have additional application requirements at 40 CFR 122.21(r). Consult with your NPDES permitting authority to determine what specific information needs to be submitted and when.) Cooling water is sourced from the TN River. As indicated in a letter to TDEC dated January 27, 2021, TVA has chosen modified traveling water screens (TWS) at the CCW intake structure and maximum through-screen intake velocity of 0.5 foot per second at the ERCW as best technology available for impingement mortality standards. TVA has constructed a fish return line and is in the process of installing the modified TWSs.

SECTION 10. VARIANCE REQUESTS (40 CFR 122.21(F)(10))

Variance Requests

10.1 Do you intend to request or renew one or more of the variances authorized at 40 CFR 122.21(m)? (Check all that apply. Consult with your NPDES permitting authority to determine what information needs to be submitted and when.)

- ☐ Fundamentally different factors (CWA Section 301(n))
- ☐ Water quality related effluent limitations (CWA Section 302(b)(2))
- ☐ Non-conventional pollutants (CWA Section 301(c) and (g))
- ☑ Thermal discharges (CWA Section 316(a))
- ☐ Not applicable

SECTION 11. CHECKLIST AND CERTIFICATION STATEMENT (40 CFR 122.22(A) AND (D))

Checklist and Certification Statement

11.1 In Column 1 below, mark the sections of Form 1 that you have completed and are submitting with your application. For each section, specify in Column 2 any attachments that you are enclosing to alert the permitting authority. Note that not all applicants are required to provide attachments.

	Column 1	Column 2	
☑	Section 1: Activities Requiring an NPDES Permit	☐ w/ attachments	
☑	Section 2: Name, Mailing Address, and Location	☐ w/ attachments	
☑	Section 3: SIC Codes	☐ w/ attachments	
☑	Section 4: Operator Information	☐ w/ attachments	
☑	Section 5: Indian Land	☐ w/ attachments	
☑	Section 6: Existing Environmental Permits	☐ w/ attachments	
☑	Section 7: Map	☑ w/ topographic map	☐ w/ additional attachments
☑	Section 8: Nature of Business	☐ w/ attachments	
☑	Section 9: Cooling Water Intake Structures	☐ w/ attachments	
☑	Section 10.: Variance Requests	☐ w/ attachments	
☑	Section 11: Checklist and Certification Statement	☐ w/ attachments	

11.2 Provide the following certification. (See instructions to determine the appropriate person to sign the application.)

Certification Statement

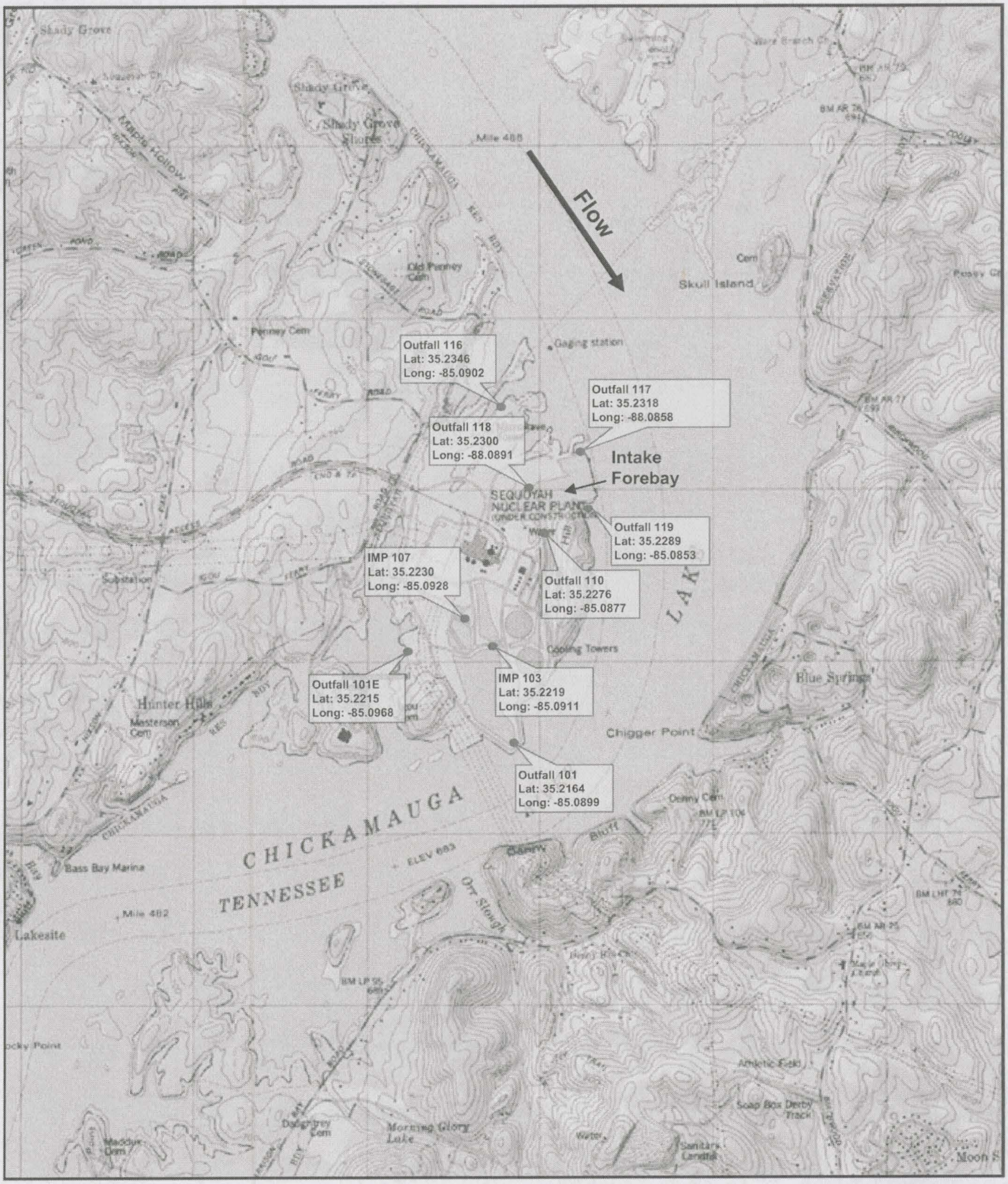
I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Name (print or type first and last name)	Official title
Thomas B. Marshall	Vice President, SQN
Signature	Date signed
	23 JANUARY, 2025

Form 1 - SECTION 6. EXISTING ENVIRONMENTAL PERMITS (40 CFR 122.21(F)(6))

Chattanooga-Hamilton County Air Pollution Control Bureau

4150-30600701-01C	Operating Permit, Cooling Tower, Unit 1
4150-30600701-03C	Operating Permit, Cooling Tower, Unit 2
4150-30700804-06C	Operating Permit, Insulation Saw A and Saw B
4150-10200501-08C	Operating Permit, Auxiliary Boilers A and B
4150-30703099-09C	Operating Permit, Carpenter Shop
4150-30900203-10C	Operating Permit, Abrasive Blasting Operation
4150-20200102-11C	Operating Permit, Emergency Generators 1A, 1B, 2A, 2B and Blackout Generators 1 and 2



TVA Sequoyah Nuclear Plant

NPDES Permit No. TN0026450
Hamilton County

EPA Identification Number	NPDES Permit Number	Facility Name
TN5640020504	TN0026450	Sequoyah Nuclear Plant (SQN)

OMB No. 2040-0004
Expires 07/31/2026

Form 2C NPDES

EPA

U.S. Environmental Protection Agency
Application for NPDES Permit to Discharge Wastewater

EXISTING MANUFACTURING, COMMERCIAL, MINING, AND SILVICULTURE OPERATIONS

SECTION 1. OUTFALL LOCATION (40 CFR 122.21(G)(1))

Outfall Location

1.1 Provide information on each of the facility's outfalls in the table below.

Outfall Number	Receiving Water Name	Latitude	Longitude
101	Tennessee River	35°12'30" N	85°5'15" W
101E	Tennessee River	35°13'15" N	85°5'45" W
IMP103	SQN Diffuser Pond	35°8'15" N	85°8'00" W

SECTION 2. LINE DRAWING (40 CFR 122.21(G)(2))

Line Drawing

2.1 Have you attached a line drawing to this application that shows the water flow through your facility with a water balance? (See instructions for drawing requirements. See Exhibit 2C–1 at end of instructions for example.)

☑ Yes

SECTION 3. AVERAGE FLOWS AND TREATMENT (40 CFR 122.21(G)(3))

Average Flows and Treatment

3.1 For each outfall identified under Item 1.1, provide average flow and treatment information. Add additional sheets if necessary.

Outfall Number 101

Operations Contributing to Flow

Operation	Average Flow
See attachment titled "Section 3"	1490.854 mgd
	mgd
	mgd
	mgd

Treatment Units

Description (include size, flow rate through each treatment unit, retention time, etc.)	Code from Exhibit 2C–2	Final Disposal of Solid or Liquid Wastes Other Than by Discharge
See attachment titled "Section 3"		

Average Flows and Treatment Continued

3.1 cont.

Outfall Number 101E

Operations Contributing to Flow

Operation	Average Flow
Discharges from Diffuser Pond during emergency	0 mgd
conditions only.	mgd
	mgd
	mgd

Treatment Units

Description (include size, flow rate through each treatment unit, retention time, etc.)	Code from Exhibit 2C–2	Final Disposal of Solid or Liquid Wastes Other Than by Discharge
Discharge to surface water	4-A	

Outfall Number IMP103

Operations Contributing to Flow

Operation	Average Flow
See attachment titled "Section 3"	1.230 mgd
	mgd
	mgd
	mgd

Treatment Units

Description (include size, flow rate through each treatment unit, retention time, etc.)	Code from Exhibit 2C–2	Final Disposal of Solid or Liquid Wastes Other Than by Discharge
See attachment titled "Section 3"		

System Users

3.2 Are you applying for an NPDES permit to operate a privately owned treatment works?

☐ Yes ☑ No → SKIP to Section 4.

3.3 Have you attached a list that identifies each user of the treatment works?

☐ Yes

EPA Identification Number	NPDES Permit Number	Facility Name	OMB No. 2040-0004 Expires 07/31/2026
TN5640020504	TN0026450	Sequoyah Nuclear Plant (SQN)	

Form 2C NPDES

EPA

U.S. Environmental Protection Agency
Application for NPDES Permit to Discharge Wastewater

EXISTING MANUFACTURING, COMMERCIAL, MINING, AND SILVICULTURE OPERATIONS

SECTION 1. OUTFALL LOCATION (40 CFR 122.21(G)(1))

Outfall Location

1.1 Provide information on each of the facility's outfalls in the table below.

Outfall Number	Receiving Water Name	Latitude	Longitude
IMP107	SQN Low Volume Waste Treatment Pond	35°8'30" N	85°8'00" W
110	Intake Forebay	35°13'30" N	85°5'15" W
116	Tennessee River	35°13'30" N	85°5'15" W

SECTION 2. LINE DRAWING (40 CFR 122.21(G)(2))

Line Drawing

2.1 Have you attached a line drawing to this application that shows the water flow through your facility with a water balance? (See instructions for drawing requirements. See Exhibit 2C–1 at end of instructions for example.)

☑ Yes

SECTION 3. AVERAGE FLOWS AND TREATMENT (40 CFR 122.21(G)(3))

Average Flows and Treatment

3.1 For each outfall identified under Item 1.1, provide average flow and treatment information. Add additional sheets if necessary.

****Outfall Number**** IMP 107

Operations Contributing to Flow

Operation	Average Flow
Discharges from Metal Cleaning Waste Ponds:	0.0022 mgd
(1) Metal cleaning waste	0.000* mgd
(2) Net Storm Water (Runoff, precipitation, less	0.0022 mgd
evaporation)	mgd

Treatment Units

Description (include size, flow rate through each treatment unit, retention time, etc.)	Code from Exhibit 2C–2	Final Disposal of Solid or Liquid Wastes Other Than by Discharge
Sedimentation (Settling)	1-U	
pH adjustment / neutralization	2-K	
Chemical precipitation, chemical oxidation	2-C, 2-B	
Flocculation	1-G	

* Influent lines to MCWP are disconnected. Last MCWP discharge occurred on 5/31/2006

Average Flows and Treatment Continued

3.1 cont.

Outfall Number 110

Operations Contributing to Flow

Operation	Average Flow
Discharges include wastewater from:	0.058 mgd
(1) ERCW system; (2) Cooling towers (closed cycle)	0** mgd
(3) Liquid rad waste treatment system	0** mgd
(4) Net Storm Water (Runoff, precipitation, less evaporatio	0.058 mgd

Treatment Units

Description (include size, flow rate through each treatment unit, retention time, etc.)	Code from Exhibit 2C–2	Final Disposal of Solid or Liquid Wastes Other Than by Discharge
Discharge to surface waters	4-A	

Outfall Number 116

Operations Contributing to Flow

Operation	Average Flow
CCW Intake Trash sluice	0.006 mgd
	mgd
	mgd
	mgd

Treatment Units

Description (include size, flow rate through each treatment unit, retention time, etc.)	Code from Exhibit 2C–2	Final Disposal of Solid or Liquid Wastes Other Than by Discharge
Discharge to surface waters	4-A	

System Users

3.2 Are you applying for an NPDES permit to operate a privately owned treatment works?

☐ Yes ☑ No → SKIP to Section 4.

3.3 Have you attached a list that identifies each user of the treatment works?

☐ Yes

** Recycle cooling water during closed mode operation is discharged through Outfall 110. Outfall 110 has been inactive for approximately 24 years, but remains in the event the plant goes into closed mode.

EPA Identification Number	NPDES Permit Number	Facility Name
TN5640020504	TN0026450	Sequoyah Nuclear Plant (SQN)

OMB No. 2040-0004
Expires 07/31/2026

Form 2C NPDES

EPA

U.S. Environmental Protection Agency
Application for NPDES Permit to Discharge Wastewater

EXISTING MANUFACTURING, COMMERCIAL, MINING, AND SILVICULTURE OPERATIONS

SECTION 1. OUTFALL LOCATION (40 CFR 122.21(G)(1))

Outfall Location

1.1 Provide information on each of the facility's outfalls in the table below.

Outfall Number	Receiving Water Name	Latitude	Longitude
117	Tennessee River	35°13'30" N	85°5'00" W
118	Intake Forebay	35°13'30" N	85°5'15" W
119	Tennessee River	35°13'44" N	85°5'7" W

SECTION 2. LINE DRAWING (40 CFR 122.21(G)(2))

Line Drawing

2.1 Have you attached a line drawing to this application that shows the water flow through your facility with a water balance? (See instructions for drawing requirements. See Exhibit 2C–1 at end of instructions for example.)

☑ Yes

SECTION 3. AVERAGE FLOWS AND TREATMENT (40 CFR 122.21(G)(3))

Average Flows and Treatment

3.1 For each outfall identified under Item 1.1, provide average flow and treatment information. Add additional sheets if necessary.

Outfall Number 117

Operations Contributing to Flow

Operation	Average Flow
Essential Raw Cooling Water screen and strainer backwash	0.014 mgd
	mgd
	mgd
	mgd

Treatment Units

Description (include size, flow rate through each treatment unit, retention time, etc.)	Code from Exhibit 2C–2	Final Disposal of Solid or Liquid Wastes Other Than by Discharge
Discharge to surface waters	4-A	

EPA Identification Number	NPDES Permit Number	Facility Name
TN5640020504	TN0026450	Sequoyah Nuclear Plant (SQN)

OMB No. 2040-0004
Expires 07/31/2026

Average Flows and Treatment Continued

3.1 cont.

Outfall Number 118

Operations Contributing to Flow

Operation	Average Flow
Dredge Pond	0* mgd
	mgd
	mgd
	mgd

Treatment Units

Description (include size, flow rate through each treatment unit, retention time, etc.)	Code from Exhibit 2C–2	Final Disposal of Solid or Liquid Wastes Other Than by Discharge
Discharge to surface waters	4-A	
Sedimentation (Settling)	1-U	
Filtration	1-Q	

Outfall Number 119

Operations Contributing to Flow

Operation	Average Flow
Backwash water from intake water screens	1.094 mgd
	mgd
	mgd
	mgd

Treatment Units

Description (include size, flow rate through each treatment unit, retention time, etc.)	Code from Exhibit 2C–2	Final Disposal of Solid or Liquid Wastes Other Than by Discharge
Discharge to surface waters	4-A	

System Users

3.2 Are you applying for an NPDES permit to operate a privately owned treatment works?

☐ Yes ☑ No → SKIP to Section 4.

3.3 Have you attached a list that identifies each user of the treatment works?

☐ Yes

*Pond is not in service at this time; therefore, outfall 118 is inactive. Only stormwater from surrounding vegetated area discharges. No industrial activity in area. If in service, the pond would provide sedimentation during dredge activities and filtration for lower depth waste waters.

SECTION 4. INTERMITTENT FLOWS (40 CFR 122.21(G)(4))

Intermittent Flows

4.1 Except for storm runoff, leaks, or spills, are any discharges described in Sections 1 and 3 intermittent or seasonal?

☑ Yes ☐ No → SKIP to Section 5.

4.2 Provide information on intermittent or seasonal flows for each applicable outfall. Attach additional pages, if necessary.

Outfall Number	Operation (list)	Frequency		Flow Rate		Duration
		Average Days/Week	Average Months/Year	Long-Term Average	Maximum Daily	
IMP 107	Metal cleaning waste	(a) days/week	(a) months/year	(a) mgd	(a) mgd	(a) days
	waters	days/week	months/year	mgd	mgd	days
	(see footnote below)	days/week	months/year	mgd	mgd	days
110	Cooling Tower blow-	(b) days/week	(b) months/year	(b) mgd	(b) mgd	(b) days
	down basin	days/week	months/year	mgd	mgd	days
	(see footnote below)	days/week	months/year	mgd	mgd	days
116	CCW Intake Trash	1 days/week	12 months/year	0.0060 mgd	0.0450 mgd	<1 days
	Sluice	days/week	months/year	mgd	mgd	days
		days/week	months/year	mgd	mgd	days

SECTION 5. PRODUCTION (40 CFR 122.21(G)(5))

Applicable ELGs

5.1 Do any effluent limitation guidelines (ELGs) promulgated by EPA under Section 304 of the CWA apply to your facility?

☑ Yes ☐ No → SKIP to Section 6.

5.2 Provide the following information on applicable ELGs.

ELG Category	ELG Subcategory	Regulatory Citation
Steam Electric Power Plant		40 CFR 423

Production-Based Limitations

5.3 Are any of the applicable ELGs expressed in terms of production (or other measure of operation)?

☐ Yes ☑ No → SKIP to Section 6.

5.4 Provide an actual measure of daily production expressed in terms and units of applicable ELGs.

Outfall Number	Operation, Product, or Material	Quantity per Day	Unit of Measure

(a) Last MCWP discharge occurred on 5/31/2006. Influent lines are cut and capped. Stormwater flows only are discharged from pond.
b) Cooling Tower blowdown basin discharges recycled cooling water through outfall 110 while the plant is in closed mode. The plant has not entered closed mode for approximately 24 years. Outfall 110 remains inactive until closed mode operation is necessary, which will result in a discharge flow of approximately 1487.4276 MGD.
(c) No dredging operations conducted during current permit cycle. Pond is vegetated and no industrial activity in the area.

EPA Identification Number	NPDES Permit Number	Facility Name	OMB No. 2040-0004 Expires 07/31/2026
TN5640020504	TN0026450	Sequoyah Nuclear Plant (SQN)	

SECTION 4. INTERMITTENT FLOWS (40 CFR 122.21(G)(4))

Intermittent Flows

4.1 Except for storm runoff, leaks, or spills, are any discharges described in Sections 1 and 3 intermittent or seasonal?

☑ Yes ☐ No → SKIP to Section 5.

4.2 Provide information on intermittent or seasonal flows for each applicable outfall. Attach additional pages, if necessary.

Outfall Number	Operation (list)	Frequency		Flow Rate		Duration
		Average Days/Week	Average Months/Year	Long-Term Average	Maximum Daily	
117	ERCW Traveling Screen	4 days/week	12 months/year	0.0060 mgd	0.0450 mgd	<1 days
	and ERCW Strainer	days/week	months/year	mgd	mgd	days
	Backwash	days/week	months/year	mgd	mgd	days
118	ERCW Dredge	3 days/week	12 months/year	0.0040 mgd	0.0096 mgd	<1 days
	Pond	days/week	months/year	mgd	mgd	days
		days/week	months/year	mgd	mgd	days
		days/week	months/year	mgd	mgd	days
		days/week	months/year	mgd	mgd	days
		days/week	months/year	mgd	mgd	days

SECTION 5. PRODUCTION (40 CFR 122.21(G)(5))

Applicable ELGs

5.1 Do any effluent limitation guidelines (ELGs) promulgated by EPA under Section 304 of the CWA apply to your facility?

☑ Yes ☐ No → SKIP to Section 6.

5.2 Provide the following information on applicable ELGs.

ELG Category	ELG Subcategory	Regulatory Citation
Steam Electric Power Plant		40 CFR 423

Production-Based Limitations

5.3 Are any of the applicable ELGs expressed in terms of production (or other measure of operation)?

☐ Yes ☑ No → SKIP to Section 6.

5.4 Provide an actual measure of daily production expressed in terms and units of applicable ELGs.

Outfall Number	Operation, Product, or Material	Quantity per Day	Unit of Measure

5.5 Are you requesting alternative limits based on an anticipated increase in the actual production during the next permit term? (Consult with your NPDES permitting authority to determine what information needs to be submitted and when.)

☐ Yes ☑ No

SECTION 6. IMPROVEMENTS (40 CFR 122.21(G)(6))

Upgrades and Improvements

6.1 Are you presently required by any federal, state, or local authority to meet an implementation schedule for constructing, upgrading, or operating wastewater treatment equipment or practices or any other environmental programs that could affect the discharges described in this application?

☑ Yes ☐ No → SKIP to Item 6.3.

6.2 Briefly identify each applicable project in the table below.

Brief Identification and Description of Project	Affected Outfalls (list outfall number)	Source(s) of Discharge	Final Compliance Dates	
			Required	Projected
Installation and optimization of modified	Intake, 119	Cooling water intake		04/30/2029
traveling water screens				
(BTA for impingement mortality)				

6.3 Have you attached sheets describing any additional water pollution control programs (or other environmental projects that may affect your discharges) that you now have underway or planned? *(optional item)*

☐ Yes ☐ No ☑ Not applicable

SECTION 7. EFFLUENT AND INTAKE CHARACTERISTICS (40 CFR 122.21(G)(7))

Effluent and Intake Characteristics

See the instructions to determine the pollutants and parameters you are required to monitor and, in turn, the tables you must complete. Not all applicants need to complete each table.

Table A. Conventional and Non-Conventional Pollutants

7.1 Are you requesting a waiver from your NPDES permitting authority for any Table A pollutants for any of your outfalls?

☐ Yes ☑ No → SKIP to Item 7.3.

7.2 If yes, indicate the applicable outfalls below or check the appropriate box to indicate that you are requesting a waiver for all outfalls. Attach waiver request and other required information to the application.

Outfall number _____ Outfall number _____ Outfall number _____

☐ I am requesting a waiver for some pollutants at all outfalls.

☐ I am requesting a waiver for all pollutants at all outfalls → SKIP to Item 7.4.

7.3 Have you completed monitoring for all Table A pollutants at each of your outfalls for which a waiver has not been requested and attached the results to this application package?

☑ Yes

Table B. Toxic Metals, Cyanide, Total Phenols, and Organic Toxic Pollutants

7.4 Do any of the facility's processes that contribute wastewater fall into one or more of the primary industry categories listed in Exhibit 2C–3? (See end of instructions for exhibit.)

☑ Yes ☐ No → SKIP to Item 7.8.

7.5 Have you checked "Testing Required" for all toxic metals, cyanide, and total phenols in Section 1 of Table B?

☑ Yes

Effluent and Intake Characteristics Continued

7.6 List the applicable primary industry categories and check the boxes indicating the required GC/MS fraction(s) identified in Exhibit 2C–3.

Primary Industry Category	Required GC/MS Fraction(s) (check applicable boxes)
Steam electric power plants	☑ Volatile ☑ Acid ☐ Base/neutral ☐ Pesticide
	☐ Volatile ☐ Acid ☐ Base/neutral ☐ Pesticide
	☐ Volatile ☐ Acid ☐ Base/neutral ☐ Pesticide

7.7 Have you checked "Testing Required" for all required pollutants in Sections 2 through 5 of Table B for each of the GC/MS fractions checked in Item 7.6?

☑ Yes

7.8 Have you checked "Believed Present" or "Believed Absent" for all pollutants listed in Sections 1 through 5 of Table B where testing is not required?

☑ Yes

7.9 Have you provided (1) quantitative data for those Section 1, Table B, pollutants for which you have indicated testing is required or (2) quantitative data or other required information for those Section 1, Table B, pollutants that you have indicated are "Believed Present" in your discharge?

☑ Yes

7.10 Does the applicant qualify for a small business exemption under the criteria specified in the instructions?

☐ Yes ➔ Note that you qualify at the top of Table B, then SKIP to Item 7.12. ☑ No

7.11 Have you provided (1) quantitative data for those Sections 2 through 5, Table B, pollutants for which you have determined testing is required or (2) quantitative data or an explanation for those Sections 2 through 5, Table B, pollutants you have indicated are "Believed Present" in your discharge?

☑ Yes

Table C. Certain Conventional and Non-Conventional Pollutants

7.12 Have you indicated whether pollutants are "Believed Present" or "Believed Absent" for all pollutants listed in Table C for all outfalls?

☑ Yes

7.13 Have you completed Table C by providing quantitative data for those pollutants that are limited either directly or indirectly in an ELG? You must provide quantitative data even if the pollutant is "Believed Absent."

☑ Yes ☐ Not applicable

7.14 Have you completed Table C by providing quantitative data or an explanation for those pollutants for which you have indicated "Believed Present"?

☑ Yes

Table D. Certain Hazardous Substances and Asbestos

7.15 Have you indicated whether pollutants are "Believed Present" or "Believed Absent" for all pollutants listed in Table D for all outfalls?

☑ Yes

7.16 Have you completed Table D by (1) describing the reasons the applicable pollutants are expected to be discharged and (2) providing quantitative data, if available?

☐ Yes ☑ No

Table E. 2,3,7,8-Tetrachlorodibenzo-p-Dioxin (2,3,7,8-TCDD)

7.17 Does the facility use or manufacture one or more of the 2,3,7,8-TCDD congeners listed in the instructions, or do you know or have reason to believe that TCDD is or may be present in the effluent?

☐ Yes ➔ Complete Table E. ☑ No ➔ SKIP to Section 8.

7.18 Have you completed Table E by reporting *qualitative* data for TCDD?

☐ Yes

SECTION 8. USED OR MANUFACTURED TOXICS (40 CFR 122.21(G)(9))

Used or Manufactured Toxics

8.1 Is any pollutant listed in Table B a substance or a component of a substance used or manufactured at your facility as an intermediate or final product or byproduct?

☐ Yes ☑ No → SKIP to Section 9.

8.2 List the pollutants below. Attach additional sheets, if necessary.

1.	4.	7.
2.	5.	8.
3.	6.	9.

SECTION 9. BIOLOGICAL TOXICITY TESTS (40 CFR 122.21(G)(11))

Biological Toxicity Tests

9.1 Do you have any knowledge or reason to believe that any biological test for acute or chronic toxicity has been made within the last three years on (1) any of your discharges or (2) a receiving water in relation to your discharge?

☑ Yes ☐ No → SKIP to Section 10.

9.2 Identify the tests and their purposes below.

Test(s)	Purpose of Test(s)	Submitted to NPDES Permitting Authority?	Date Submitted
IC25 Static Renewal 7 Day Chronic Ceriodaphnia	Biomonitoring, chronic	☑ Yes ☐ No	07/11/2024
IC25 Static Renewal 7 Day Chronic Pimephales promelas	Biomonitoring, chronic	☑ Yes ☐ No	07/11/2024
		☐ Yes ☐ No	

SECTION 10. CONTRACT ANALYSES (40 CFR 122.21(G)(12))

Contract Analyses

10.1 Were any of the analyses reported in Section 7 performed by a contract laboratory or consulting firm?

☑ Yes ☐ No → SKIP to Section 11.

10.2 Provide information for each contract laboratory or consulting firm below.

	Laboratory Number 1	Laboratory Number 2	Laboratory Number 3
Name of laboratory/firm	GEL Laboratories, LLC		
Laboratory address	2040 Savage Road Charleston, SC 29407		
Phone number	(843) 556-8171		
Pollutant(s) analyzed	All parameters except field parameters (pH, temperature, flow, TRC)		

SECTION 11. ADDITIONAL INFORMATION (40 CFR 122.21(G)(13))

Additional Information			
	11.1	Has the NPDES permitting authority requested additional information?	
		☐ Yes	☑ No ➔ SKIP to Section 12.
	11.2	List the information requested and attach it to this application.	
		1.	4.
		2.	5.
		3.	6.

SECTION 12. CHECKLIST AND CERTIFICATION STATEMENT (40 CFR 122.22(A) AND (D))

Checklist and Certification Statement

12.1 In Column 1 below, mark the sections of Form 2C that you have completed and are submitting with your application. For each section, specify in Column 2 any attachments that you are enclosing to alert the permitting authority. Note that not all applicants are required to complete all sections or provide attachments.

Column 1	Column 2	
☑ Section 1: Outfall Location	☐ w/ attachments	
☑ Section 2: Line Drawing	☑ w/ line drawing	☐ w/ additional attachments
☑ Section 3: Average Flows and Treatment	☑ w/ attachments	☐ w/ list of each user of privately owned treatment works
☑ Section 4: Intermittent Flows	☐ w/ attachments	
☑ Section 5: Production	☐ w/ attachments	
☑ Section 6: Improvements	☐ w/ attachments	☐ w/ optional additional sheets describing any additional pollution control plans
☑ Section 7: Effluent and Intake Characteristics	☐ w/ request for a waiver and supporting information	☐ w/ explanation for identical outfalls
	☐ w/ small business exemption request	☐ w/ other attachments
	☑ w/ Table A	☑ w/ Table B
	☑ w/ Table C	☑ w/ Table D
	☑ w/ Table E	☐ w/ analytical results as an attachment
☑ Section 8: Used or Manufactured Toxics	☐ w/ attachments	
☑ Section 9: Biological Toxicity Tests	☐ w/ attachments	
☑ Section 10: Contract Analyses	☐ w/ attachments	
☑ Section 11: Additional Information	☐ w/ attachments	
☑ Section 12: Checklist and Certification Statement	☐ w/ attachments	

SECTION 12. CHECKLIST AND CERTIFICATION STATEMENT (40 CFR 122.22(a) and (d)) (Continued)

Checklist and Certification Statement

12.2 Provide the following certification. (See instructions to determine the appropriate person to sign the application.)

Certification Statement

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Name (print or type first and last name)	Official title
THOMAS B MARSHALL	VICE PRESIDENT, SQN
Signature	Date signed
	23 JANUARY, 2025

SECTION 3. AVERAGE FLOWS AND TREATMENT (40 CFR 122.21(G)(3))

OUTFALL NO	OPERATION(S) CONTRIBUTING FLOW		TREATMENT		
	OPERATION	**AVERAGE FLOW**	**DESCRIPTION**	**LIST CODE**	**FINAL DISPOSAL**
101	Discharges from Diffuser Pond include:	**1490.854 MGD**	Discharge to surface water; sedimentation	4-A; 1-U	
	(1) Low Volume Waste Treatment Pond (via Internal Monitoring Point 103): (a) Discharge from metal cleaning waste ponds (IMP 107) (b) Turbine building sump	(1.230 MGD)	pH adjustment / neutralization	2-K	
	(2) CCW Discharge Channel: (a) Raw cooling water system (b) Diesel fuel recover trench; high pressure fire water, potable water (c) Condenser Circulating system (d) Stormwater Runoff	(1447.014 MGD)	(a) Disinfection (other)	2-H	
	(3) Cooling tower blowdown basin (a) Essential Raw Cooling Water system (b) Cooling towers (closed/helper mode) stormwater runoff (c) Liquid rad waste treatment system (d) Steam Generator Blowdown	(40.436 MGD)	(a) Disinfection (other) (c) Ion exchange (d) Multi-media filtration	2-H; 2-J; 1-Q	
	(4) Yard drainage pond: (a) Construction/ Demo landfill stormwater (b) Switchyard runoff (c) Various building heat loads (d) Yard drainage system	(2.125 MGD)	Sedimentation (settling)	1-U	
	(5) Net Storm Water (Runoff, precipitation, less evaporation)	(0.049 MGD)			

SECTION 3. AVERAGE FLOWS AND TREATMENT (40 CFR 122.21(G)(3))

OUTFALL NO	OPERATION(S) CONTRIBUTING FLOW		TREATMENT		
	OPERATION	**AVERAGE FLOW**	**DESCRIPTION**	**LIST CODE**	**FINAL DISPOSAL**
103	Discharges from Low Volume Waste Treatment Pond (LVWTP):	**1.230 MGD**	Sedimentation (Settling), pH adjustment/ neutralization	1-U; 2-K	
	(1) Discharges from metal cleaning waste ponds (IMP 107)	(0.0022 MGD)			
	(2) Turbine Building Sump: (a) Miscellaneous Low Volume Wastewaters (b) Turbine building floor and equipment drains (c) Condensate demin. regeneration waste (d) Secondary system leaks and draindown (e) Steam Generator blowdown (f) Component Cooling System wastewater (g) Miscellaneous equipment cooling (h) Ice condenser waste (i) Alum sludge ponds (WTP)	(1.047 MGD)	(b) pH adjustment / neutralization; (h) Sedimentation (settling); (i) Landfill	2-K; 1-U; 5-Q	(i) Landfill
	(3) Neutral waste sump (WTP)	(0.177 MGD)			
	(4) Net Storm Water (Runoff, precipitation, less evaporation	(0.004 MGD)			

EPA Identification Number	NPDES Permit Number	Facility Name	Outfall Number
TN5640020504	TN0026450	Sequoyah Nuclear Plant (SQN)	101, Intake

OMB No. 2040-0004
Expires 07/31/2026

TABLE A. CONVENTIONAL AND NON CONVENTIONAL POLLUTANTS (40 CFR 122.21(g)(7)(iii)) [1]

	Pollutant	Waiver Requested (if applicable)	Units (specify)		Effluent: Maximum Daily Discharge (required)	Effluent: Maximum Monthly Discharge (if available)	Effluent: Long-Term Average Daily Discharge (if available)	Effluent: Number of Analyses	Intake (optional): Long-Term Average Value	Intake (optional): Number of Analyses
☐	Check here if you have applied to your NPDES permitting authority for a waiver for *all* of the pollutants listed on this table for the noted outfall.									
1.	Biochemical oxygen demand (BOD_5)	☐	Concentration	mg/L	2.32			1	2.81	1
			Mass							
2.	Chemical oxygen demand (COD)	☐	Concentration	mg/L	<20.0			1	<20.0	1
			Mass							
3.	Total organic carbon (TOC)	☐	Concentration	mg/L	1.59			1	2.05	1
			Mass							
4.	Total suspended solids (TSS)	☐	Concentration	mg/L	<5.00			1	<10.0	1
			Mass							
5.	Ammonia (as N)	☐	Concentration	mg/L	0.0750			1	0.0530	1
			Mass							
6.	Flow	☐	Rate	MGD	2228.3		1784.4	46		
7.	Temperature (winter)	☐	°C	°C	27.1		16.5	24		
	Temperature (summer)	☐	°C	°C	30.5		26.9	22	26.5	4
8.	pH (minimum)	☐	Standard units	s.u.	6.11			4	6.34	4
	pH (maximum)	☐	Standard units	s.u.	6.71			4	6.76	4

[1] Sampling shall be conducted according to sufficiently sensitive test procedures (i.e., methods) approved under 40 CFR 136 for the analysis of pollutants or pollutant parameters or required under 40 CFR Chapter I, Subchapter N or O. See instructions and 40 CFR 122.21(e)(3).

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EPA Identification Number	NPDES Permit Number	Facility Name	Outfall Number
TN5640020504	TN0026450	Sequoyah Nuclear Plant (SQN)	101, Intake

OMB No. 2040-0004
Expires 07/31/2026

TABLE B. TOXIC METALS, CYANIDE, TOTAL PHENOLS, AND ORGANIC TOXIC POLLUTANTS (40 CFR 122.21(g)(7)(v))[1]

	Pollutant/Parameter (and CAS Number, if available)	Testing Required	Presence or Absence (check one)		Units (specify)		Effluent				Intake (optional)	
			Believed Present	Believed Absent			Maximum Daily Discharge (required)	Maximum Monthly Discharge (if available)	Long-Term Average Daily Discharge (if available)	Number of Analyses	Long-Term Average Value	Number of Analyses
☐	Check here if you qualify as a small business per the instructions to Form 2C and, therefore, do not need to submit quantitative data for any of the organic toxic pollutants in Sections 2 through 5 of this table. Note, however, that you must still indicate in the appropriate column of this table if you believe any of the pollutants listed are present in your discharge.											
Section 1. Toxic Metals, Cyanide, and Total Phenols												
1.1	Antimony, total (7440-36-0)	☑	☐	☐	Concentration	mg/L	<0.003			1	<0.003	1
					Mass							
1.2	Arsenic, total (7440-38-2)	☑	☐	☐	Concentration	mg/L	<0.005			1	<0.005	1
					Mass							
1.3	Beryllium, total (7440-41-7)	☑	☐	☐	Concentration	mg/L	<0.0005			1	<0.0005	1
					Mass							
1.4	Cadmium, total (7440-43-9)	☑	☐	☐	Concentration	mg/L	<0.001			1	<0.001	1
					Mass							
1.5	Chromium, total (7440-47-3)	☑	☐	☐	Concentration	mg/L	<0.01			1	<0.01	1
					Mass							
1.6	Copper, total (7440-50-8)	☑	☐	☐	Concentration	mg/L	<0.002			1	<0.002	1
					Mass							
1.7	Lead, total (7439-92-1)	☑	☐	☐	Concentration	mg/L	<0.002			1	<0.002	1
					Mass							
1.8	Mercury, total (7439-97-6)	☑	☐	☐	Concentration	mg/L	7.27e-7			4	5.7e-7	4
					Mass							
1.9	Nickel, total (7440-02-0)	☑	☐	☐	Concentration	mg/L	<0.002			1	<0.002	1
					Mass							
1.10	Selenium, total (7782-49-2)	☑	☐	☐	Concentration	mg/L	<0.005			1	<0.005	1
					Mass							
1.11	Silver, total (7440-22-4)	☑	☐	☐	Concentration	mg/L	<0.001			1	<0.001	1
					Mass							

EPA Identification Number	NPDES Permit Number	Facility Name	Outfall Number
TN5640020504	TN0026450	Sequoyah Nuclear Plant (SQN)	101, Intake

OMB No. 2040-0004
Expires 07/31/2026

TABLE B. TOXIC METALS, CYANIDE, TOTAL PHENOLS, AND ORGANIC TOXIC POLLUTANTS (40 CFR 122.21(g)(7)(v))[1]

	Pollutant/Parameter (and CAS Number, if available)	Testing Required	Presence or Absence (check one)		Units (specify)		Effluent				Intake (optional)	
			Believed Present	Believed Absent			Maximum Daily Discharge (required)	Maximum Monthly Discharge (if available)	Long-Term Average Daily Discharge (if available)	Number of Analyses	Long-Term Average Value	Number of Analyses
1.12	Thallium, total (7440-28-0)	☑	☐	☐	Concentration	mg/L	<0.002			1	<0.002	1
					Mass							
1.13	Zinc, total (7440-66-6)	☑	☐	☐	Concentration	mg/L	<0.020			1	<0.020	1
					Mass							
1.14	Cyanide, total (57-12-5)	☑	☐	☐	Concentration	mg/L	<0.005			4	<0.005	4
					Mass							
1.15	Phenols, total	☑	☐	☐	Concentration	mg/L	<0.005			4	<0.005	4
					Mass							
Section 2. Organic Toxic Pollutants (GC/MS Fraction—Volatile Compounds)												
2.1	Acrolein (107-02-8)	☑	☐	☐	Concentration	mg/L	<0.005			1	<0.005	1
					Mass							
2.2	Acrylonitrile (107-13-1)	☑	☐	☐	Concentration	mg/L	<0.005			1	<0.005	1
					Mass							
2.3	Benzene (71-43-2)	☑	☐	☐	Concentration	mg/L	<0.001			1	<0.001	1
					Mass							
2.4	Bromoform (75-25-2)	☑	☐	☐	Concentration	mg/L	<0.001			1	<0.001	1
					Mass							
2.5	Carbon tetrachloride (56-23-5)	☑	☐	☐	Concentration	mg/L	<0.001			1	<0.001	1
					Mass							
2.6	Chlorobenzene (108-90-7)	☑	☐	☐	Concentration	mg/L	<0.001			1	<0.001	1
					Mass							
2.7	Chlorodibromomethane (124-48-1)	☑	☐	☐	Concentration	mg/L	<0.001			1	<0.001	1
					Mass							
2.8	Chloroethane (75-00-3)	☑	☐	☐	Concentration	mg/L	<0.001			1	<0.001	1
					Mass							

EPA Identification Number	NPDES Permit Number	Facility Name	Outfall Number
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OMB No. 2040-0004
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TABLE B. TOXIC METALS, CYANIDE, TOTAL PHENOLS, AND ORGANIC TOXIC POLLUTANTS (40 CFR 122.21(g)(7)(v))[1]

	Pollutant/Parameter (and CAS Number, if available)	Testing Required	Presence or Absence (check one)		Units (specify)		Effluent				Intake (optional)	
			Believed Present	Believed Absent			Maximum Daily Discharge (required)	Maximum Monthly Discharge (if available)	Long-Term Average Daily Discharge (if available)	Number of Analyses	Long-Term Average Value	Number of Analyses
2.9	2-chloroethylvinyl ether (110-75-8)	☑	☐	☐	Concentration	mg/L	<0.005			1	<0.005	1
					Mass							
2.10	Chloroform (67-66-3)	☑	☐	☐	Concentration	mg/L	<0.001			1	<0.001	1
					Mass							
2.11	Dichlorobromomethane (75-27-4)	☑	☐	☐	Concentration	mg/L	<0.001			1	<0.001	1
					Mass							
2.12	1,1-dichloroethane (75-34-3)	☑	☐	☐	Concentration	mg/L	<0.001			1	<0.001	1
					Mass							
2.13	1,2-dichloroethane (107-06-2)	☑	☐	☐	Concentration	mg/L	<0.001			1	<0.001	1
					Mass							
2.14	1,1-dichloroethylene (75-35-4)	☑	☐	☐	Concentration	mg/L	<0.001			1	<0.001	1
					Mass							
2.15	1,2-dichloropropane (78-87-5)	☑	☐	☐	Concentration	mg/L	<0.001			1	<0.001	1
					Mass							
2.16	1,3-dichloropropylene (542-75-6)	☑	☐	☐	Concentration	mg/L	<0.001			1	<0.001	1
					Mass							
2.17	Ethylbenzene (100-41-4)	☑	☐	☐	Concentration	mg/L	<0.001			1	<0.001	1
					Mass							
2.18	Methyl bromide (74-83-9)	☑	☐	☐	Concentration	mg/L	<0.001			1	<0.001	1
					Mass							
2.19	Methyl chloride (74-87-3)	☑	☐	☐	Concentration	mg/L	<0.001			1	<0.001	1
					Mass							
2.20	Methylene chloride (75-09-2)	☑	☐	☐	Concentration	mg/L	0.00421*			1	0.00337*	1
					Mass							
2.21	1,1,2,2- tetrachloroethane (79-34-5)	☑	☐	☐	Concentration	mg/L	<0.001			1	<0.001	1
					Mass							

* The lab report flagged this analysis: "The target analyte was detected in the associated blank."

EPA Identification Number	NPDES Permit Number	Facility Name	Outfall Number
TN5640020504	TN0026450	Sequoyah Nuclear Plant (SQN)	101, Intake

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TABLE B. TOXIC METALS, CYANIDE, TOTAL PHENOLS, AND ORGANIC TOXIC POLLUTANTS (40 CFR 122.21(g)(7)(v))[1]

	Pollutant/Parameter (and CAS Number, if available)	Testing Required	Presence or Absence (check one)		Units (specify)		Effluent				Intake (optional)	
			Believed Present	Believed Absent			Maximum Daily Discharge (required)	Maximum Monthly Discharge (if available)	Long-Term Average Daily Discharge (if available)	Number of Analyses	Long-Term Average Value	Number of Analyses
2.22	Tetrachloroethylene (127-18-4)	☑	☐	☐	Concentration	mg/L	<0.001			1	<0.001	1
					Mass							
2.23	Toluene (108-88-3)	☑	☐	☐	Concentration	mg/L	<0.001			1	<0.001	1
					Mass							
2.24	1,2-trans-dichloroethylene (156-60-5)	☑	☐	☐	Concentration	mg/L	<0.001			1	<0.001	1
					Mass							
2.25	1,1,1-trichloroethane (71-55-6)	☑	☐	☐	Concentration	mg/L	<0.001			1	<0.001	1
					Mass							
2.26	1,1,2-trichloroethane (79-00-5)	☑	☐	☐	Concentration	mg/L	<0.001			1	<0.001	1
					Mass							
2.27	Trichloroethylene (79-01-6)	☑	☐	☐	Concentration	mg/L	<0.001			1	<0.001	1
					Mass							
2.28	Vinyl chloride (75-01-4)	☑	☐	☐	Concentration	mg/L	<0.001			1	<0.001	1
					Mass							
Section 3. Organic Toxic Pollutants (GC/MS Fraction—Acid Compounds)												
3.1	2-chlorophenol (95-57-8)	☑	☐	☐	Concentration	mg/L	<0.00960			1	<0.00958	1
					Mass							
3.2	2,4-dichlorophenol (120-83-2)	☑	☐	☐	Concentration	mg/L	<0.00960			1	<0.00958	1
					Mass							
3.3	2,4-dimethylphenol (105-67-9)	☑	☐	☐	Concentration	mg/L	<0.00960			1	<0.00958	1
					Mass							
3.4	4,6-dinitro-o-cresol (534-52-1)	☑	☐	☐	Concentration	mg/L	<0.00960			1	<0.00958	1
					Mass							
3.5	2,4-dinitrophenol (51-28-5)	☑	☐	☐	Concentration	mg/L	<0.0192			1	<0.0192	1
					Mass							

TABLE B. TOXIC METALS, CYANIDE, TOTAL PHENOLS, AND ORGANIC TOXIC POLLUTANTS (40 CFR 122.21(g)(7)(v))[1]

	Pollutant/Parameter (and CAS Number, if available)	Testing Required	Presence or Absence (check one)		Units (specify)		Effluent				Intake (optional)	
			Believed Present	Believed Absent			Maximum Daily Discharge (required)	Maximum Monthly Discharge (if available)	Long-Term Average Daily Discharge (if available)	Number of Analyses	Long-Term Average Value	Number of Analyses
3.6	2-nitrophenol (88-75-5)	☑	☐	☐	Concentration	mg/L	<0.00960			1	<0.00958	1
					Mass							
3.7	4-nitrophenol (100-02-7)	☑	☐	☐	Concentration	mg/L	<0.00960			1	<0.00958	1
					Mass							
3.8	p-chloro-m-cresol (59-50-7)	☑	☐	☐	Concentration	mg/L	<0.00960			1	<0.00958	1
					Mass							
3.9	Pentachlorophenol (87-86-5)	☑	☐	☐	Concentration	mg/L	<0.00960			1	<0.00958	1
					Mass							
3.10	Phenol (108-95-2)	☑	☐	☐	Concentration	mg/L	<0.00960			1	<0.00958	1
					Mass							
3.11	2,4,6-trichlorophenol (88-05-2)	☑	☐	☐	Concentration	mg/L	<0.00960			1	<0.00958	1
					Mass							
Section 4. Organic Toxic Pollutants (GC/MS Fraction—Base /Neutral Compounds)												
4.1	Acenaphthene (83-32-9)	☐	☐	☑	Concentration							
					Mass							
4.2	Acenaphthylene (208-96-8)	☐	☐	☑	Concentration							
					Mass							
4.3	Anthracene (120-12-7)	☐	☐	☑	Concentration							
					Mass							
4.4	Benzidine (92-87-5)	☐	☐	☑	Concentration							
					Mass							
4.5	Benzo (a) anthracene (56-55-3)	☐	☐	☑	Concentration							
					Mass							
4.6	Benzo (a) pyrene (50-32-8)	☐	☐	☑	Concentration							
					Mass							

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TABLE B. TOXIC METALS, CYANIDE, TOTAL PHENOLS, AND ORGANIC TOXIC POLLUTANTS (40 CFR 122.21(g)(7)(v))[1]

	Pollutant/Parameter (and CAS Number, if available)	Testing Required	Presence or Absence (check one)		Units (specify)		Effluent				Intake (optional)	
			Believed Present	Believed Absent			Maximum Daily Discharge (required)	Maximum Monthly Discharge (if available)	Long-Term Average Daily Discharge (if available)	Number of Analyses	Long-Term Average Value	Number of Analyses
4.7	3,4-benzofluoranthene (205-99-2)	☐	☐	☑	Concentration							
					Mass							
4.8	Benzo (ghi) perylene (191-24-2)	☐	☐	☑	Concentration							
					Mass							
4.9	Benzo (k) fluoranthene (207-08-9)	☐	☐	☑	Concentration							
					Mass							
4.10	Bis (2-chloroethoxy) methane (111-91-1)	☐	☐	☑	Concentration							
					Mass							
4.11	Bis (2-chloroethyl) ether (111-44-4)	☐	☐	☑	Concentration							
					Mass							
4.12	Bis (2-chloroisopropyl) ether (102-80-1)	☐	☐	☑	Concentration							
					Mass							
4.13	Bis (2-ethylhexyl) phthalate (117-81-7)	☐	☐	☑	Concentration							
					Mass							
4.14	4-bromophenyl phenyl ether (101-55-3)	☐	☐	☑	Concentration							
					Mass							
4.15	Butyl benzyl phthalate (85-68-7)	☐	☐	☑	Concentration							
					Mass							
4.16	2-chloronaphthalene (91-58-7)	☐	☐	☑	Concentration							
					Mass							
4.17	4-chlorophenyl phenyl ether (7005-72-3)	☐	☐	☑	Concentration							
					Mass							
4.18	Chrysene (218-01-9)	☐	☐	☑	Concentration							
					Mass							
4.19	Dibenzo (a,h) anthracene (53-70-3)	☐	☐	☑	Concentration							
					Mass							

TABLE B. TOXIC METALS, CYANIDE, TOTAL PHENOLS, AND ORGANIC TOXIC POLLUTANTS (40 CFR 122.21(g)(7)(v))[1]

	Pollutant/Parameter (and CAS Number, if available)	Testing Required	Presence or Absence (check one)		Units (specify)		Effluent				Intake (optional)	
			Believed Present	Believed Absent			Maximum Daily Discharge (required)	Maximum Monthly Discharge (if available)	Long-Term Average Daily Discharge (if available)	Number of Analyses	Long-Term Average Value	Number of Analyses
4.20	1,2-dichlorobenzene (95-50-1)	☐	☐	☑	Concentration							
					Mass							
4.21	1,3-dichlorobenzene (541-73-1)	☐	☐	☑	Concentration							
					Mass							
4.22	1,4-dichlorobenzene (106-46-7)	☐	☐	☑	Concentration							
					Mass							
4.23	3,3-dichlorobenzidine (91-94-1)	☐	☐	☑	Concentration							
					Mass							
4.24	Diethyl phthalate (84-66-2)	☐	☐	☑	Concentration							
					Mass							
4.25	Dimethyl phthalate (131-11-3)	☐	☐	☑	Concentration							
					Mass							
4.26	Di-n-butyl phthalate (84-74-2)	☐	☐	☑	Concentration							
					Mass							
4.27	2,4-dinitrotoluene (121-14-2)	☐	☐	☑	Concentration							
					Mass							
4.28	2,6-dinitrotoluene (606-20-2)	☐	☐	☑	Concentration							
					Mass							
4.29	Di-n-octyl phthalate (117-84-0)	☐	☐	☑	Concentration							
					Mass							
4.30	1,2-Diphenylhydrazine (as azobenzene) (122-66-7)	☐	☐	☑	Concentration							
					Mass							
4.31	Fluoranthene (206-44-0)	☐	☐	☑	Concentration							
					Mass							
4.32	Fluorene (86-73-7)	☐	☐	☑	Concentration							
					Mass							

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TABLE B. TOXIC METALS, CYANIDE, TOTAL PHENOLS, AND ORGANIC TOXIC POLLUTANTS (40 CFR 122.21(g)(7)(v))[1]

	Pollutant/Parameter (and CAS Number, if available)	Testing Required	Presence or Absence (check one)		Units (specify)		Effluent				Intake (optional)	
			Believed Present	Believed Absent			Maximum Daily Discharge (required)	Maximum Monthly Discharge (if available)	Long-Term Average Daily Discharge (if available)	Number of Analyses	Long-Term Average Value	Number of Analyses
4.33	Hexachlorobenzene (118-74-1)	☐	☐	☑	Concentration							
					Mass							
4.34	Hexachlorobutadiene (87-68-3)	☐	☐	☑	Concentration							
					Mass							
4.35	Hexachlorocyclopentadiene (77-47-4)	☐	☐	☑	Concentration							
					Mass							
4.36	Hexachloroethane (67-72-1)	☐	☐	☑	Concentration							
					Mass							
4.37	Indeno (1,2,3-cd) pyrene (193-39-5)	☐	☐	☑	Concentration							
					Mass							
4.38	Isophorone (78-59-1)	☐	☐	☑	Concentration							
					Mass							
4.39	Naphthalene (91-20-3)	☐	☐	☑	Concentration							
					Mass							
4.40	Nitrobenzene (98-95-3)	☐	☐	☑	Concentration							
					Mass							
4.41	N-nitrosodimethylamine (62-75-9)	☐	☐	☑	Concentration							
					Mass							
4.42	N-nitrosodi-n-propylamine (621-64-7)	☐	☐	☑	Concentration							
					Mass							
4.43	N-nitrosodiphenylamine (86-30-6)	☐	☐	☑	Concentration							
					Mass							
4.44	Phenanthrene (85-01-8)	☐	☐	☑	Concentration							
					Mass							
4.45	Pyrene (129-00-0)	☐	☐	☑	Concentration							
					Mass							

TABLE B. TOXIC METALS, CYANIDE, TOTAL PHENOLS, AND ORGANIC TOXIC POLLUTANTS (40 CFR 122.21(g)(7)(v))[1]

	Pollutant/Parameter (and CAS Number, if available)	Testing Required	Presence or Absence (check one): Believed Present	Presence or Absence (check one): Believed Absent	Units (specify)		Effluent: Maximum Daily Discharge (required)	Effluent: Maximum Monthly Discharge (if available)	Effluent: Long-Term Average Daily Discharge (if available)	Effluent: Number of Analyses	Intake (optional): Long-Term Average Value	Intake (optional): Number of Analyses
4.46	1,2,4-trichlorobenzene (120-82-1)	☐	☐	☑	Concentration							
					Mass							
Section 5. Organic Toxic Pollutants (GC/MS Fraction—Pesticides)												
5.1	Aldrin (309-00-2)	☐	☐	☑	Concentration							
					Mass							
5.2	α-BHC (319-84-6)	☐	☐	☑	Concentration							
					Mass							
5.3	β-BHC (319-85-7)	☐	☐	☑	Concentration							
					Mass							
5.4	γ-BHC (58-89-9)	☐	☐	☑	Concentration							
					Mass							
5.5	δ-BHC (319-86-8)	☐	☐	☑	Concentration							
					Mass							
5.6	Chlordane (57-74-9)	☐	☐	☑	Concentration							
					Mass							
5.7	4,4'-DDT (50-29-3)	☐	☐	☑	Concentration							
					Mass							
5.8	4,4'-DDE (72-55-9)	☐	☐	☑	Concentration							
					Mass							
5.9	4,4'-DDD (72-54-8)	☐	☐	☑	Concentration							
					Mass							
5.10	Dieldrin (60-57-1)	☐	☐	☑	Concentration							
					Mass							
5.11	α-endosulfan (115-29-7)	☐	☐	☑	Concentration							
					Mass							

TABLE B. TOXIC METALS, CYANIDE, TOTAL PHENOLS, AND ORGANIC TOXIC POLLUTANTS (40 CFR 122.21(g)(7)(v))[1]

	Pollutant/Parameter (and CAS Number, if available)	Testing Required	Presence or Absence (check one)		Units (specify)		Effluent				Intake (optional)	
			Believed Present	Believed Absent			Maximum Daily Discharge (required)	Maximum Monthly Discharge (if available)	Long-Term Average Daily Discharge (if available)	Number of Analyses	Long-Term Average Value	Number of Analyses
5.12	β-endosulfan (115-29-7)	☐	☐	☑	Concentration							
					Mass							
5.13	Endosulfan sulfate (1031-07-8)	☐	☐	☑	Concentration							
					Mass							
5.14	Endrin (72-20-8)	☐	☐	☑	Concentration							
					Mass							
5.15	Endrin aldehyde (7421-93-4)	☐	☐	☑	Concentration							
					Mass							
5.16	Heptachlor (76-44-8)	☐	☐	☑	Concentration							
					Mass							
5.17	Heptachlor epoxide (1024-57-3)	☐	☐	☑	Concentration							
					Mass							
5.18	PCB-1242 (53469-21-9)	☐	☐	☑	Concentration	mg/L	<0.001			4		
					Mass							
5.19	PCB-1254 (11097-69-1)	☐	☐	☑	Concentration	mg/L	<0.001			4		
					Mass							
5.20	PCB-1221 (11104-28-2)	☐	☐	☑	Concentration	mg/L	<0.001			4		
					Mass							
5.21	PCB-1232 (11141-16-5)	☐	☐	☑	Concentration	mg/L	<0.001			4		
					Mass							
5.22	PCB-1248 (12672-29-6)	☐	☐	☑	Concentration	mg/L	<0.001			4		
					Mass							
5.23	PCB-1260 (11096-82-5)	☐	☐	☑	Concentration	mg/L	<0.001			4		
					Mass							
5.24	PCB-1016 (12674-11-2)	☐	☐	☑	Concentration	mg/L	<0.001			4		
					Mass							

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TABLE B. TOXIC METALS, CYANIDE, TOTAL PHENOLS, AND ORGANIC TOXIC POLLUTANTS (40 CFR 122.21(g)(7)(v))[1]

	Pollutant/Parameter (and CAS Number, if available)	Testing Required	Presence or Absence (check one)		Units (specify)		Effluent				Intake (optional)	
			Believed Present	Believed Absent			Maximum Daily Discharge (required)	Maximum Monthly Discharge (if available)	Long-Term Average Daily Discharge (if available)	Number of Analyses	Long-Term Average Value	Number of Analyses
5.25	Toxaphene (8001-35-2)	☐	☐	☑	Concentration							
					Mass							

[1] Sampling shall be conducted according to sufficiently sensitive test procedures (i.e., methods) approved under 40 CFR 136 for the analysis of pollutants or pollutant parameters or required under 40 CFR Chapter I, Subchapter N or O. See instructions and 40 CFR 122.21(e)(3).

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TABLE C. CERTAIN CONVENTIONAL AND NON CONVENTIONAL POLLUTANTS (40 CFR 122.21(g)(7)(vi))[1]

☐ Check here if you believe all pollutants in Table C to be ***present*** in your discharge from the noted outfall. You need *not* complete the "Presence or Absence" column of Table C for *each* pollutant.

☐ Check here if you believe all pollutants in Table C to be ***absent*** in your discharge from the noted outfall. You need *not* complete the "Presence or Absence" column of Table C for *each* pollutant.

	Pollutant	Presence or Absence (check one)		Units (specify)		Effluent				Intake (optional)	
		Believed Present	Believed Absent			Maximum Daily Discharge (required)	Maximum Monthly Discharge (if available)	Long-Term Average Daily Discharge (if available)	Number of Analyses	Long-Term Average Value	Number of Analyses
1.	Bromide (24959-67-9)	☑	☐	Concentration	mg/L	<0.200			1	<0.200	1
				Mass							
2.	Chlorine, total residual	☑	☐	Concentration	mg/L	<0.047		<0.027	46	0.01	4
				Mass							
3.	Color	☑	☐	Concentration	PCU	30.0			1	20.0	1
				Mass							
4.	Fecal coliform	☐	☑	Concentration							
				Mass							
5.	Fluoride (16984-48-8)	☑	☐	Concentration	mg/L	<0.100			1	<0.100	1
				Mass							
6	Nitrate-nitrite	☑	☐	Concentration	mg/L	0.168			1	0.146	1
				Mass							
7.	Nitrogen, total organic (as N)	☑	☐	Concentration	mg/L	0.229			1	0.265	1
				Mass							
8.	Oil and grease	☑	☐	Concentration	mg/L	<5.578			4	<5.6025	4
				Mass							
9.	Phosphorus (as P), total (7723-14-0)	☑	☐	Concentration	mg/L	<0.0500			1	<0.0500	1
				Mass							
10.	Sulfate (as SO_4) (14808-79-8)	☑	☐	Concentration	mg/L	7.72			1	7.66	1
				Mass							
11.	Sulfide (as S)	☑	☐	Concentration	mg/L	<0.100			1	<0.100	1
				Mass							

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TABLE C. CERTAIN CONVENTIONAL AND NON CONVENTIONAL POLLUTANTS (40 CFR 122.21(g)(7)(vi))[1]

	Pollutant	Presence or Absence (check one)		Units (specify)		Effluent				Intake (optional)	
		Believed Present	Believed Absent			Maximum Daily Discharge (required)	Maximum Monthly Discharge (if available)	Long-Term Average Daily Discharge (if available)	Number of Analyses	Long-Term Average Value	Number of Analyses
12.	Sulfite (as SO_3) (14265-45-3)	☑	☐	Concentration	mg/L	3.2			4	5.12	4
				Mass							
13.	Surfactants	☑	☐	Concentration	mg/L	0.0519			1	<0.0500	1
				Mass							
14.	Aluminum, total (7429-90-5)	☑	☐	Concentration	mg/L	0.0531			1	<0.050	1
				Mass							
15.	Barium, total (7440-39-3)	☑	☐	Concentration	mg/L	0.0296			1	0.0266	1
				Mass							
16.	Boron, total (7440-42-8)	☑	☐	Concentration	mg/L	0.015			1	<0.015	1
				Mass							
17.	Cobalt, total (7440-48-4)	☑	☐	Concentration	mg/L	<0.001			1	<0.001	1
				Mass							
18.	Iron, total (7439-89-6)	☑	☐	Concentration	mg/L	0.103			1	<0.100	1
				Mass							
19.	Magnesium, total (7439-95-4)	☑	☐	Concentration	mg/L	5.08			1	5.18	1
				Mass							
20.	Molybdenum, total (7439-98-7)	☑	☐	Concentration	mg/L	<0.001			1	<0.001	1
				Mass							
21.	Manganese, total (7439-96-5)	☑	☐	Concentration	mg/L	0.385			1	0.202	1
				Mass							
22.	Tin, total (7440-31-5)	☑	☐	Concentration	mg/L	<0.005			1	<0.005	1
				Mass							
23.	Titanium, total (7440-32-6)	☑	☐	Concentration	mg/L	<0.010			1	<0.010	1
				Mass							

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TABLE C. CERTAIN CONVENTIONAL AND NON CONVENTIONAL POLLUTANTS (40 CFR 122.21(g)(7)(vi))[1]

	Pollutant	Presence or Absence (check one)		Units (specify)		Effluent				Intake (optional)	
		Believed Present	Believed Absent			Maximum Daily Discharge (required)	Maximum Monthly Discharge (if available)	Long-Term Average Daily Discharge (if available)	Number of Analyses	Long-Term Average Value	Number of Analyses
24.	**Radioactivity**										
	Alpha, total	☐	☑	Concentration	pCi/L	<3.00				<3.00	1
				Mass							
	Beta, total	☐	☑	Concentration	pCi/L	<4.00				<4.00	1
				Mass							
	Radium, total	☐	☑	Concentration	pCi/L	<3.00				<3.00	1
				Mass							
	Radium 226, total	☐	☑	Concentration	pCi/L	1.25				<1.00	1
				Mass							

[1] Sampling shall be conducted according to sufficiently sensitive test procedures (i.e., methods) approved under 40 CFR 136 for the analysis of pollutants or pollutant parameters or required under 40 CFR Chapter I, Subchapter N or O. See instructions and 40 CFR 122.21(e)(3).

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TABLE D. CERTAIN HAZARDOUS SUBSTANCES AND ASBESTOS (40 CFR 122.21(g)(7)(vii))[1]

	Pollutant	Presence or Absence (check one)		Reason Pollutant Believed Present in Discharge	Available Quantitative Data (specify units)
		Believed Present	Believed Absent		
1.	Asbestos	☐	☑		
2.	Acetaldehyde	☐	☑		
3.	Allyl alcohol	☐	☑		
4.	Allyl chloride	☐	☑		
5.	Amyl acetate	☐	☑		
6.	Aniline	☐	☑		
7.	Benzonitrile	☐	☑		
8.	Benzyl chloride	☐	☑		
9.	Butyl acetate	☐	☑		
10.	Butylamine	☐	☑		
11.	Captan	☐	☑		
12.	Carbaryl	☐	☑		
13.	Carbofuran	☐	☑		
14.	Carbon disulfide	☐	☑		
15.	Chlorpyrifos	☐	☑		
16.	Coumaphos	☐	☑		
17.	Cresol	☐	☑		
18.	Crotonaldehyde	☐	☑		
19.	Cyclohexane	☐	☑		

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TABLE D. CERTAIN HAZARDOUS SUBSTANCES AND ASBESTOS (40 CFR 122.21(g)(7)(vii))[1]

	Pollutant	Presence or Absence (check one)		Reason Pollutant Believed Present in Discharge	Available Quantitative Data (specify units)
		Believed Present	Believed Absent		
20.	2,4-D (2,4-dichlorophenoxyacetic acid)	☐	☑		
21.	Diazinon	☐	☑		
22.	Dicamba	☐	☑		
23.	Dichlobenil	☐	☑		
24.	Dichlone	☐	☑		
25.	2,2-dichloropropionic acid	☐	☑		
26.	Dichlorvos	☐	☑		
27.	Diethyl amine	☐	☑		
28.	Dimethyl amine	☐	☑	See Biocide Corrosion Treatment Plan (B/CTP)	See below*
29.	Dintrobenzene	☐	☑		
30.	Diquat	☐	☑		
31.	Disulfoton	☐	☑		
32.	Diuron	☐	☑		
33.	Epichlorohydrin	☐	☑		
34.	Ethion	☐	☑		
35.	Ethylene diamine	☐	☑		
36.	Ethylene dibromide	☐	☑		
37.	Formaldehyde	☐	☑		
38.	Furfural	☐	☑		

*The use of dimethylamine will not result in detectible quantities at Outfall 101

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TABLE D. CERTAIN HAZARDOUS SUBSTANCES AND ASBESTOS (40 CFR 122.21(g)(7)(vii))[1]

	Pollutant	Presence or Absence (check one)		Reason Pollutant Believed Present in Discharge	Available Quantitative Data (specify units)
		Believed Present	Believed Absent		
39.	Guthion	☐	☑		
40.	Isoprene	☐	☑		
41.	Isopropanolamine	☐	☑		
42.	Kelthane	☐	☑		
43.	Kepone	☐	☑		
44.	Malathion	☐	☑		
45.	Mercaptodimethur	☐	☑		
46.	Methoxychlor	☐	☑		
47.	Methyl mercaptan	☐	☑		
48.	Methyl methacrylate	☐	☑		
49.	Methyl parathion	☐	☑		
50.	Mevinphos	☐	☑		
51.	Mexacarbate	☐	☑		
52.	Monoethyl amine	☐	☑		
53.	Monomethyl amine	☐	☑		
54.	Naled	☐	☑		
55.	Naphthenic acid	☐	☑		
56.	Nitrotoluene	☐	☑		
57.	Parathion	☐	☑		

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TABLE D. CERTAIN HAZARDOUS SUBSTANCES AND ASBESTOS (40 CFR 122.21(g)(7)(vii))[1]

	Pollutant	Presence or Absence (check one)		Reason Pollutant Believed Present in Discharge	Available Quantitative Data (specify units)
		Believed Present	Believed Absent		
58.	Phenolsulfonate	☐	☑		
59.	Phosgene	☐	☑		
60.	Propargite	☐	☑		
61.	Propylene oxide	☐	☑		
62.	Pyrethrins	☐	☑		
63.	Quinoline	☐	☑		
64.	Resorcinol	☐	☑		
65.	Strontium	☐	☑		
66.	Strychnine	☐	☑		
67.	Styrene	☐	☑		
68.	2,4,5-T (2,4,5-trichlorophenoxyacetic acid)	☐	☑		
69.	TDE (tetrachlorodiphenyl ethane)	☐	☑		
70.	2,4,5-TP [2-(2,4,5-trichlorophenoxy) propanoic acid]	☐	☑		
71.	Trichlorofon	☐	☑		
72.	Triethanolamine	☐	☑		
73.	Triethylamine	☐	☑		
74.	Trimethylamine	☐	☑		
75.	Uranium	☐	☑		
76.	Vanadium	☐	☑		

TABLE D. CERTAIN HAZARDOUS SUBSTANCES AND ASBESTOS (40 CFR 122.21(g)(7)(vii))[1]

	Pollutant	Presence or Absence (check one)		Reason Pollutant Believed Present in Discharge	Available Quantitative Data (specify units)
		Believed Present	Believed Absent		
77.	Vinyl acetate	☐	☑		
78.	Xylene	☐	☑		
79.	Xylenol	☐	☑		
80.	Zirconium	☐	☑		

[1] Sampling shall be conducted according to sufficiently sensitive test procedures (i.e., methods) approved under 40 CFR 136 for the analysis of pollutants or pollutant parameters or required under 40 CFR Chapter I, Subchapter N or O. See instructions and 40 CFR 122.21(e)(3).

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TABLE E. 2,3,7,8 TETRACHLORODIBENZO P DIOXIN (2,3,7,8 TCDD) (40 CFR 122.21(g)(7)(viii))

Pollutant	TCDD Congeners Used or Manufactured	Presence or Absence (check one)		Results of Screening Procedure
		Believed Present	Believed Absent	
2,3,7,8-TCDD	☐	☐	☑	

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TABLE A. CONVENTIONAL AND NON CONVENTIONAL POLLUTANTS (40 CFR 122.21(g)(7)(iii))[1]

	Pollutant	Waiver Requested (if applicable)	Units (specify)		Effluent				Intake (optional)	
					Maximum Daily Discharge (required)	Maximum Monthly Discharge (if available)	Long-Term Average Daily Discharge (if available)	Number of Analyses	Long-Term Average Value	Number of Analyses
☐	Check here if you have applied to your NPDES permitting authority for a waiver for *all* of the pollutants listed on this table for the noted outfall.									
1.	Biochemical oxygen demand (BOD_5)	☐	Concentration	mg/L	3.05			1		
			Mass							
2.	Chemical oxygen demand (COD)	☐	Concentration	mg/L	<20.0			1		
			Mass							
3.	Total organic carbon (TOC)	☐	Concentration	mg/L	1.84			1		
			Mass							
4.	Total suspended solids (TSS)	☐	Concentration	mg/L	30.3		10.1	46		
			Mass							
5.	Ammonia (as N)	☐	Concentration	mg/L	0.0630			1		
			Mass							
6.	Flow	☐	Rate	MGD	2.214		1.326	46		
7.	Temperature (winter)	☐	°C	°C						
	Temperature (summer)	☐	°C	°C	32.2			4		
8.	pH (minimum)	☐	Standard units	s.u.	6			50		
	pH (maximum)	☐	Standard units	s.u.	8.8			50		

[1] Sampling shall be conducted according to sufficiently sensitive test procedures (i.e., methods) approved under 40 CFR 136 for the analysis of pollutants or pollutant parameters or required under 40 CFR Chapter I, Subchapter N or O. See instructions and 40 CFR 122.21(e)(3).

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TABLE B. TOXIC METALS, CYANIDE, TOTAL PHENOLS, AND ORGANIC TOXIC POLLUTANTS (40 CFR 122.21(g)(7)(v))[1]

	Pollutant/Parameter (and CAS Number, if available)	Testing Required	Presence or Absence (check one)		Units (specify)		Effluent				Intake (optional)	
			Believed Present	Believed Absent			Maximum Daily Discharge (required)	Maximum Monthly Discharge (if available)	Long-Term Average Daily Discharge (if available)	Number of Analyses	Long-Term Average Value	Number of Analyses
☐	Check here if you qualify as a small business per the instructions to Form 2C and, therefore, do not need to submit quantitative data for any of the organic toxic pollutants in Sections 2 through 5 of this table. Note, however, that you must still indicate in the appropriate column of this table if you believe any of the pollutants listed are present in your discharge.											
Section 1. Toxic Metals, Cyanide, and Total Phenols												
1.1	Antimony, total (7440-36-0)	☑	☐	☐	Concentration	mg/l	<0.003			1		
					Mass							
1.2	Arsenic, total (7440-38-2)	☑	☐	☐	Concentration	mg/L	<0.005			1		
					Mass							
1.3	Beryllium, total (7440-41-7)	☑	☐	☐	Concentration	mg/L	<0.0005			1		
					Mass							
1.4	Cadmium, total (7440-43-9)	☑	☐	☐	Concentration	mg/L	<0.001			1		
					Mass							
1.5	Chromium, total (7440-47-3)	☑	☐	☐	Concentration	mg/L	<0.010			1		
					Mass							
1.6	Copper, total (7440-50-8)	☑	☐	☐	Concentration	mg/L	0.00235			1		
					Mass							
1.7	Lead, total (7439-92-1)	☑	☐	☐	Concentration	mg/L	<0.002			1		
					Mass							
1.8	Mercury, total (7439-97-6)	☑	☐	☐	Concentration	mg/L	8.82e-7			4		
					Mass							
1.9	Nickel, total (7440-02-0)	☑	☐	☐	Concentration	mg/L	<0.002			1		
					Mass							
1.10	Selenium, total (7782-49-2)	☑	☐	☐	Concentration	mg/L	<0.005			1		
					Mass							
1.11	Silver, total (7440-22-4)	☑	☐	☐	Concentration	mg/L	<0.001			1		
					Mass							

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TABLE B. TOXIC METALS, CYANIDE, TOTAL PHENOLS, AND ORGANIC TOXIC POLLUTANTS (40 CFR 122.21(g)(7)(v))[1]

	Pollutant/Parameter (and CAS Number, if available)	Testing Required	Presence or Absence (check one)		Units (specify)		Effluent				Intake (optional)	
			Believed Present	Believed Absent			Maximum Daily Discharge (required)	Maximum Monthly Discharge (if available)	Long-Term Average Daily Discharge (if available)	Number of Analyses	Long-Term Average Value	Number of Analyses
1.12	Thallium, total (7440-28-0)	☑	☐	☐	Concentration	mg/L	<0.002			1		
					Mass							
1.13	Zinc, total (7440-66-6)	☑	☐	☐	Concentration	mg/L	<0.020			1		
					Mass							
1.14	Cyanide, total (57-12-5)	☑	☐	☐	Concentration	mg/L	<0.005			4		
					Mass							
1.15	Phenols, total	☑	☐	☐	Concentration	mg/L	<0.005			4		
					Mass							
Section 2. Organic Toxic Pollutants (GC/MS Fraction—Volatile Compounds)												
2.1	Acrolein (107-02-8)	☑	☐	☐	Concentration	mg/L	<0.005			1		
					Mass							
2.2	Acrylonitrile (107-13-1)	☑	☐	☐	Concentration	mg/L	<0.005			1		
					Mass							
2.3	Benzene (71-43-2)	☑	☐	☐	Concentration	mg/L	<0.001			1		
					Mass							
2.4	Bromoform (75-25-2)	☑	☐	☐	Concentration	mg/L	<0.001			1		
					Mass							
2.5	Carbon tetrachloride (56-23-5)	☑	☐	☐	Concentration	mg/L	<0.001			1		
					Mass							
2.6	Chlorobenzene (108-90-7)	☑	☐	☐	Concentration	mg/L	<0.001			1		
					Mass							
2.7	Chlorodibromomethane (124-48-1)	☑	☐	☐	Concentration	mg/L	<0.001			1		
					Mass							
2.8	Chloroethane (75-00-3)	☑	☐	☐	Concentration	mg/L	<0.001			1		
					Mass							

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	Pollutant/Parameter (and CAS Number, if available)	Testing Required	Presence or Absence (check one)		Units (specify)		Effluent				Intake (optional)	
			Believed Present	Believed Absent			Maximum Daily Discharge (required)	Maximum Monthly Discharge (if available)	Long-Term Average Daily Discharge (if available)	Number of Analyses	Long-Term Average Value	Number of Analyses
2.9	2-chloroethylvinyl ether (110-75-8)	☑	☐	☐	Concentration	mg/L	<0.005			1		
					Mass							
2.10	Chloroform (67-66-3)	☑	☐	☐	Concentration	mg/L	<0.001			1		
					Mass							
2.11	Dichlorobromomethane (75-27-4)	☑	☐	☐	Concentration	mg/L	<0.001			1		
					Mass							
2.12	1,1-dichloroethane (75-34-3)	☑	☐	☐	Concentration	mg/L	<0.001			1		
					Mass							
2.13	1,2-dichloroethane (107-06-2)	☑	☐	☐	Concentration	mg/L	<0.001			1		
					Mass							
2.14	1,1-dichloroethylene (75-35-4)	☑	☐	☐	Concentration	mg/L	<0.001			1		
					Mass							
2.15	1,2-dichloropropane (78-87-5)	☑	☐	☐	Concentration	mg/L	<0.001			1		
					Mass							
2.16	1,3-dichloropropylene (542-75-6)	☑	☐	☐	Concentration	mg/L	<0.001			1		
					Mass							
2.17	Ethylbenzene (100-41-4)	☑	☐	☐	Concentration	mg/L	<0.001			1		
					Mass							
2.18	Methyl bromide (74-83-9)	☑	☐	☐	Concentration	mg/L	<0.001			1		
					Mass							
2.19	Methyl chloride (74-87-3)	☑	☐	☐	Concentration	mg/L	<0.001			1		
					Mass							
2.20	Methylene chloride (75-09-2)	☑	☐	☐	Concentration	mg/L	3.35*			1		
					Mass							
2.21	1,1,2,2- tetrachloroethane (79-34-5)	☑	☐	☐	Concentration	mg/L	<0.001			1		
					Mass							

* The lab report flagged this analysis: "The target analyte was detected in the associated blank."

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TABLE B. TOXIC METALS, CYANIDE, TOTAL PHENOLS, AND ORGANIC TOXIC POLLUTANTS (40 CFR 122.21(g)(7)(v))[1]

	Pollutant/Parameter (and CAS Number, if available)	Testing Required	Presence or Absence (check one)		Units (specify)		Effluent				Intake (optional)	
			Believed Present	Believed Absent			Maximum Daily Discharge (required)	Maximum Monthly Discharge (if available)	Long-Term Average Daily Discharge (if available)	Number of Analyses	Long-Term Average Value	Number of Analyses
2.22	Tetrachloroethylene (127-18-4)	☑	☐	☐	Concentration	mg/L	<0.001			1		
					Mass							
2.23	Toluene (108-88-3)	☑	☐	☐	Concentration	mg/L	<0.001			1		
					Mass							
2.24	1,2-trans-dichloroethylene (156-60-5)	☑	☐	☐	Concentration	mg/L	<0.001			1		
					Mass							
2.25	1,1,1-trichloroethane (71-55-6)	☑	☐	☐	Concentration	mg/L	<0.001			1		
					Mass							
2.26	1,1,2-trichloroethane (79-00-5)	☑	☐	☐	Concentration	mg/L	<0.001			1		
					Mass							
2.27	Trichloroethylene (79-01-6)	☑	☐	☐	Concentration	mg/L	<0.001			1		
					Mass							
2.28	Vinyl chloride (75-01-4)	☑	☐	☐	Concentration	mg/L	<0.001			1		
					Mass							
Section 3. Organic Toxic Pollutants (GC/MS Fraction—Acid Compounds)												
3.1	2-chlorophenol (95-57-8)	☑	☐	☐	Concentration	mg/L	<0.00950			1		
					Mass							
3.2	2,4-dichlorophenol (120-83-2)	☑	☐	☐	Concentration	mg/L	<0.00950			1		
					Mass							
3.3	2,4-dimethylphenol (105-67-9)	☑	☐	☐	Concentration	mg/L	<0.00950			1		
					Mass							
3.4	4,6-dinitro-o-cresol (534-52-1)	☑	☐	☐	Concentration	mg/L	<0.00950			1		
					Mass							
3.5	2,4-dinitrophenol (51-28-5)	☑	☐	☐	Concentration	mg/L	<0.019			1		
					Mass							

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	Pollutant/Parameter (and CAS Number, if available)	Testing Required	Presence or Absence (check one)		Units (specify)		Effluent				Intake (optional)	
			Believed Present	Believed Absent			Maximum Daily Discharge (required)	Maximum Monthly Discharge (if available)	Long-Term Average Daily Discharge (if available)	Number of Analyses	Long-Term Average Value	Number of Analyses
3.6	2-nitrophenol (88-75-5)	☑	☐	☐	Concentration	mg/L	<0.00950			1		
					Mass							
3.7	4-nitrophenol (100-02-7)	☑	☐	☐	Concentration	mg/L	<0.00950			1		
					Mass							
3.8	p-chloro-m-cresol (59-50-7)	☑	☐	☐	Concentration	mg/L	<0.00950			1		
					Mass							
3.9	Pentachlorophenol (87-86-5)	☑	☐	☐	Concentration	mg/L	<0.00950			1		
					Mass							
3.10	Phenol (108-95-2)	☑	☐	☐	Concentration	mg/L	<0.00950			1		
					Mass							
3.11	2,4,6-trichlorophenol (88-05-2)	☑	☐	☐	Concentration	mg/L	<0.00950			1		
					Mass							
Section 4. Organic Toxic Pollutants (GC/MS Fraction—Base /Neutral Compounds)												
4.1	Acenaphthene (83-32-9)	☐	☐	☑	Concentration							
					Mass							
4.2	Acenaphthylene (208-96-8)	☐	☐	☑	Concentration							
					Mass							
4.3	Anthracene (120-12-7)	☐	☐	☑	Concentration							
					Mass							
4.4	Benzidine (92-87-5)	☐	☐	☑	Concentration							
					Mass							
4.5	Benzo (a) anthracene (56-55-3)	☐	☐	☑	Concentration							
					Mass							
4.6	Benzo (a) pyrene (50-32-8)	☐	☐	☑	Concentration							
					Mass							

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	Pollutant/Parameter (and CAS Number, if available)	Testing Required	Presence or Absence (check one)		Units (specify)		Effluent				Intake (optional)	
			Believed Present	Believed Absent			Maximum Daily Discharge (required)	Maximum Monthly Discharge (if available)	Long-Term Average Daily Discharge (if available)	Number of Analyses	Long-Term Average Value	Number of Analyses
4.7	3,4-benzofluoranthene (205-99-2)	☐	☐	☑	Concentration							
					Mass							
4.8	Benzo (ghi) perylene (191-24-2)	☐	☐	☑	Concentration							
					Mass							
4.9	Benzo (k) fluoranthene (207-08-9)	☐	☐	☑	Concentration							
					Mass							
4.10	Bis (2-chloroethoxy) methane (111-91-1)	☐	☐	☑	Concentration							
					Mass							
4.11	Bis (2-chloroethyl) ether (111-44-4)	☐	☐	☑	Concentration							
					Mass							
4.12	Bis (2-chloroisopropyl) ether (102-80-1)	☐	☐	☑	Concentration							
					Mass							
4.13	Bis (2-ethylhexyl) phthalate (117-81-7)	☐	☐	☑	Concentration							
					Mass							
4.14	4-bromophenyl phenyl ether (101-55-3)	☐	☐	☑	Concentration							
					Mass							
4.15	Butyl benzyl phthalate (85-68-7)	☐	☐	☑	Concentration							
					Mass							
4.16	2-chloronaphthalene (91-58-7)	☐	☐	☑	Concentration							
					Mass							
4.17	4-chlorophenyl phenyl ether (7005-72-3)	☐	☐	☑	Concentration							
					Mass							
4.18	Chrysene (218-01-9)	☐	☐	☑	Concentration							
					Mass							
4.19	Dibenzo (a,h) anthracene (53-70-3)	☐	☐	☑	Concentration							
					Mass							

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	Pollutant/Parameter (and CAS Number, if available)	Testing Required	Presence or Absence (check one)		Units (specify)		Effluent				Intake (optional)	
			Believed Present	Believed Absent			Maximum Daily Discharge (required)	Maximum Monthly Discharge (if available)	Long-Term Average Daily Discharge (if available)	Number of Analyses	Long-Term Average Value	Number of Analyses
4.20	1,2-dichlorobenzene (95-50-1)	☐	☐	☑	Concentration							
					Mass							
4.21	1,3-dichlorobenzene (541-73-1)	☐	☐	☑	Concentration							
					Mass							
4.22	1,4-dichlorobenzene (106-46-7)	☐	☐	☑	Concentration							
					Mass							
4.23	3,3-dichlorobenzidine (91-94-1)	☐	☐	☑	Concentration							
					Mass							
4.24	Diethyl phthalate (84-66-2)	☐	☐	☑	Concentration							
					Mass							
4.25	Dimethyl phthalate (131-11-3)	☐	☐	☑	Concentration							
					Mass							
4.26	Di-n-butyl phthalate (84-74-2)	☐	☐	☑	Concentration							
					Mass							
4.27	2,4-dinitrotoluene (121-14-2)	☐	☐	☑	Concentration							
					Mass							
4.28	2,6-dinitrotoluene (606-20-2)	☐	☐	☑	Concentration							
					Mass							
4.29	Di-n-octyl phthalate (117-84-0)	☐	☐	☑	Concentration							
					Mass							
4.30	1,2-Diphenylhydrazine (as azobenzene) (122-66-7)	☐	☐	☑	Concentration							
					Mass							
4.31	Fluoranthene (206-44-0)	☐	☐	☑	Concentration							
					Mass							
4.32	Fluorene (86-73-7)	☐	☐	☑	Concentration							
					Mass							

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TN5640020504	TN0026450	Sequoyah Nuclear Plant (SQN)	103

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TABLE B. TOXIC METALS, CYANIDE, TOTAL PHENOLS, AND ORGANIC TOXIC POLLUTANTS (40 CFR 122.21(g)(7)(v))[1]

	Pollutant/Parameter (and CAS Number, if available)	Testing Required	Presence or Absence (check one)		Units (specify)		Effluent				Intake (optional)	
			Believed Present	Believed Absent			Maximum Daily Discharge (required)	Maximum Monthly Discharge (if available)	Long-Term Average Daily Discharge (if available)	Number of Analyses	Long-Term Average Value	Number of Analyses
4.33	Hexachlorobenzene (118-74-1)	☐	☐	☑	Concentration							
					Mass							
4.34	Hexachlorobutadiene (87-68-3)	☐	☐	☑	Concentration							
					Mass							
4.35	Hexachlorocyclopentadiene (77-47-4)	☐	☐	☑	Concentration							
					Mass							
4.36	Hexachloroethane (67-72-1)	☐	☐	☑	Concentration							
					Mass							
4.37	Indeno (1,2,3-cd) pyrene (193-39-5)	☐	☐	☑	Concentration							
					Mass							
4.38	Isophorone (78-59-1)	☐	☐	☑	Concentration							
					Mass							
4.39	Naphthalene (91-20-3)	☐	☐	☑	Concentration							
					Mass							
4.40	Nitrobenzene (98-95-3)	☐	☐	☑	Concentration							
					Mass							
4.41	N-nitrosodimethylamine (62-75-9)	☐	☐	☑	Concentration							
					Mass							
4.42	N-nitrosodi-n-propylamine (621-64-7)	☐	☐	☑	Concentration							
					Mass							
4.43	N-nitrosodiphenylamine (86-30-6)	☐	☐	☑	Concentration							
					Mass							
4.44	Phenanthrene (85-01-8)	☐	☐	☑	Concentration							
					Mass							
4.45	Pyrene (129-00-0)	☐	☐	☑	Concentration							
					Mass							

EPA Identification Number	NPDES Permit Number	Facility Name	Outfall Number
TN5640020504	TN0026450	Sequoyah Nuclear Plant (SQN)	103

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TABLE B. TOXIC METALS, CYANIDE, TOTAL PHENOLS, AND ORGANIC TOXIC POLLUTANTS (40 CFR 122.21(g)(7)(v))[1]

	Pollutant/Parameter (and CAS Number, if available)	Testing Required	Presence or Absence (check one)		Units (specify)		Effluent				Intake (optional)	
			Believed Present	Believed Absent			Maximum Daily Discharge (required)	Maximum Monthly Discharge (if available)	Long-Term Average Daily Discharge (if available)	Number of Analyses	Long-Term Average Value	Number of Analyses
4.46	1,2,4-trichlorobenzene (120-82-1)	☐	☐	☑	Concentration							
					Mass							
Section 5. Organic Toxic Pollutants (GC/MS Fraction—Pesticides)												
5.1	Aldrin (309-00-2)	☐	☐	☑	Concentration							
					Mass							
5.2	α-BHC (319-84-6)	☐	☐	☑	Concentration							
					Mass							
5.3	β-BHC (319-85-7)	☐	☐	☑	Concentration							
					Mass							
5.4	γ-BHC (58-89-9)	☐	☐	☑	Concentration							
					Mass							
5.5	δ-BHC (319-86-8)	☐	☐	☑	Concentration							
					Mass							
5.6	Chlordane (57-74-9)	☐	☐	☑	Concentration							
					Mass							
5.7	4,4'-DDT (50-29-3)	☐	☐	☑	Concentration							
					Mass							
5.8	4,4'-DDE (72-55-9)	☐	☐	☑	Concentration							
					Mass							
5.9	4,4'-DDD (72-54-8)	☐	☐	☑	Concentration							
					Mass							
5.10	Dieldrin (60-57-1)	☐	☐	☑	Concentration							
					Mass							
5.11	α-endosulfan (115-29-7)	☐	☐	☑	Concentration							
					Mass							

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TABLE B. TOXIC METALS, CYANIDE, TOTAL PHENOLS, AND ORGANIC TOXIC POLLUTANTS (40 CFR 122.21(g)(7)(v))[1]

	Pollutant/Parameter (and CAS Number, if available)	Testing Required	Presence or Absence (check one)		Units (specify)		Effluent				Intake (optional)	
			Believed Present	Believed Absent			Maximum Daily Discharge (required)	Maximum Monthly Discharge (if available)	Long-Term Average Daily Discharge (if available)	Number of Analyses	Long-Term Average Value	Number of Analyses
5.12	β-endosulfan (115-29-7)	☐	☐	☑	Concentration							
					Mass							
5.13	Endosulfan sulfate (1031-07-8)	☐	☐	☑	Concentration							
					Mass							
5.14	Endrin (72-20-8)	☐	☐	☑	Concentration							
					Mass							
5.15	Endrin aldehyde (7421-93-4)	☐	☐	☑	Concentration							
					Mass							
5.16	Heptachlor (76-44-8)	☐	☐	☑	Concentration							
					Mass							
5.17	Heptachlor epoxide (1024-57-3)	☐	☐	☑	Concentration							
					Mass							
5.18	PCB-1242 (53469-21-9)	☐	☐	☑	Concentration							
					Mass							
5.19	PCB-1254 (11097-69-1)	☐	☐	☑	Concentration							
					Mass							
5.20	PCB-1221 (11104-28-2)	☐	☐	☑	Concentration							
					Mass							
5.21	PCB-1232 (11141-16-5)	☐	☐	☑	Concentration							
					Mass							
5.22	PCB-1248 (12672-29-6)	☐	☐	☑	Concentration							
					Mass							
5.23	PCB-1260 (11096-82-5)	☐	☐	☑	Concentration							
					Mass							
5.24	PCB-1016 (12674-11-2)	☐	☐	☑	Concentration							
					Mass							

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TABLE B. TOXIC METALS, CYANIDE, TOTAL PHENOLS, AND ORGANIC TOXIC POLLUTANTS (40 CFR 122.21(g)(7)(v))[1]

	Pollutant/Parameter (and CAS Number, if available)	Testing Required	Presence or Absence (check one)		Units (specify)		Effluent				Intake (optional)	
			Believed Present	Believed Absent			Maximum Daily Discharge (required)	Maximum Monthly Discharge (if available)	Long-Term Average Daily Discharge (if available)	Number of Analyses	Long-Term Average Value	Number of Analyses
5.25	Toxaphene (8001-35-2)	☐	☐	☑	Concentration							
					Mass							

[1] Sampling shall be conducted according to sufficiently sensitive test procedures (i.e., methods) approved under 40 CFR 136 for the analysis of pollutants or pollutant parameters or required under 40 CFR Chapter I, Subchapter N or O. See instructions and 40 CFR 122.21(e)(3).

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EPA Identification Number	NPDES Permit Number	Facility Name	Outfall Number
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TABLE C. CERTAIN CONVENTIONAL AND NON CONVENTIONAL POLLUTANTS (40 CFR 122.21(g)(7)(vi))[1]

	Pollutant	Presence or Absence (check one)		Units (specify)		Effluent				Intake (optional)	
		Believed Present	Believed Absent			Maximum Daily Discharge (required)	Maximum Monthly Discharge (if available)	Long-Term Average Daily Discharge (if available)	Number of Analyses	Long-Term Average Value	Number of Analyses
☐ Check here if you believe all pollutants in Table C to be ***present*** in your discharge from the noted outfall. You need *not* complete the "Presence or Absence" column of Table C for *each* pollutant.											
☐ Check here if you believe all pollutants in Table C to be ***absent*** in your discharge from the noted outfall. You need *not* complete the "Presence or Absence" column of Table C for *each* pollutant.											
1.	Bromide (24959-67-9)	☑	☐	Concentration	mg/L	<0.200			1		
				Mass							
2.	Chlorine, total residual	☑	☐	Concentration	mg/L	0.05			4		
				Mass							
3.	Color	☑	☐	Concentration	PCU	40.0			1		
				Mass							
4.	Fecal coliform	☐	☑	Concentration							
				Mass							
5.	Fluoride (16984-48-8)	☑	☐	Concentration	mg/L	<0.100			1		
				Mass							
6	Nitrate-nitrite	☑	☐	Concentration	mg/L	0.155			1		
				Mass							
7.	Nitrogen, total organic (as N)	☑	☐	Concentration	mg/L	0.544			1		
				Mass							
8.	Oil and grease	☑	☐	Concentration	mg/L	13		5.18	46		
				Mass							
9.	Phosphorus (as P), total (7723-14-0)	☑	☐	Concentration	mg/L	0.109			1		
				Mass							
10.	Sulfate (as SO_4) (14808-79-8)	☑	☐	Concentration	mg/L	7.84			1		
				Mass							
11.	Sulfide (as S)	☑	☐	Concentration	mg/L	<0.100			1		
				Mass							

EPA Identification Number	NPDES Permit Number	Facility Name	Outfall Number
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TABLE C. CERTAIN CONVENTIONAL AND NON CONVENTIONAL POLLUTANTS (40 CFR 122.21(g)(7)(vi))[1]

	Pollutant	Presence or Absence (check one)		Units (specify)		Effluent				Intake (optional)	
		Believed Present	Believed Absent			Maximum Daily Discharge (required)	Maximum Monthly Discharge (if available)	Long-Term Average Daily Discharge (if available)	Number of Analyses	Long-Term Average Value	Number of Analyses
12.	Sulfite (as SO_3) (14265-45-3)	☑	☐	Concentration	mg/L	3.2			4		
				Mass							
13.	Surfactants	☑	☐	Concentration	mg/L	<0.0500			1		
				Mass							
14.	Aluminum, total (7429-90-5)	☑	☐	Concentration	mg/L	0.0791			1		
				Mass							
15.	Barium, total (7440-39-3)	☑	☐	Concentration	mg/L	0.0329			1		
				Mass							
16.	Boron, total (7440-42-8)	☑	☐	Concentration	mg/L	0.0179			1		
				Mass							
17.	Cobalt, total (7440-48-4)	☑	☐	Concentration	mg/L	<0.001			1		
				Mass							
18.	Iron, total (7439-89-6)	☑	☐	Concentration	mg/L	0.148			1		
				Mass							
19.	Magnesium, total (7439-95-4)	☑	☐	Concentration	mg/L	5.43			1		
				Mass							
20.	Molybdenum, total (7439-98-7)	☑	☐	Concentration	mg/L	<0.001			1		
				Mass							
21.	Manganese, total (7439-96-5)	☑	☐	Concentration	mg/L	0.440			1		
				Mass							
22.	Tin, total (7440-31-5)	☑	☐	Concentration	mg/L	<0.005			1		
				Mass							
23.	Titanium, total (7440-32-6)	☑	☐	Concentration	mg/L	<0.01			1		
				Mass							

EPA Identification Number	NPDES Permit Number	Facility Name	Outfall Number
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TABLE C. CERTAIN CONVENTIONAL AND NON CONVENTIONAL POLLUTANTS (40 CFR 122.21(g)(7)(vi))[1]

	Pollutant	Presence or Absence (check one)		Units (specify)		Effluent				Intake (optional)	
		Believed Present	Believed Absent			Maximum Daily Discharge (required)	Maximum Monthly Discharge (if available)	Long-Term Average Daily Discharge (if available)	Number of Analyses	Long-Term Average Value	Number of Analyses
24.	**Radioactivity**										
	Alpha, total	☐	☐	Concentration	pCi/L	<3.00					
				Mass							
	Beta, total	☐	☐	Concentration	pCi/L	<4.00					
				Mass							
	Radium, total	☐	☐	Concentration	pCi/L	<3.00					
				Mass							
	Radium 226, total	☐	☐	Concentration	pCi/L	<1.00					
				Mass							

[1] Sampling shall be conducted according to sufficiently sensitive test procedures (i.e., methods) approved under 40 CFR 136 for the analysis of pollutants or pollutant parameters or required under 40 CFR Chapter I, Subchapter N or O. See instructions and 40 CFR 122.21(e)(3).

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TABLE D. CERTAIN HAZARDOUS SUBSTANCES AND ASBESTOS (40 CFR 122.21(g)(7)(vii))[1]

	Pollutant	Presence or Absence (check one)		Reason Pollutant Believed Present in Discharge	Available Quantitative Data (specify units)
		Believed Present	Believed Absent		
1.	Asbestos	☐	☑		
2.	Acetaldehyde	☐	☑		
3.	Allyl alcohol	☐	☑		
4.	Allyl chloride	☐	☑		
5.	Amyl acetate	☐	☑		
6.	Aniline	☐	☑		
7.	Benzonitrile	☐	☑		
8.	Benzyl chloride	☐	☑		
9.	Butyl acetate	☐	☑		
10.	Butylamine	☐	☑		
11.	Captan	☐	☑		
12.	Carbaryl	☐	☑		
13.	Carbofuran	☐	☑		
14.	Carbon disulfide	☐	☑		
15.	Chlorpyrifos	☐	☑		
16.	Coumaphos	☐	☑		
17.	Cresol	☐	☑		
18.	Crotonaldehyde	☐	☑		
19.	Cyclohexane	☐	☑		

EPA Identification Number	NPDES Permit Number	Facility Name	Outfall Number
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TABLE D. CERTAIN HAZARDOUS SUBSTANCES AND ASBESTOS (40 CFR 122.21(g)(7)(vii))[1]

	Pollutant	Presence or Absence (check one)		Reason Pollutant Believed Present in Discharge	Available Quantitative Data (specify units)
		Believed Present	Believed Absent		
20.	2,4-D (2,4-dichlorophenoxyacetic acid)	☐	☑		
21.	Diazinon	☐	☑		
22.	Dicamba	☐	☑		
23.	Dichlobenil	☐	☑		
24.	Dichlone	☐	☑		
25.	2,2-dichloropropionic acid	☐	☑		
26.	Dichlorvos	☐	☑		
27.	Diethyl amine	☐	☑		
28.	Dimethyl amine	☐	☑		
29.	Dintrobenzene	☐	☑		
30.	Diquat	☐	☑		
31.	Disulfoton	☐	☑		
32.	Diuron	☐	☑		
33.	Epichlorohydrin	☐	☑		
34.	Ethion	☐	☑		
35.	Ethylene diamine	☐	☑		
36.	Ethylene dibromide	☐	☑		
37.	Formaldehyde	☐	☑		
38.	Furfural	☐	☑		

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TABLE D. CERTAIN HAZARDOUS SUBSTANCES AND ASBESTOS (40 CFR 122.21(g)(7)(vii))[1]

	Pollutant	Presence or Absence (check one)		Reason Pollutant Believed Present in Discharge	Available Quantitative Data (specify units)
		Believed Present	Believed Absent		
39.	Guthion	☐	☑		
40.	Isoprene	☐	☑		
41.	Isopropanolamine	☐	☑		
42.	Kelthane	☐	☑		
43.	Kepone	☐	☑		
44.	Malathion	☐	☑		
45.	Mercaptodimethur	☐	☑		
46.	Methoxychlor	☐	☑		
47.	Methyl mercaptan	☐	☑		
48.	Methyl methacrylate	☐	☑		
49.	Methyl parathion	☐	☑		
50.	Mevinphos	☐	☑		
51.	Mexacarbate	☐	☑		
52.	Monoethyl amine	☐	☑		
53.	Monomethyl amine	☐	☑		
54.	Naled	☐	☑		
55.	Naphthenic acid	☐	☑		
56.	Nitrotoluene	☐	☑		
57.	Parathion	☐	☑		

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TABLE D. CERTAIN HAZARDOUS SUBSTANCES AND ASBESTOS (40 CFR 122.21(g)(7)(vii))[1]

	Pollutant	Presence or Absence (check one)		Reason Pollutant Believed Present in Discharge	Available Quantitative Data (specify units)
		Believed Present	Believed Absent		
58.	Phenolsulfonate	☐	☑		
59.	Phosgene	☐	☑		
60.	Propargite	☐	☑		
61.	Propylene oxide	☐	☑		
62.	Pyrethrins	☐	☑		
63.	Quinoline	☐	☑		
64.	Resorcinol	☐	☑		
65.	Strontium	☐	☑		
66.	Strychnine	☐	☑		
67.	Styrene	☐	☑		
68.	2,4,5-T (2,4,5-trichlorophenoxyacetic acid)	☐	☑		
69.	TDE (tetrachlorodiphenyl ethane)	☐	☑		
70.	2,4,5-TP [2-(2,4,5-trichlorophenoxy) propanoic acid]	☐	☑		
71.	Trichlorofon	☐	☑		
72.	Triethanolamine	☐	☑		
73.	Triethylamine	☐	☑		
74.	Trimethylamine	☐	☑		
75.	Uranium	☐	☑		
76.	Vanadium	☐	☑		

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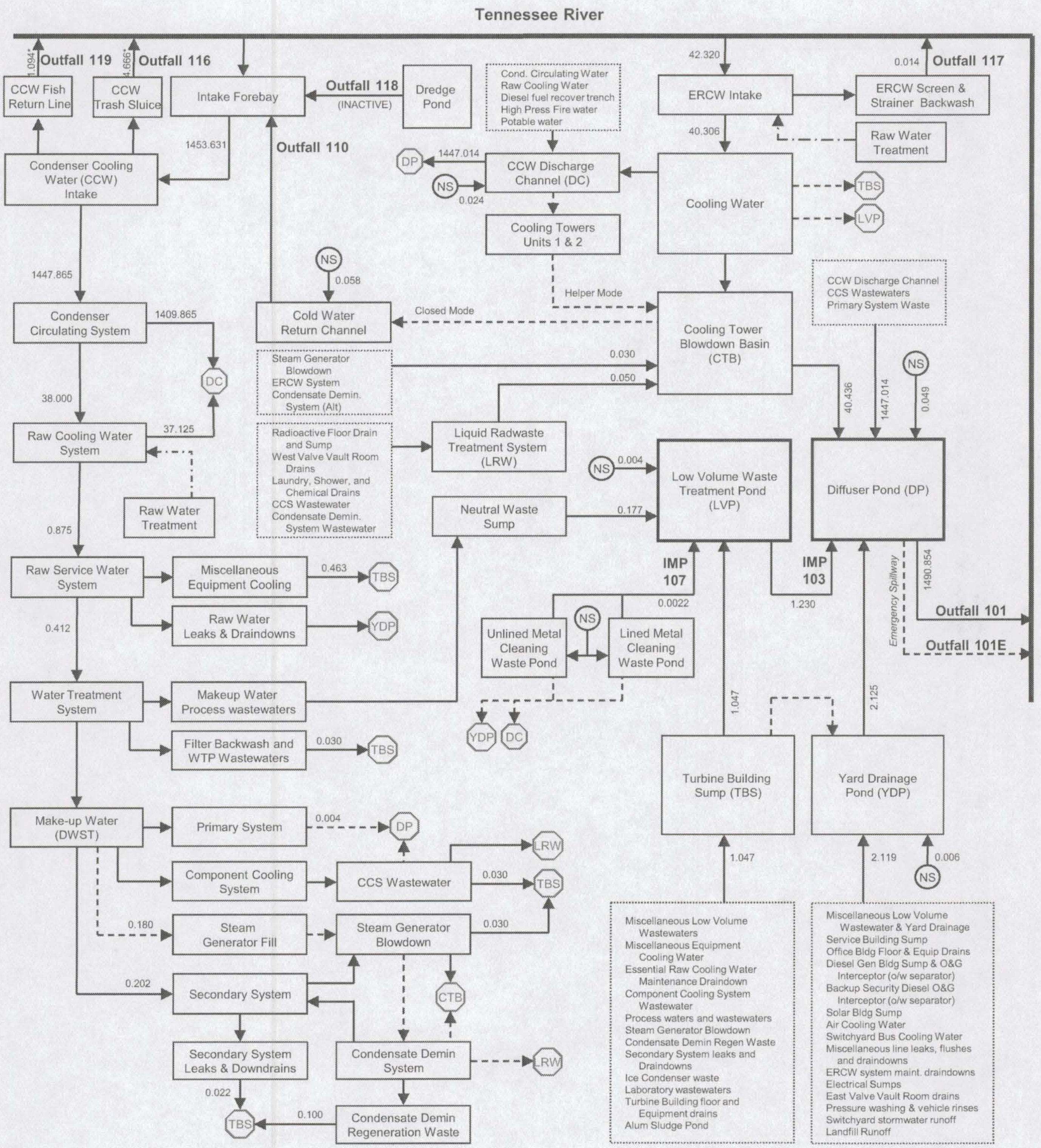
TABLE D. CERTAIN HAZARDOUS SUBSTANCES AND ASBESTOS (40 CFR 122.21(g)(7)(vii))[1]

	Pollutant	Presence or Absence (check one)		Reason Pollutant Believed Present in Discharge	Available Quantitative Data (specify units)
		Believed Present	Believed Absent		
77.	Vinyl acetate	☐	☑		
78.	Xylene	☐	☑		
79.	Xylenol	☐	☑		
80.	Zirconium	☐	☑		

[1] Sampling shall be conducted according to sufficiently sensitive test procedures (i.e., methods) approved under 40 CFR 136 for the analysis of pollutants or pollutant parameters or required under 40 CFR Chapter I, Subchapter N or O. See instructions and 40 CFR 122.21(e)(3).



DC CCW Discharge Channel
CTB Cooling Tower Basin
LRW Liquid Radwaste Treatment System
TBS Turbine Building Sump
LVP Low Volume Waste Treatment Pond
YDP Yard Discharge Pond
DP Diffuser Pond

n Negligible flow
Alternate path
Chemical Additive
NS Net Stormwater Flow (runoff, precipitation, less evaporation)
* Pump Rated Capacity

Tennessee Valley Authority
Sequoyah Nuclear Plant
Wastewater Flow Schematic
NPDES Permit No. TN0026450
December 2024

All flows shown in million gallons per day (MGD)

TENNESSEE VALLEY AUTHORITY (TVA) – SEQUOYAH NUCLEAR PLANT (SQN) - NPDES PERMIT NO. TN0026450 – WET REASONABLE POTENTIAL

Current Whole Effluent Toxicity (WET) Requirements:

Outfall 101 - 7-day or 3-brood IC_{25} = 69%
[IWC = 69% effluent (1.4 TUc)]

Monitoring Frequency Governed by B/CTP:
1/year when oxidizing biocides used
1/year when non-oxidizing biocides used

Proposed WET Requirements:

Outfall 101 - 7-day or 3-brood IC_{25} = 58.2%
[IWC = 58.2% effluent (1.7 TUc)]

Monitoring Frequency Governed by B/CTP:
1/year when oxidizing biocides used
1/year when non-oxidizing biocides used

Background:

The current permit, effective August 1, 2020, requires chronic toxicity biomonitoring at a frequency governed by the B/CTP and with a monitoring limit $IC_{25} \geq 69\%$. Previous to the issuance of the current permit, Outfall 101 demonstrated No Reasonable Potential for excursions above the ambient water quality chronic (CCC) criterion using historical effluent data. This demonstration of No Reasonable Potential has been maintained throughout the current permit cycle as evidenced in the accompanying historical effluent data for the last 20 studies.

Based on guidance in EPA's Technical Support Document (TSD) for Water Quality-based Toxics Control (EPA/505/2-90-001), a permit limit is not required when No Reasonable Potential exists for excursions above the CCC. In this situation, the TSD recommends that biomonitoring be conducted at a frequency of once every 5 years as part of the permit renewal process.

Dilution and Instream Waste Concentration Calculations

Outfall 101:

Design Flow = 1491 MGD

Tennessee River 1Q10 = 2563 MGD

Dilution Factor (DF): $DF = \frac{Qs}{Qw} = \frac{2563}{1491} = 1.72$

Instream Wastewater Concentration (IWC): $IWC = \frac{Qw}{Qs} = \frac{1491}{2563}\ x\ 100 = 58.2\%$

Reasonable Potential Determination:

The last 20 studies for Outfall 101 were used for determining Reasonable Potential, with all studies resulting in no observed toxicity (<1.0 TUc) and a coefficient of variation equal to zero. This outcome demonstrates that no Reasonable Potential for excursions above the CCC exists, based on data obtained from testing conducted under the current operating conditions.

Historical data for the last 20 studies follows.

SQN Documentation:

Summary of SQN Outfall 101 WET Biomonitoring Results **

Test Date	Test Species	Acute Results (96-h Survival) % Survival in Undiluted Sample	Acute Results (96-h Survival) Study Toxicity Units (TUa)	Chronic Results Study Toxicity Units (TUc)
87. Sep 9-16, 2014	*Ceriodaphnia dubia*	100	<1.0	<1.0
	Pimephales promelas	100		
88. Aug 11-18, 2015	*Ceriodaphnia dubia*	100	<1.0	<1.0
	Pimephales promelas	95		
89. Oct 20-27, 2015	*Ceriodaphnia dubia*	100	<1.0	<1.0
	Pimephales promelas	75		
90. May 17-24, 2016	*Ceriodaphnia dubia*	100	<1.0	<1.0
	Pimephales promelas	100		
91. Aug 2-9, 2016	*Ceriodaphnia dubia*	100	<1.0	<1.0
	Pimephales promelas	98		
92. May 2-9, 2017	*Ceriodaphnia dubia*	100	<1.0	<1.0
	Pimephales promelas	100		
93. Jul 25 - Aug 1, 2017	*Ceriodaphnia dubia*	100	<1.0	<1.0
	Pimephales promelas	100		
94. May 15-22, 2018	*Ceriodaphnia dubia*	100	<1.0	<1.0
	Pimephales promelas	100		
95. Oct 9-16, 2018	*Ceriodaphnia dubia*	100	<1.0	<1.0
	Pimephales promelas	100		
96. Apr 30 – May 7, 2019	*Ceriodaphnia dubia*	100	<1.0	<1.0
	Pimephales promelas	100		
97. Aug 6-13, 2019	*Ceriodaphnia dubia*	100	<1.0	<1.0
	Pimephales promelas	100		
98. May 5-12, 2020	*Ceriodaphnia dubia*	100	<1.0	<1.0
	Pimephales promelas	100		
99. Oct 6-13, 2020	*Ceriodaphnia dubia*	100	<1.0	<1.0
	Pimephales promelas	100		
100. Jun 8-15, 2021	*Ceriodaphnia dubia*	100	<1.0	<1.0
	Pimephales promelas	100		
101. Sep 14-21, 2021	*Ceriodaphnia dubia*	100	<1.0	<1.0
	Pimephales promelas	100		
102. May 3-10, 2022	*Ceriodaphnia dubia*	100	<1.0	<1.0
	Pimephales promelas	100		
103. Sep 13-20, 2022	*Ceriodaphnia dubia*	100	<1.0	<1.0
	Pimephales promelas	100		
104. Jul 11-18, 2023	*Ceriodaphnia dubia*	100	<1.0	<1.0
	Pimephales promelas	100		
105. Sep 12-19, 2023	*Ceriodaphnia dubia*	100	<1.0	<1.0
	Pimephales promelas	100		
106. Jun 4-11, 2024	*Ceriodaphnia dubia*	100	<1.0	<1.0
	Pimephales promelas	100		
n		**40**	**20**	**20**
Maximum		**100**	**<1.0**	**<1.0**
Minimum		**75**	**<1.0**	**<1.0**
Mean		**99.2**	**<1.0**	**<1.0**
CV		**4.0%**	**0.00**	**0.00**

**Last 20 studies only were included for determining RP.

Shaded area includes data collected under the current permit.

TENNESSEE VALLEY AUTHORITY

Study to Confirm the Calibration of the Numerical Model for the Thermal Discharge from Sequoyah Nuclear Plant as Required by NPDES Permit No. TN0026450 of August 1, 2020

Prepared by

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Knoxville, Tennessee
December 2024

EXECUTIVE SUMMARY

The National Pollutant Discharge Elimination System (NPDES) permit for Sequoyah Nuclear Plant (SQN) identifies the release of cooling water to the Tennessee River through the plant discharge diffusers as Outfall 101. The primary method to monitor compliance with the NPDES temperature limits for this outfall includes the use of a numerical model that solves a set of governing equations for the hydrothermal conditions produced in the river by the interaction of the SQN release and the river discharge. The numerical model operates in real-time and utilizes a combination of measured and computed values for the temperature, flow, and stage in the river; and the temperature and flow from the SQN discharge diffusers. The basic formulation of the numerical model is presented herein.

Part III, Section G of the permit states: *The numerical model used to determine compliance with the temperature requirements for Outfall 101 shall be subject of a calibration study once during the permit cycle. The study should be accomplished in time for data to be available for the next permit application for re-issuance of the permit. A report of the study will be presented to the division of Water Pollution Control.* This report is provided in fulfillment of these requirements.

Temperature measurements across the downstream end of the SQN mixing zone from fifty-three samples collected between 1982 and 2023 were used in this calibration study. This observed data was compared with computed downstream temperatures from the numerical model for the same periods of time. The results show acceptable agreement between computed and measured temperatures, particularly at river temperatures greater than 75ºF. The overall average discrepancy between the measured and computed downstream temperatures was approximately 0.55 Fº (0.31 Cº). For downstream temperatures above 75ºF, the average discrepancy was approximately 0.38 Fº (0.21 Cº). There was no significant change in the model performance compared to the previous calibration.

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INTRODUCTION

The Sequoyah Nuclear Plant (SQN) is located on the right bank of Chickamauga Reservoir at Tennessee River Mile (TRM) 484.5. As shown in Figure 1, the plant is northeast of Chattanooga, Tennessee, about 13.5 miles upstream and 45.4 miles downstream of Chickamauga Dam and Watts Bar Dam, respectively. As shown in Figure 2, the reservoir in the vicinity of SQN contains a deep main channel with adjacent overbanks and embayments. The main channel is approximately 900 feet wide and 50 to 60 feet deep, depending on the pool elevation in Chickamauga Reservoir. The overbanks are highly irregular and usually less than 20 feet deep.

SQN has two units with a total summertime gross generating capacity of about 2350 MWe and an associated waste heat load of about $15.6x10^9$ Btu/hr (TVA, 2010). The heat transferred from the steam condensers to the cooling water is dissipated to the atmosphere by two natural draft cooling towers, to the river by a two-leg submerged multiport diffuser, or by a combination of both. The release to the river is identified in the National Pollutant Discharge Elimination System (NPDES) Permit as Outfall 101.

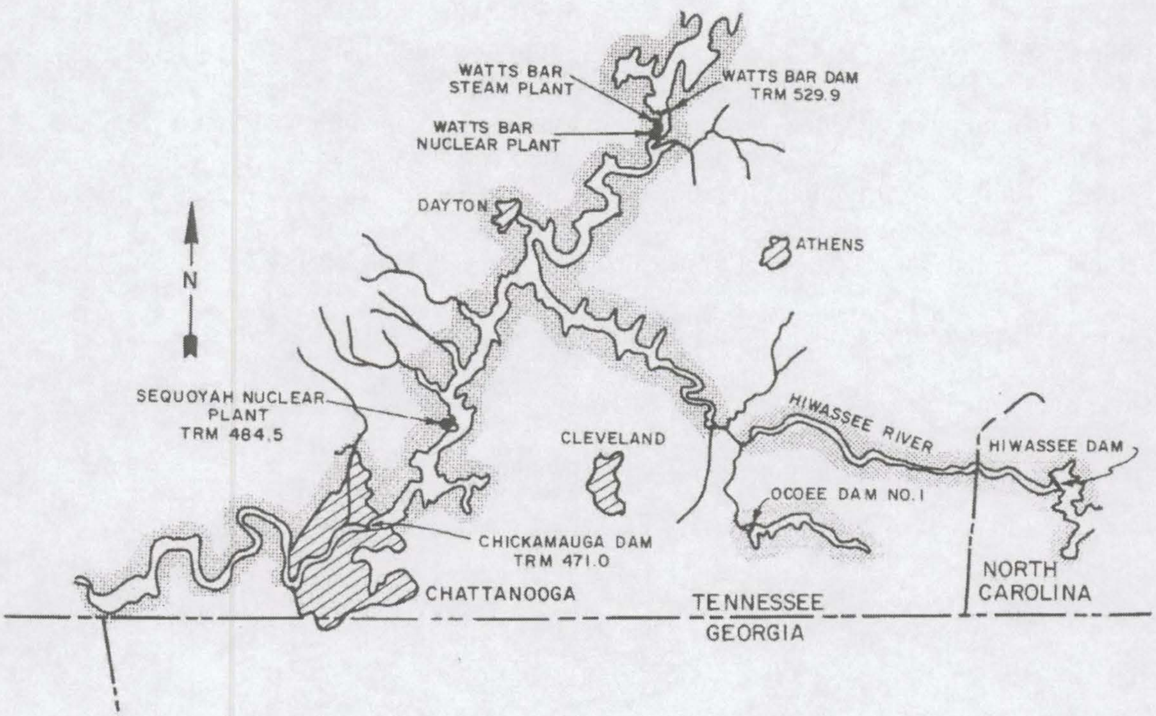

Figure 1. Location of Sequoyah Nuclear Plant

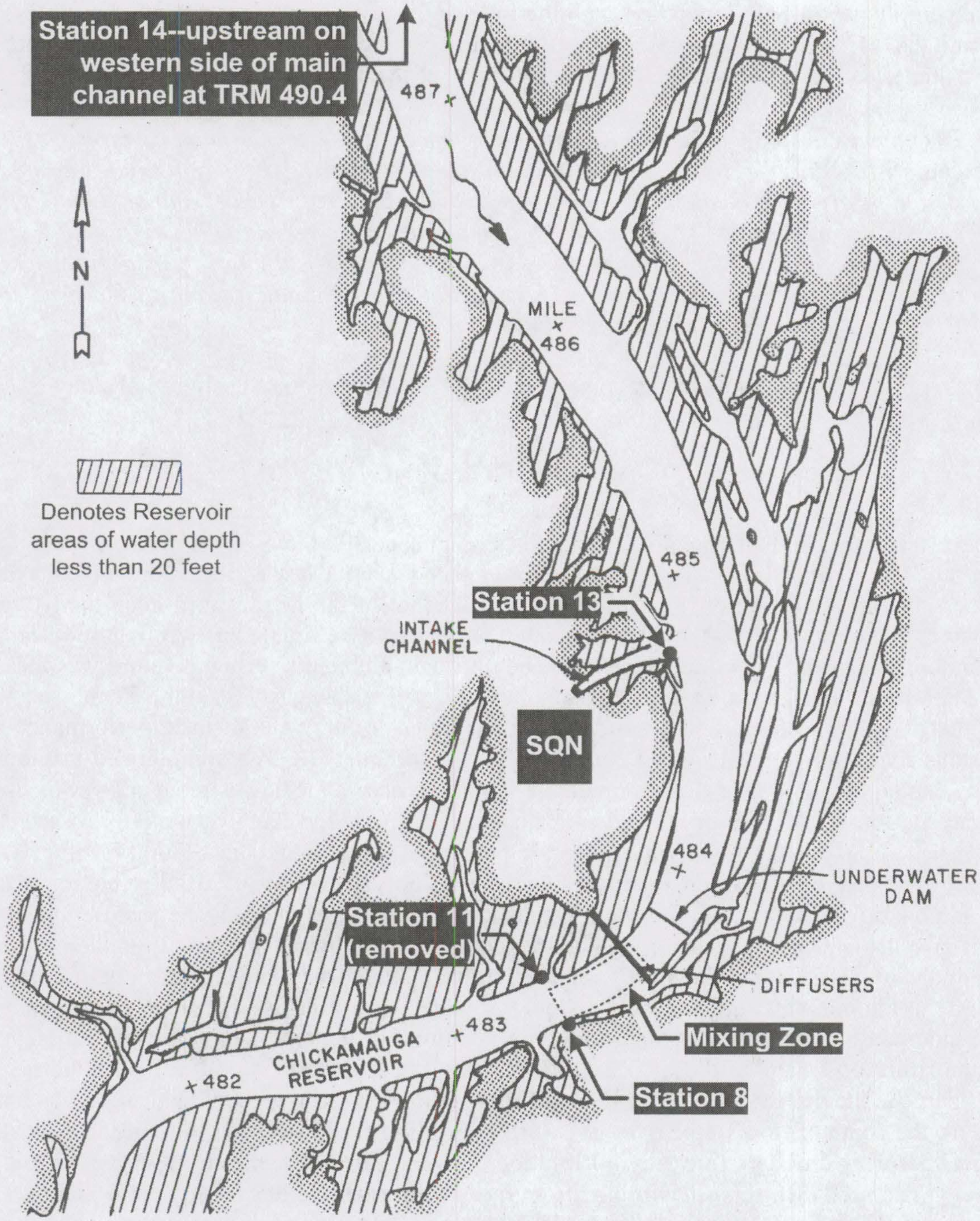

Figure 2. Chickamauga Reservoir in the Vicinity of Sequoyah Nuclear Plant

The compliance of SQN operation with the instream temperature limits specified in the NPDES permit (TDEC, 2020) is based on a downstream temperature that is calculated on a real-time basis by a numerical computer model. Part III, Section G of the permit states:

> *The numerical model used to determine compliance with the temperature requirements for Outfall 101 shall be subject of a calibration study once during the permit cycle. The study should be accomplished in time for data to be available for the next permit application for re-issuance of the permit. A report of the study will be presented to the Division of Water Pollution Control. Any adjustments to the numerical model to improve its accuracy will not need separate approval from the Division of Water Pollution Control; however, the Division will be notified when such adjustments are made.*

This report presents a summary of compliance model and the required calibration study.

BACKGROUND

The original method of monitoring thermal compliance for the SQN diffuser discharge (i.e., Outfall 101), included two temperature stations located near the downstream corners of the mixing zone, Station 8 and Station 11 (see Figure 2). Because of the necessity to keep the navigation channel free of obstructions, temperature stations could not be situated between these locations to monitor the center of the thermal plume. The upstream ambient river temperature was measured at Station 13, located on the plant intake skimmer wall. In August 1983, the Tennessee Valley Authority (TVA) reported the results of six field studies of the SQN diffuser performance under various river and plant operating conditions (TVA, 1983a). The data summarized in the report showed that based on measured temperature variations across the downstream edge of the mixing zone, Station 8 and Station 11 were inadequate in providing a representative cross-sectional average temperature of the thermal plume. In particular, it was found that Station 11 often was not in the main path of flow of the thermal plume and did not always show elevated temperatures. The remaining downstream monitor, Station 8, also was not considered adequate because it again was located outside the navigation channel. In the report, TVA proposed an alternate method to monitor thermal compliance involving the use of a numerical model to simulate the behavior of the thermal plume in the mixing zone. The model would provide a real-time assessment of compliance with the thermal discharge limitations. Information required for the model included: the ambient river temperature upstream of the diffuser mixing zone (measured at Station 13, see Figure 2), the discharge in the river at SQN (determined from measurements at Watts Bar Dam and Chickamauga Dam), the depth of flow in the river (measured at Station 13), the temperature of the flow issuing from the plant diffusers (measured at Station 12, see Figure 2), and the discharge of the flow issuing from the diffusers (determined from measurements at both Station 12 and Station 13). A PC, located in the SQN Environmental Data Station (EDS), was to be used collect the required data, compute the thermal compliance parameters, and distribute the results to plant operators (see TVA, 1983b). The August 1983 report presented results demonstrating the validity of using the numerical model for tracking compliance with the Outfall 101 thermal limitations.

The method of using the numerical model was sent to the Environmental Protection Agency (EPA) and the Tennessee Department of Environment and Conservation (TDEC), requesting approval for implementation as a valid means for monitoring SQN thermal compliance. The key advantage of the method includes a representation of the cross-sectional average downstream temperature that is at least as good as the instream temperature measurements from Station 8 and Station 11. The method also provides consistency with procedures that are used for scheduling releases from Watts Bar Dam and Chickamauga Dam, as well as procedures for operating Sequoyah Nuclear Plant. This consistency helps TVA minimize unexpected events that can potentially threaten the NPDES thermal limits for Outfall 101. In March 1984 approval was granted for TVA to use the numerical model as the primary method to track thermal compliance. Except for infrequent outages, the model has been in use ever since. Subsequently, Station 11 was removed from the river. However, Station 8 was retained to provide an optional method to track thermal compliance should there be a need to remove the model from service.

Due to the ever changing understanding of the hydrothermal aspects of Chickamauga Reservoir, as well as the operational aspects of the nuclear plant and river system, modifications have been necessary over the years for both the numerical model and thermal criteria for Outfall 101. The current version of the model is presented in more detail later. The current thermal criteria are presented in Table 1. The limit for the temperature at the downstream end of the mixing zone (T_d) is a 24-hour average value of 86.9°F (30.5°C) and an hourly average value of 93.0°F (33.9°C). The instream temperature rise (ΔT) is limited to a 24-hour average of 5.4 F° (3.0 C°) for months April through October, and 9.0 F° (5.0 C°) for months November through March. The latter "wintertime" limit was obtained by a 316(a) variance. The temperature rate-of-change at the downstream end of the mixing zone (dT_d/dt) is limited to ±3.6 F°/hr (±2 C°/hr). With the compliance model, dT_d/dt is based on 24-hour average river conditions and 15 minute plant conditions. Other details related to the temperature limits for Outfall 101 are provided in the notes accompanying Table 1. It is important to note that compliance with instream temperature limits are based on a computed downstream temperature at a depth of 5.0 feet. And in a similar fashion, the upstream temperature is measured at the 5.0 foot depth, based on the average of temperature readings at the 3-foot, 5-foot and 7-foot depths.

Originally, the ambient river temperature for the temperature rise was measured at Station 13, about 1.1 miles upstream of the discharge diffusers. However, under sustained low flow conditions, it was discovered that heat from the diffusers can migrate upstream and reach the area of Station 13. In this manner, the ambient temperature can become elevated, thereby artificially reducing the measured impact of the plant on the river (i.e., ΔT). As such, in late March 2006, a new ambient temperature station was installed in the river further upstream at TRM 490.4, about 6.8 miles upstream of the diffusers. In 2023, Station 14 was relocated nearby to a location more representative of the ambient river temperature profile. The location of Station 14 is shown in Figure 3.

Table 1. Summary of SQN Instream Thermal Limits for Outfall 101

Type of Limit	Averaging (hours)	NPDES Limit[2]
Max Downstream Temperature, T_d	24	86.9°F (30.5°C)
Max Downstream Temperature, T_d	1	93.0°F (33.9°C)
Max Temperature Rise, ΔT	24	5.4 F°/9.0 F° (3.0 C°/5.0 C°)
Max Temperature Rate-of-Change, dT_d/dt	Mixed	±3.6 F°/hr (±2 C°/hr)

Notes:

1. Compliance with the river limitations (river temperature, temperature rise, and rate of temperature change) shall be monitored by means of a numerical model that solves the thermohydrodynamic equations governing the flow and thermal conditions in the reservoir. This numerical model will utilize measured values of the upstream temperature profile and river stage; flow, temperature and performance characteristics of the diffuser discharge; and river flow as determined from releases at the Watts Bar and Chickamauga Dams. In the event that the modeling system described here is out of service, an alternate method will be employed to measure water temperatures at least one time per day and verify compliance of the maximum river temperature and maximum temperature rise. Depth average measurements can be taken at a downstream backup temperature monitor at the downstream end of the diffuser mixing zone (left bank Tennessee River mile 483.4) or by grab sampling from boats. Boat sampling will include average 5-foot depth measurements (average of 3, 5, and 7-foot depths). Sampling from a boat shall be made outside the skimmer wall (ambient temperature) and at quarter points and mid-channel at downstream Tennessee River mile 483.4 (downstream temperature). The downstream reported value will be a depth (3, 5, and 7-foot) and lateral (quarter points and midpoint) average of the instream measurements. Monitoring in the alternative mode using boat sampling shall not be required when unsafe boating conditions occur.
2. Compliance with river temperature, temperature rise, and rate of temperature change limitations shall be applicable at the edge of a mixing zone which shall not exceed the following dimensions: (1) a maximum length of 1500 feet downstream of the diffusers, (2) a maximum width of 750 feet, and (3) a maximum length of 275 feet upstream of the diffusers. The depth of the mixing zone measured from the surface varies linearly from the surface 275 feet upstream of the diffusers to the top of the diffuser pipes and extends to the bottom downstream of the diffusers. When the plant is operated in closed mode, the mixing zone shall also include the area of the intake forebay.
3. Information required by the numerical model and evaluations for the river temperature, temperature rise, and rate of temperature change shall be made every 15 minutes. The ambient temperature shall be determined at the 5-foot depth as the average of measurements at depths 3 feet, 5 feet, and 7 feet. The river temperature at the downstream end of the mixing zone shall be determined as that computed by the numerical model at a depth of 5 feet.
4. Daily maximum temperatures for the ambient temperature, the river temperature at the downstream edge of the mixing zone, and temperature rise shall be determined from 24-hour average values. The 24-hour average values shall be calculated every 15 minutes using the current and previous ninety-six 15-minute values, thus creating a 'rolling' average. The maximum of the ninety-six observations generated per day by this procedure shall be reported as the daily maximum value. For the river temperature at the downstream end of the mixing zone, the 1-hour average shall also be determined. The 1-hour average values shall be calculated every 15 minutes using the average of the current and previous four 15-minute values, again creating a rolling average.
5. The daily maximum 24-hour average river temperature is limited to 86.9°F (30.5°C). Since the state's criteria makes exception for exceeding the value as a result of natural conditions, when the 24-hour average ambient temperature exceeds 84.9°F (29.4°C) and the plant is operated in helper mode, the maximum temperature may exceed 86.9°F (30.5°C). In no case shall the plant discharge cause the 1-hour average downstream river temperature at the downstream of the mixing zone to exceed 93.0°F (33.9°C) without the consent of the permitting authority.
6. The temperature rise is the difference between the 24-hour average ambient river temperature measured at Station 14 and the computed 24-hour average temperature at the downstream end of the mixing zone. The 24-hour average temperature rise shall be limited to 5.4F° (3.0 C°) during the months of April through October. The 24-hour average temperature rise shall be limited to 9.0F° (5.0 C°) during the months of November through March.
7. The rate of temperature change shall be computed at 15-minute intervals based on the current 24-hour average ambient river temperature, current 24-hour-hour average river flow, and current values of the flow and temperature of water discharging through the diffuser pipes. The 1-hour average rate of temperature change shall be calculated every 15-minutes by averaging the current and previous four 15-minute values. The 1-hour average rate of temperature change shall be limited to 3.6F° (2 C°) per hour.

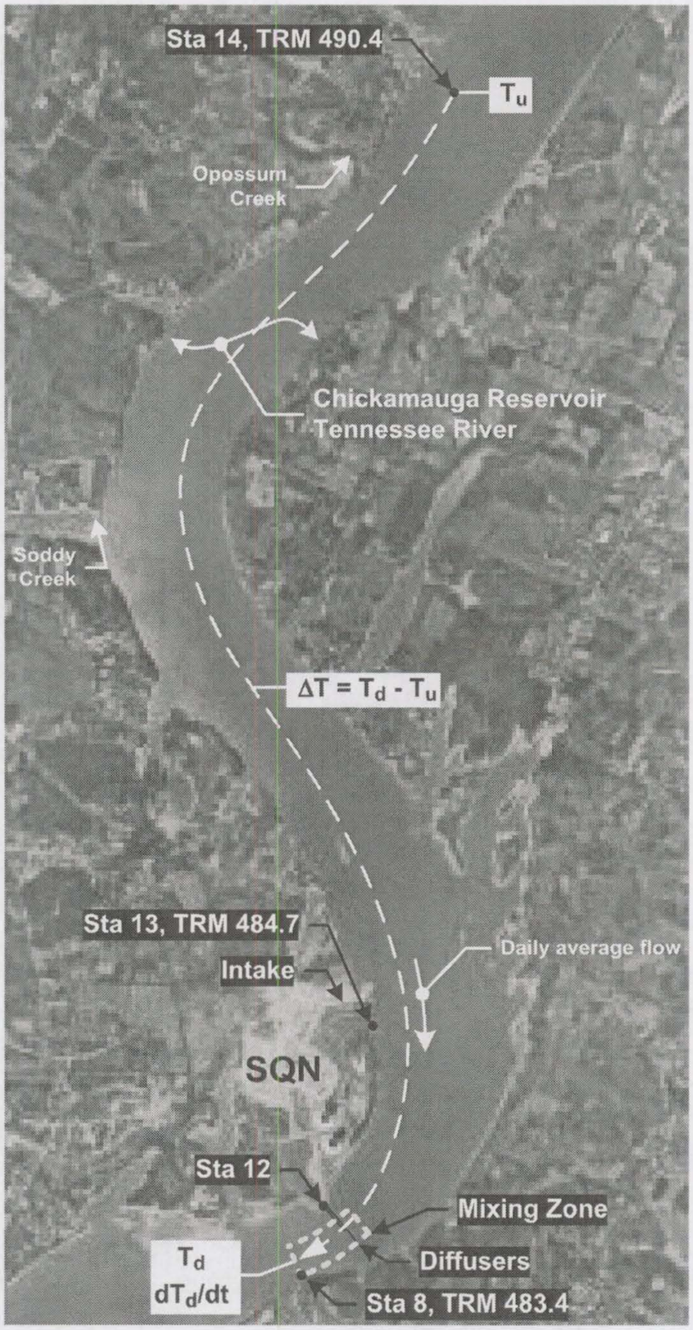

Figure 3. Locations of Instream Temperature Monitors for Sequoyah Nuclear Plant

NUMERICAL MODEL

The diffusers at SQN are located on the bottom of the navigation channel in Chickamauga Reservoir. As shown in Figure 4, each diffuser is 350 feet long, and contains seventeen 2-inch diameter ports per linear foot of pipe, arranged in rows over an arc of approximately 18 degrees in the downstream upper quadrant of the diffuser conduit. The two diffuser legs rest on an elevated pad approximately 10 feet above the bottom of the river, occupying the 700 feet of navigation channel on the plant-side of the river (right side of the channel, looking downstream). The flow in the immediate vicinity of the ports is far too complex to be analyzed on a real-time basis with current computer technology. Therefore, a simplifying assumption is made that the diffusers can be treated as a slot jet with a length equal to that of the perforated sections of the pipe. The width of this assumed slot is one of three empirical parameters used to calibrate the model. The second is a relationship used to compute the entrainment of ambient water along the trajectory of the plume and the third is a relationship for the amount of diffuser effluent that is re-entrained into the diffuser plume for sustained low river flow.

The initial development of the numerical model is described in detail by Benton (2003). Based on later studies that provided evidence that re-entrainment occurs (TVA, 2009), the original numerical model was modified to better reflect the local buildup of heat that occurs in the river under such conditions. Before presenting calibration results, it is appropriate first to provide a brief description of the model formulation.

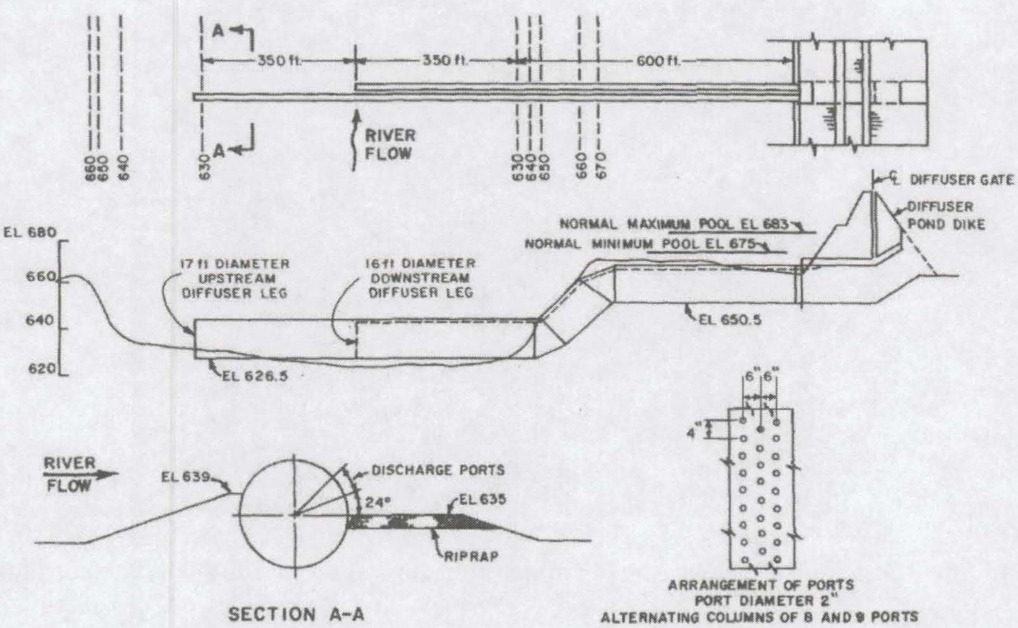

Figure 4. Sequoyah Nuclear Plant Outfall 101 Discharge Diffusers

In general, the model treats the effluent discharge from the diffusers as a fully mixed, plane buoyant jet with a two-dimensional (vertical and longitudinal) trajectory. This is shown schematically in Figure 5. The jet discharges into a temperature-stratified, uniform-velocity flow and entrains ambient fluid as it evolves along its trajectory. The width, *b*, of the jet and the dilution of the effluent heat energy increase along the jet trajectory, decreasing the bulk mixed temperature along its path.

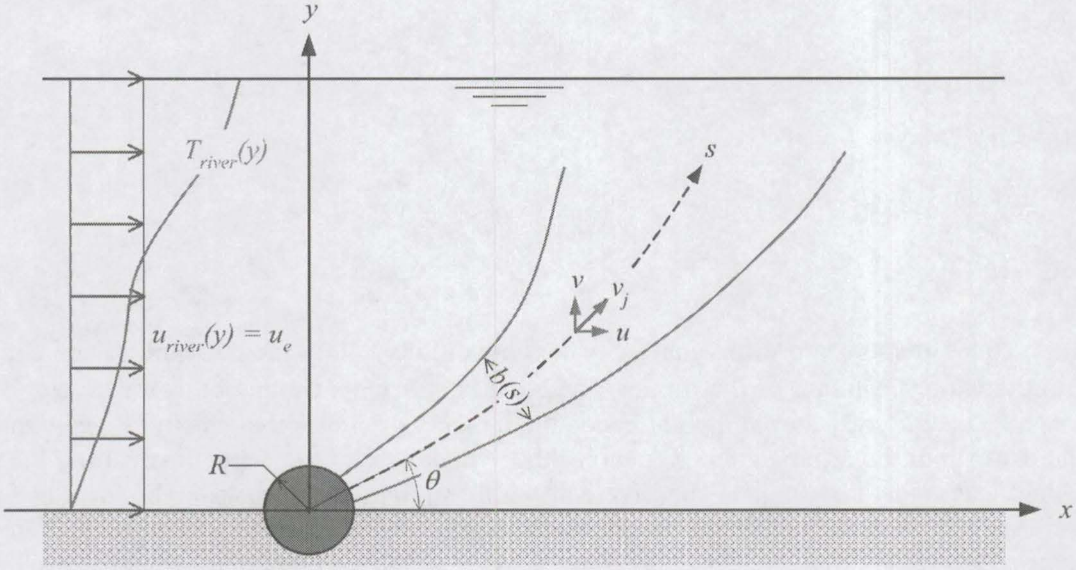

Figure 5. Two-Dimensional Plane Buoyant Jet Model for a Submerged Diffuser

Consideration of the mass, momentum, and energy for a cross section of the plume orthogonal to the jet trajectory and having a differential thickness *ds,* yields the following system of ordinary differential equations,

$$\frac{d}{ds}\left(\rho_j v_j b\right) = m_e \text{ (conservation of mass in jet),} \tag{1}$$

$$\frac{d}{ds}\left(\rho_j v_j bu\right) = m_e u_e \text{ (conservation of x momentum in jet),} \tag{2}$$

$$\frac{d}{ds}\left(\rho_j v_j bv\right) = m_e v_e + bg\left(\rho_e - \rho_j\right) \text{ (conservation of y momentum in jet),} \tag{3}$$

$$\frac{d}{ds}\left(\rho_j v_j bcT_j\right) = m_e cT_e \text{ (conservation of thermal energy in jet),} \tag{4}$$

$$\frac{dx}{ds} = \frac{u}{v_j}\text{, and} \tag{5}$$

$$\frac{dy}{ds} = \frac{v}{v_j} \text{ (velocity of jet tangent to trajectory).} \tag{6}$$

The following auxiliary relationships also are needed to solve the differential equations,

$$m_e = \alpha \rho_e \left[(u_e - u)^2 + v^2 \right]^{1/2}, \tag{7}$$

$$\rho_j = \rho_{water}(T_j), \tag{8}$$

$$\rho_e = \rho_{water}(T_e), \tag{9}$$

$$T_e = T_{river}(y), \tag{10}$$

$$u_e = u_{river}, \tag{11}$$

$$v_e = 0 \text{, and} \tag{12}$$

$$v_j = \left(u^2 + v^2\right)^{1/2}. \tag{13}$$

In these equations, the subscripts j and e denote conditions within the buoyant *jet* and conditions within the water upstream of the mixing zone that is *entrained* by the jet, respectively. Thus, ρ_j denotes the density of water at a point inside the jet and ρ_e denotes the density of water entrained from upstream of the mixing zone. T_e denotes the temperature of the water upstream of the mixing zone that is entrained by the jet. The x-velocity of the entrained water, u_e, is the same as the river velocity, u_{river}, which is negligible in the vertical direction (i.e., $v_e = 0$). The magnitude of the velocity along the jet trajectory is denoted by v_j, with x- and y-components u and v, respectively. The individual jets issuing from the array of 2-inch diameter outlet ports of each diffuser are modeled as a plane jet issuing from a slot of width b_0. Ideally, the slot width is chosen to preserve the total momentum flux issuing from the circular ports of the diffuser. However, for this formulation, the slot width is used as a term to calibrate the numerical model. The river velocity u_{river} is computed by a one-dimensional unsteady flow model of Chickamauga Reservoir. Apart from information for the reservoir geometry, the basic input for the flow model includes the measured hydro releases at Watts Bar Dam and Chickamauga Hydro Dam and the measured river water surface elevation at SQN.

The transverse gradients of velocity, temperature, and density that occur within the jet due to turbulent diffusion of the effluent momentum and energy are modeled as an entrainment mass flux, m_e, induced by the vectorial difference between the velocity of the jet and that of the river flow upstream of the mixing zone. Empirical relationships for the entrainment coefficient α are based on arguments of jet self-similarity and asymptotic behavior. These relationships incorporate non-dimensional parameters, such as a Richardson or densimetric Froude number, that describe the relative strengths of buoyancy and momentum flux in the jet (e.g., see Fischer et al., 1979). Again, as indicated earlier, the entrainment coefficient, like the slot width, is adjusted as part of the calibration process.

The initial conditions required by the model include,

$$b\big|_{s=s_0} = b_0 \quad , \tag{14}$$

$$x\big|_{s=s_0} = R\cos\theta \quad , \tag{15}$$

$$y\big|_{s=s_0} = R\sin\theta \quad , \tag{16}$$

$$u\big|_{s=s_0} = \frac{q_0}{b_0}\cos\theta \quad , \tag{17}$$

$$v\big|_{s=s_0} = \frac{q_0}{b_0}\sin\theta \quad \text{, and} \tag{18}$$

$$T_j\big|_{s=s_0} = T_0 \quad . \tag{19}$$

This system of differential equations, auxiliary equations, and initial conditions comprise a first-order, initial-value problem that can be integrated from the diffuser slot outlet ($s = s_0$) to any point along the plume trajectory. Note in the above that R is the radius of the diffuser conduit, b_0 is the effective width of the diffuser slot, θ is the exit angle of the diffuser jet, T_0 is the temperature of effluent issuing from the slot, and q_0 is the effluent discharge per unit length of diffuser. In practice, integration of the governing equations is halted when the jet centerline reaches a point five feet below the water surface (the regulatory compliance depth) or when the upper boundary of the jet reaches the water surface. The jet temperature, T_j, at this point is reported as the fully-mixed temperature to which the thermal regulatory criteria are applied or to which monitoring station data at the edge of the regulatory mixing zone are compared. The integration is done with an adaptive step-size, fourth-order Runge-Kutta algorithm.

In the model, Station 13 (Figure 2), located 1.1 miles upstream of the diffusers, is used to represent the temperature of the water entrained in the mixing zone, $T_e = T_{river}(y)$. Whereas this is a good assumption for river flows where the effluent plume is carried downstream, it weakens for low river flows. Based on the understanding gained in field studies (TVA, 2009), it is known that partial re-entrainment of the effluent plume occurs at sustained low river flow, increasing the temperature of the water entering the mixing zone above that represented by Station 13. To simulate this phenomenon, the model modifies the Station 13 temperature profile for low river flows. For each point in the profile, a local densimetric Froude number is computed as

$$F_r = \frac{u_{river}}{\sqrt{g\left(\dfrac{\rho_e - \rho_p}{\rho_e}\right)(Z_e - Z_b)}} \quad , \tag{20}$$

where u_{river} is the average river velocity, Z_e-Z_b is the elevation of the profile point relative to the bottom elevation of the river, ρ_e is the entrainment water density at that elevation, and ρ_p is the density of the effluent plume at the 5-foot compliance depth. The densimetric Froude number represents the ratio of momentum forces to buoyancy forces in the river flow. If F_r is less than 1.0 (i.e., buoyancy greater than momentum), it is assumed that the buoyancy of the plume is sufficient to cause part of the plume to travel upstream and become re-entrained into the flow, thereby increasing the temperature of the water entering the mixing zone. The modified entrainment temperature T_e^N at each point in the Station 13 profile is computed by repeatedly evaluating

$$T_e^n = R \times T_p + (1.0 - R) \times T_e^{n-1} \tag{21}$$

for values of n from 1 to N, where N is the number of iterations of Eq. (21), R is a re-entrainment fraction, $T_e^{n=0}$ is the original Station 13 temperature, and T_p is the computed plume temperature at the 5-foot depth. N and R are functions of the 24-hour average river velocity. After new Station 13 temperatures have been computed for the entire profile, the mixing zone computation is performed again, using the modified profile to get a new plume temperature at the 5-foot depth. It is emphasized that the final result of the model is the computed temperature at the downstream end of the mixing zone. The instream temperature rise is still computed based on the temperature measurement at the new ambient temperature monitor, Station 14.

Values for N and R are calibrated based on observed temperatures at the downstream end of the diffuser mixing zone for low river flow conditions, as indicated earlier. Depending on the river stage, the modifications by Equation 21 begin to take effect as the 24-hour average river flow drops through the range of 17,000 cfs to 25,000 cfs, and increases as the 24-hour average river flow continues to drop. For river flows above this range, no modification is needed for re-entrainment.

The downstream temperature and instream temperature rise provided by the model are computed every 15 minutes, using instantaneous values of the measured diffuser discharge temperature (Station 12), measured upstream temperature profile (Station 13), measured ambient temperature (Station 14), measured river elevation (Station 13), and computed values of the river velocity (one-dimensional unsteady flow model of Chickamauga Reservoir) and diffuser discharge. The diffuser discharge is computed based on the difference in water elevation between the SQN diffuser pond (Station 12) and the river (Station 13). All computations are performed every 15 minutes to provide rolling hourly and 24-hour average values. The hourly averages are based on the current and previous four 15-minute values, whereas the 24 hour averages are based on current and previous ninety-six 15-minute values. The temperature rate-of-change is determined slightly different, being computed every 15 minutes based on current 24-hour average river conditions and current 15-minute values of the flow and temperature of water discharging from the SQN diffusers. This method was adopted in August 2001 in order to distinguish between rate-of-change events due to changes in SQN operations (i.e. changes in plant discharge flow and/or temperature) and those due to non-SQN changes in operations (e.g., changes in river flow). Prior to this change, SQN was held accountable for temperature rate-of-change events over which it had very little control or influence.

Plume Entrainment

McIntosh Coefficient

Three empirical relationships for the plume entrainment coefficient are available in the numerical model. The first, developed by McIntosh, was inferred from a relationship for the entrainment coefficient determined from the data reported in 1983 (TVA, 1983a) and is given by

$$\propto = \begin{cases} 0.55 \textit{ for } F_d < 0.75 \\ \frac{0.27}{F_d^{2.5}} \textit{ for } 0.75 \le F_d \le 1.00 \\ 0.27 \textit{ for } F_d > 1.00 \end{cases}, \tag{22}$$

where F_d is the densimetric Froude number of the diffuser discharge defined by

$$F_d = \frac{w_d}{\sqrt{g b_o \frac{(\rho_d - \rho_o)}{\rho_o}}}. \tag{23}$$

The term w_d is the velocity of the diffuser discharge, g is the gravitational constant, b_0 is the diffuser slot width, ρ_d is the density of the diffuser discharge, and ρ_o is the density of the ambient river water at the discharge depth.

Benton Coefficient

The second entrainment coefficient, based on laboratory data, was originally developed by Benton in 1986 and is given by

$$\alpha = 0.31 + 1.69\left[\frac{1 + tanh(6.543 * rmf - 2.0584)}{2}\right], \tag{24}$$

where

$$rmf = u_{river}^3 / b, \tag{25}$$

and

$$b = Q_0\left(\frac{g}{l}\right)\left(\frac{\rho_o - \rho_d}{\rho_o}\right). \tag{26}$$

Term u_{river} is the ambient river velocity, as previously defined, Q_0 is the diffuser discharge flowrate, and l is the length of the ported section of the diffuser.

HydroK Coefficient

A third coefficient, termed HydroK, was introduced as a reduced form of the entrainment coefficient from Jirka (2006). HydroK is appropriate for the range of operating conditions encountered at the power plant.

$$\frac{d\,q}{d\,s} = \beta\,\overline{w} \equiv \overline{w}\left\{2\sqrt{2}\,\alpha_{1s} + \frac{2\sqrt{2}\,\alpha_{2s}\sin\theta}{F_j} + \alpha_{4s}\,\frac{U_{riv}}{\overline{w}}\left|\cos\theta\right|\sin\theta\right\} \tag{27}$$

A detailed accounting of the analysis and derivation of this entrainment coefficient is provided by Uittenbogaard and Vlijm (2019).

Comparison

A comparison of the McIntosh, Benton, and HydroK entrainment coefficients is presented in Figure 6. The plume centerline using the HydroK coefficient is deemed to be the most realistic and aligns with literature and laboratory studies. Accordingly, the HydroK coefficient has been adopted. A detailed discussion is available in Uittenbogaard and Vlijm (2019).

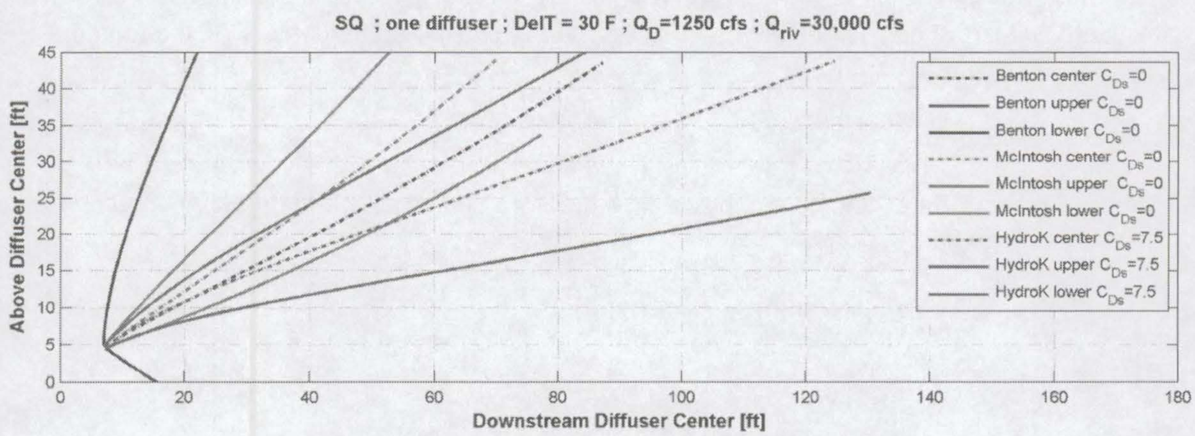

Figure 6. Plume Centerline with Benton, McIntosh, and HydroK Entrainment Coefficients

A comparison of the computed compliance model for 2018–2024 using the HydroK entrainment coefficient is provided in Table 2. Computed temperatures from the model were compared to the 15-minute observed 5 ft temperatures at Station 8. For all years, the computed temperatures using the HydroK coefficient was closer to the observed temperatures than simulations using the Benton coefficient (the previous default). The standard deviation also outperformed in all cases.

Table 2. Comparison of Model Variation from Observed Temperatures at Station 8

Year	Benton Entrainment		HydroK Entrainment	
	Average Computed Temperature Difference from Observed Temperature at St 8 (°F)	Standard Deviation of Computed Temperature from Observed Temperature at St 8 (°F)	Average Computed Temperature Difference from Observed Temperature at St 8 (°F)	Standard Deviation of Computed Temperature from Observed Temperature at St 8 (°F)
2018	3.1	1.9	1.2	1.0
2019	3.4	3.4	1.6	2.3
2020	3.1	1.7	0.9	0.7
2021*	3.9	1.8	2.0	2.0
2022	2.0	1.9	1.2	1.6
2023	2.0	1.4	0.8	0.8
2024*	2.3	1.9	2.0	1.4

** Partial year analyzed*

<u>*Diffuser Effluent Re-Entrainment*</u>

Partial re-entrainment of the diffuser plume is known to occur under conditions of low river flow. When the diffuser plume attempts to entrain an amount of ambient flow greater than what is available from further upstream, the upper portions of the plume tend to migrate upstream and plunge downward to be mixed with the flow in the lower portion of the river. The formulation to simulate this phenomenon was presented earlier (Equations 20 and 21). The unknown coefficients to be determined in the calibration process are the number of iterations N and re-entrainment fraction R in Eq. (21), which are functions of the 24-hour average river velocity.

Based on the evaluation of numerous combinations of N and R for diffuser effluent re-entrainment (Eq. 20 and 21), Table 3 gives the values that resulted in computed downstream temperatures that most closely matched measurements in field surveys. For river velocities between the values given in Table 3, the re-entrainment factor R is interpolated between the table values. The number of iterations N is interpolated and then rounded to the nearest integer. No re-entrainment correction is performed for 24-hour river velocities greater than the highest value in the table.

Model runs were previously performed with and without the re-entrainment option enabled. With re-entrainment enabled, 54% of simulated data points more closely match the observed data. Without re-entrainment enabled, only 12% of simulated data points more closely match the observed data. Based upon these results, the re-entrainment correction method is used. The observed data points used for this comparison were collected from 1982-2018 and are reported in Tables 4, 5, and 6.

Table 3. Plume Re-Entrainment Iteration Numbers and Factors

River Velocity (ft/sec)	Number of Iterations N	Re-entrainment Factor R
0.000	3	0.21930
0.050	3	0.13300
0.075	3	0.11000
0.100	3	0.10000
0.200	3	0.02670
0.300	3	0.03507
0.400	3	0.00893
0.500	3	0.00447
0.600	0	0.00000

Diffuser Slot Width

The effective slot width for a multiport diffuser of the type at SQN can be assumed to fall somewhere between the width of a rectangle with length equal to that of the diffuser section and area equal to the total area of the ports; and the width a rectangle with length equal to that of the diffuser section and area equal to the arc length of the perforated section of the diffuser. For the HydroK entrainment coefficient the slot with was determined to be 0.198 ft (Uittenbogaard and Vlijm 2019).

CALIBRATION

The numerical model is calibrated to achieve the best match between computed downstream temperatures and field measurements at the downstream end of the mixing zone. Field measurements at the downstream end of the mixing zone are of two types—those including samples from field surveys across the entire width of the mixing zone and those from Station 8, which includes samples only at the left-hand corner of the mixing zone (e.g., see Figure 2). Higher priority is given to matching data from field surveys, since such measurements are made across the entire width of the plume mixing zone and are more representative of the average temperature in the thermal plume at the 5-foot compliance depth.

Previous Calibration Data and Calibration Work

Prior to the NPDES permit of August 2020, field surveys were performed in 1981, 1982, 1983, 1987, 1996, 1997, 1999, 2000, 2002, 2003, 2004, 2006, 2007, 2012 and 2018. In July 1981, TVA conducted the first field survey of the SQN thermal discharge (TVA, 1982). The results of the field surveys were compared to projections from modeling relationships developed from mixing theory and a physical model test of the discharge diffusers. Adequate agreement was achieved between measured data and model projections. In cases where there were discrepancies, the model under-predicted the observed dilutions (i.e., over-predicted temperatures).

Between April 1982 and March 1983, five field surveys containing seventeen sets of samples across the downstream end of the mixing zone were performed to acquire data for validation of the computed compliance technique (TVA, 1983a). The results of these surveys are given in Table 4. Only one SQN unit was operating during the March 1983 test—the other five tests were for operation with two units. The results of the numerical model compared favorably with the field-measured downstream temperatures. On average, the discrepancy between the measured and computed downstream temperatures was about 0.40 F° (0.22 C°). Since the accuracy of the temperature sensors used by TVA are only about ±0.25 F° (±0.14 C°), the agreement between the field measurements and the computer model was considered good. A similar comparison between the Station 8 and Station 11 temperatures and the measured average temperatures across the downstream edge of the mixing zone revealed that the discrepancy for Station 8 was about 0.79 F° (0.44 C°) and for Station 11 about 0.65 F° (0.36 C°). Consequently, it was concluded that the numerical model is not only an accurate representation of the downstream temperature but also is likely superior to the monitoring approach using Station 8 and Station 11.

In September 1987, TVA released a report describing the field surveys in support of the validation and calibration of the SQN numerical model that had been performed up to that date (TVA, 1987). In the report, a chart was introduced that described the ambient and operational conditions for which field surveys had been performed. This chart indicated combinations of river flow, season, and number of operating units, showing what tests had been performed, and assigning relative priorities for tests to be performed in the future. With this guidance, six more field surveys were performed between March 1996 and April 2003, to measure downstream temperatures for various river flows and at different times of year. The results of these surveys produced ten sets of samples across the downstream end of the mixing zone, as given in Table 55.

Between 2004 and 2023 a number of additional field surveys were performed, providing twenty-six more sets of samples containing temperature measurements across the downstream end of the diffuser mixing for various river flows and at different times of the year. The results of these surveys are given in
Table 6 and Table 7.

Table 4. Thermal Surveys at SQN from April 1982 through March 1983

Date	Approx Time	River		Temperatures (5-foot depth)		
		Flow (cfs)	Stage (ft MSL)	T_u	T_d	ΔT
				Measured (°F)	Measured (°F)	Measured (°F)
04/04/1982	0900 CST	19900	676.46	56.8	61.9	5.1
04/04/1982	1000 CST	19800	676.46	56.7	60.1	3.4
04/04/1982	1100 CST	19600	676.47	56.7	61.2	4.5
04/04/1982	1200 CST	19700	676.50	57.2	61.9	4.7
04/04/1982	1300 CST	19700	676.45	57.4	62.2	4.8
05/14/1982	0900 CDT	7200	682.43	74.5	71.8	-2.7
05/14/1982	1100 CDT	9100	682.40	73.4	71.8	-1.6
05/14/1982	1300 CDT	6300	682.42	72.1	73.6	1.5
09/02/1982	1400 CDT	38500	680.30	78.1	80.1	2.0

Date	Approx Time	River		Temperatures (5-foot depth)		
		Flow (cfs)	Stage (ft MSL)	T_u Measured (°F)	T_d Measured (°F)	ΔT Measured (°F)
11/10/1982	1300 CST	36200	677.57	59.0	60.1	1.1
11/10/1982	1400 CST	31600	677.59	59.0	60.6	1.6
11/10/1982	1500 CST	32300	677.58	59.0	60.4	1.4
03/31/1983	1100 CST	9800	676.34	51.4	54.3	2.9
03/31/1983	1200 CST	9400	676.34	50.4	54.7	4.3
03/31/1983	1300 CST	9300	676.34	52.5	54.5	2.0
03/31/1983	1400 CST	9500	676.34	51.4	54.9	3.5
03/31/1983	1500 CST	9400	676.36	51.4	54.9	3.5

Table 5. Thermal Surveys at SQN from March 1996 through April 2003

Date	Approx Time	River		Temperatures (5-foot depth)		
		Flow (cfs)	Stage (ft MSL)	T_u Measured (°F)	T_d Measured (°F)	ΔT Measured (°F)
03/01/1996	1100 CST	42456	676.96	45.9	48.8	2.9
03/01/1996	1445 CST	28136	677.04	46.2	50.2	4.0
03/01/1996	1600 CST	21962	677.00	46.1	51.4	5.3
03/01/1996	1700 CST	20280	677.00	46.0	51.5	5.5
07/24/1997	1550 CDT	40441	682.57	83.5	84.7	1.2
03/24/1999*	1250 CST	35731	677.46	51.9	54.5	2.7
08/02/2000	1000 CDT	12472	682.20	82.1	85.1	3.0
08/02/2000	1100 CDT	8624	682.20	82.1	85.3	3.1
07/27/2002	1250 CDT	17231	682.37	84.0	86.6	2.6
04/23/2003	1445 CDT	34178	682.53	63.7	64.2	0.5

* The survey of 03/24/1999 is lacking valid upstream temperature data and was not used in the calibration.

Table 6. Thermal Surveys at SQN from February 2004 through November 2023

Date	Approx Time	River		Temperatures (5-foot depth)		
		Flow (cfs)	Stage (ft MSL)	T_u Measured (°F)	T_d Measured (°F)	ΔT Measured (°F)
02/14/2004	0600 CST	51133	677.50	43.7	46.3	2.6
02/22/2004	1800 CST	18468	678.40	45.8	50.5	4.7
08/22/2004	1800 CST	12340	682.00	79.8	84.1	4.3
08/23/2004	1800 CST	39238	682.20	79.8	82.4	2.6
04/01/2006	1915 CST	7084	677.20	59.7	63.5	3.8
04/04/2006	0015 CST	7996	677.70	59.3	63.9	4.6

04/04/2006	1105 CST	8251	677.80	59.6	61.3	1.7
04/04/2006	2030 CST	8258	678.00	59.0	63.2	4.2
04/05/2006	0915 CST	7917	678.20	59.2	62.8	3.6
04/05/2006	2215 CST	8277	678.40	60.4	64.2	3.8
04/06/2006	0915 CST	8174	678.50	59.7	63.3	3.6
04/06/2006	2315 CST	8077	678.70	61.0	64.5	3.5
04/07/2006	0840 CST	8162	678.80	59.9	63.9	4.0
04/07/2006	1435 CST	7889	678.80	60.0	64.7	4.7
05/22/2006	1445 CST	14511	682.00	73.4	72.9	-0.5
05/23/2006	1455 CST	17878	682.20	73.5	73.9	0.4
05/28/2006	1440 CST	13396	682.30	76.6	76.7	0.1
05/29/2006	1435 CST	13713	682.40	77.5	77.6	0.1
05/30/2006	1425 CST	14304	682.40	79.7	79.2	-0.5
09/20/2007	1200 CST	8545	681.80	79.3	83.4	4.1
09/21/2007	1300 CST	8629	681.70	80.6	82.5	1.9
09/22/2007	0600 CST	6969	681.70	79.5	81.8	2.3
11/04/2007	1200 CST	7664	678.70	64.9	69.5	4.6
11/16/2012	1400 CST	12599	678.62	57.0	60.3	3.3
08/22/2018	1600 CST	12531	682.70	81.9	84.0	2.1

The most recent calibration of the numerical model was performed in 2018 to support the NPDES permit of June 2015 (TVA, 2015). The data from Table 44, Table 5, and Table were used in this calibration. The average overall discrepancy between the measured and computed downstream temperatures was about 0.55 F° (0.31 C°). For downstream temperatures above 75°F, the average discrepancy improved to about 0.38 F° (0.21 C°).

New Calibration Data and Calibration Work

Since the 2018 model calibration, an additional field study was performed in November 2023 (Table 77). The study included the operation of two units at SQN and was conducted concurrently with independent measurements for the discharge through the diffusers (TVA, 2018). Measured data of downstream temperatures was collected for a 6-hour period at 5 locations which were spread equally across the entire end of the mixing zone. Those five locations were averaged across the 3 foot, 5 foot, and 7 foot depths. With this new field measurement, altogether fifty-three data points with sets of temperature samples across the downstream end of the mixing zone were available for updating the model calibration (i.e., Table 4 through Table 77).

Table 7. Thermal Surveys at SQN from November 2023

Date	Approx Time	River		Temperatures (5-foot depth)		
		Flow (cfs)	Stage (ft MSL)	T_u	T_d	ΔT
				Measured (°F)	Measured (°F)	Measured (°F)
11/15/2023	1500 CST	20566	677.48	62.0	66.2	4.2

Results of Updated Calibration

The computed and measured downstream temperatures for the fifty-three downstream temperature data points collected in SQN field surveys since March 1982 are shown in Figure 77. The newest measurement on Figure 7 is denoted with a blue circle. A modeled value of 65.7ºF (18.72ºC) was calculated compared to the newly measured field value of 66.2ºF (19.0ºC) for a difference of 0.5 Fº. The average discrepancy between all the measured and all the computed downstream temperatures was approximately 0.55 Fº (0.31 Cº). For downstream temperatures above 75ºF (23.89ºC), the average discrepancy was 0.38 Fº (0.21 Cº); however, for the most recent field measurement the downstream temperature was not above 75ºF. There was no discernable change in the overall model performance compared to the previous calibration.

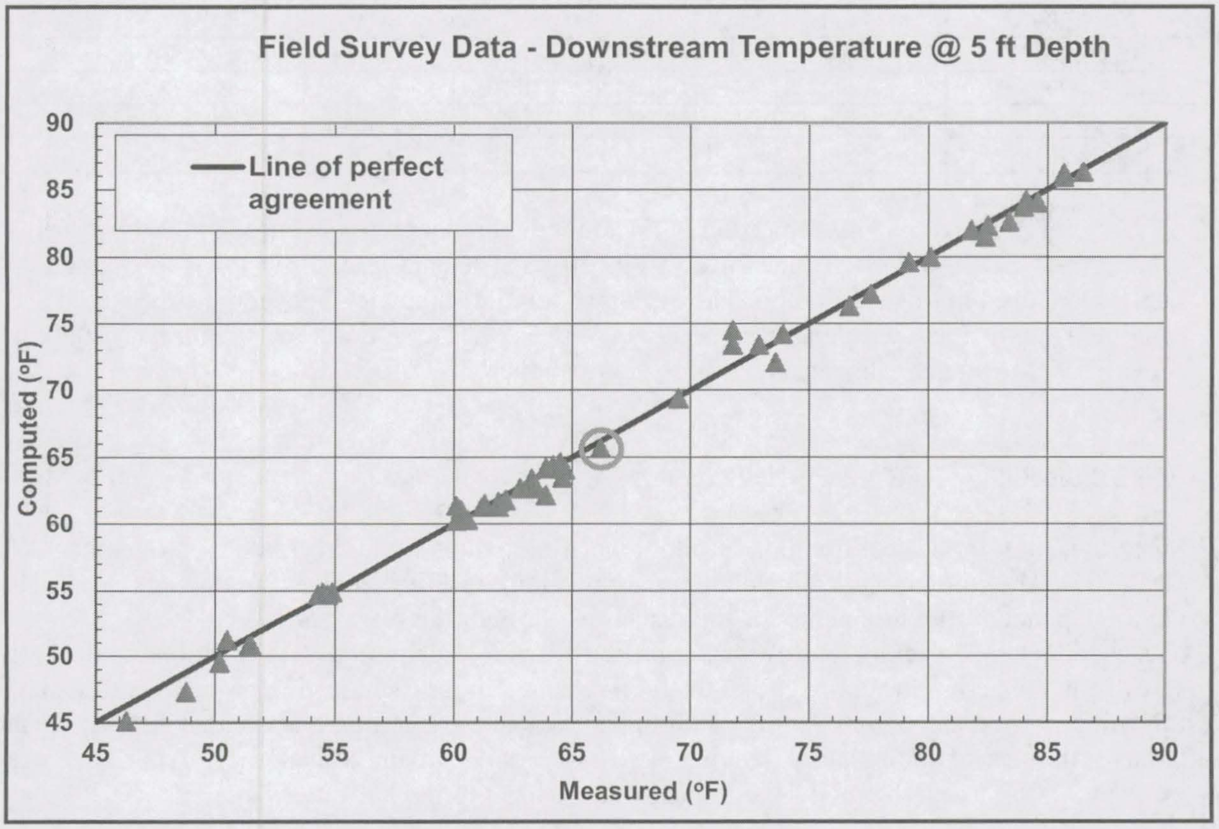

Figure 7. Comparison of Computed and Measured Temperatures T_d for Field Studies from April 1982 through August 2023

CONCLUSIONS

The numerical model for the SQN effluent discharge computes the temperature at the downstream end of the mixing zone with sufficient accuracy for use as the primary method of verifying thermal compliance for Outfall 101. In the updated calibration study summarized herein, which used the results from fifty-three sets of temperature samples across the downstream end of the diffuser mixing zone, the average discrepancy between the measured and computed downstream temperatures was approximately 0.55 F° (0.31 C°). For downstream temperatures above 75°F, the average discrepancy was approximately 0.38 F° (0.21 C°). There was no discernable change in the overall model performance compared to the previous calibration.

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STATE OF TENNESSEE
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
DIVISION OF WATER RESOURCES
William R. Snodgrass - Tennessee Tower
312 Rosa L. Parks Avenue, 11th Floor
Nashville, Tennessee 37243-1102

CERTIFIED MAIL
RETURN RECEIPT REQUESTED
RETURN RECEIPT # 7009 2820 0003 6036 8543

November 23, 2015

Mr. Terry Cheek
Senior Manager
TVA Water Permits, Compliance, and Monitoring
1101 Market Street, BR 4A
ecopy: techeek@tva.gov
Chattanooga, TN 37402

Re: **UV Treatment of Effluent for Toxicity Testing for Fathead Minnows (*Pimephales promelas*)**
TVA-Sequoyah Nuclear Plant
NPDES TN0026450, Hamilton County

Dear Mr. Cheek:

The Division has received your request dated October 26, 2015, to use UV treatment on the effluent from Sequoyah Nuclear Plant, for the purposes of pathogen removal. This treated effluent is used during Whole Effluent Toxicity (WET) testing for Fathead Minnows (*Pimephales promelas*).

The Division approves the use of UV radiation at the above referenced facility, similar to prior approvals granted in 2006 at Kingston and Cumberland fossil plants. We have considered the concern for potential changes in test results when organic compounds are present, as identified in section 11.3.4.6.1 (Use of UV light to irradiate the sample) in EPA's Guidance Document for WET testing. Since organic compounds are not routinely reported in this facility's effluent, it is reasonable to approve testing in this manner.

If you have any further questions, please contact Robert Alexander at (615) 532-0659 or via e-mail at robert.alexander@tn.gov, or you may contact me at (615) 532-0670 or via e-mail at jessica.murphy@tn.gov.

Sincerely,

Jessica Murphy
Manager, Compliance and Enforcement

cc: Vojin Janjic, Water-Based Systems
EPA Region 4, r4permits@epa.gov

Sequoyah Nuclear Plant
Biocide/Chemical Treatment Plan
NPDES Permit No. TN0026450

Chemical treatment programs have been implemented at Sequoyah Nuclear Plant to control fouling, plugging, and pipe wall thinning of the raw water systems. Most of the chemicals used in these treatment programs are added at three locations: Essential Raw Cooling Water (ERCW intake for ERCW A train and ERCW B train and Raw Cooling Water (RCW) pump suction header for RCW to ensure these raw water systems are protected. These systems, the ERCW and RCW, are essential for the safe and reliable operation of the plant. The SQN Biocide/Chemical Treatment Plan (B/CTP) is designed to allow for protection of these systems while ensuring that the concentration of chemicals in the effluent does not adversely impact the receiving stream. SQN demonstrates compliance with the treatment plans below using mass balance calculations where possible. The chemicals currently used are described below.

Carbon Steel Corrosion Inhibition

SQN uses a combination of two chemicals to provide corrosion protection for carbon steel piping in the plant: Spectrus BD1500 (nonionic surfactant biodispersant) and Flogard MS6236 (phosphate additive). These products are injected into the ERCW and RCW (approved by TDEC May 26, 2009). Spectrus BD1500 is injected up to 3 times per week, for 30 minutes, year round. Flogard MS 6236 is injected seasonly from March to November, 5 days per week in the ERCW system. Flogard MS 6236 is also injected year round in the RCW, five times per week. The concentration of nonionic surfactant (Spectrus BD1500) in the plant effluents will not exceed 2.0 ppm, and the phosphorus (Flogard MS6236) will not exceed 0.20 ppm.

Raw Cooling Water Biocide Treatments

Protection of the raw cooling water pipe systems requires oxidizing biocide (chlorination) and non-oxidizing biocide treatments to control macro invertebrates and microbiologically induced corrosion. Oxidizing treatments are aimed at both macro-invertebrate and microbiologically induced corrosion control. Non-oxidizing biocides are aimed at macro-invertebrate control. SQN treats plant systems for mollusk control with a non-oxidizing biocide, Spectrus CT 1300 (approved April 27, 2005).

Routine Raw Water Treatment with Oxidizing Biocides (Chlorination)

To control macro invertebrates and microbiologically induced corrosion, routine raw water treatments with oxidizing biocide are necessary. SQN Plans to treat with oxidizing biocides 2-5 days per week during cool weather periods and 5-7 days per week during warm weather periods for 4-12 hours per day. Continuous treatment is sometimes necessary (up to 24 hours per day). Periods of continuous oxidizing biocide treatment may also be required following treatments with non-oxidizing biocide.

Towerbrom 960 (approved by TDEC April 27, 2005) is used for oxidizing biocide treatments. Application of this product will be in compliance with the NPDES permit limits for Outfall 101 for Total Residual Chlorine (TRC).

Non Oxidizing Biocide Treatment (Mollusk Control)

SQN will use Spectrus CT 1300 for 48 hour treatments, 5 times per year per train for ERCW A and B. It will also be injected in the RCW 6 times per year. SQN will show by mass balance calculation that the required concentrations are being met for each application.

GENERAL REQUIREMENTS OF THE B/CTP

The following are general requirements issued to Sequoyah Nuclear Plant in an April 27, 2005 letter from TDEC:

1. Oxidizing and non-oxidizing biocides are not to be used at the same time, in each system train, (e.g., ERCW Train A, ERCW Train B, or RCW),
2. Whole effluent toxicity testing (biomonitoring) of Outfall 101 shall be undertaken once per year when oxidizing biocides are being used and once per year when non-oxidizing biocides are being used.
3. Whole effluent toxicity testing (biomonitoring) of Outfall 110 shall be undertaken once per year when oxidizing biocides are being used and once per year when non-oxidizing biocides are being used.
4. Whole effluent toxicity testing performed under requirements of the NPDES permit may be coordinated with the requirements of (2) and (3) above.
5. The sampling and test procedures used for biomonitoring shall be the same as those described in the NPDES permit. Analysis of the samples shall be preformed the same regardless of how the sample is collected, e.g., if composite sample collection is used, the test method for the sample shall be the same as if the sample was collected by grab sample.
6. The acceptable methods for detection of TRO shall be the same as those specified in the NPDES permit for TRC.
7. Annually, a report shall be submitted to the Division presenting the biomonitoring data for tests conducted during treatments, a summary of analytical results (daily maximum, daily average, number of samples), the approximate duration in hours of each chemical used, quantity in pounds of each chemical used, and any minor changes that have occurred to the plan. The report shall be submitted to the Enforcement and Compliance Section in Nashville and to the Chattanooga Field office by February 15 of the year following the reporting year. Significant changes to the plan must be submitted for Division approval prior to their initiation. Minor changes (e.g. chemical names or vendor changes of essentially the same chemical) do not require pre-approval, but shall be indicated in the annual report or when the plan is revised.
8. TVA-SQN is required to maintain all records on file of sampling and analytical data, toxicity test results, records of quantities fed per day of each chemical, and mass balance calculations. These records shall be maintained on site for a period of at least three years.

Table 1. Raw Water Chemical Additives at Sequoyah Nuclear Plant

PRODUCT	PURPOSE	FREQUENCY of Discharge	ACTIVE INGREDIENTS	% ACTIVE INGREDIENT	REPRESENTATIVE AQUATIC TOXICITY /DESCRIPTOR	DISCHARGE CONCENTRATION[1]
					(ppm active ingredients)	(ppm active ingredients)
Flogard MS6236	Iron Corrosion Inhibition	Continuous	Orthophosphate, sodium tripolyphosphate	30	7-d IC_{25} = 152 (C. dubia) 7-d IC_{25} = 494 (P. promelas)	<0.2
Spectrus BD1500	Surfactant to facilitate oxidizing biocides	Periodic	Nonionic Surfactant	15	7-d IC_{25} = 98 (C. dubia) 7-d IC_{25} = 450 (P. promelas)	<2.0
Towerbrom 960	Oxidizing Biocide (Chlorination)	Periodic	Sodium Bromide & Sodium Dichloroisocyanurate	96	48-h LC_{50} = 2.43 (D. magna) 48-h LC_{50} = 0.679 (P. promelas)	< 0.05 mg/L TRC (NPDES permit limit at OSN 101)
Spectrus CT1300[2]	Non Oxidizing Biocide (Mollusk Control)	Periodic	Alkyl Dimethyl Benzyl Ammonium Chloride (ADBAC)	50	7-d IC_{25} = 0.049 (C. dubia) 7-d IC_{25} = 0.130 (P. promelas)	<0.001 active ingredient in stream after mixing <0.05 measured in effluent

1. The maximum discharge concentration is indicated EXCEPT where noted. Concentrations are achieved through dilution.
2. Spectrus CT 1300 is a non-oxidizing biocide used for mollusk control.
3. Non-oxidizing biocide treatments are not applied at the same time as oxidizing biocide treatments.

Table 2. **Raw Water Chemical Application Guide**[1]

Product	Injection Point	Max Feed (ppm)	In Plant Target (ppm)	Frequency of Application	Average Duration of Application.	Estimated Max Days per Year	Maximum Daily Usage (lbs)[2]
Flogard MS6236[5]	ERCW Trains A & B and RCW	2.4	2.6	Daily	24 hours per day	365	2275[4]
Spectrus BD1500	ERCW Trains A & B and RCW	2.5	2.5	156 days per year	0.5 hrs/day	156	50
Spectrus CT1300[4] (CT App)	ERCW Trains A & B and RCW	3.0	3.0	22 days per year	48 hours	22	855
Towerbrom 960[3]	ERCW Trains A & B and RCW	1.5	1.5	312 days per year	4-12 hours/day	312	1425

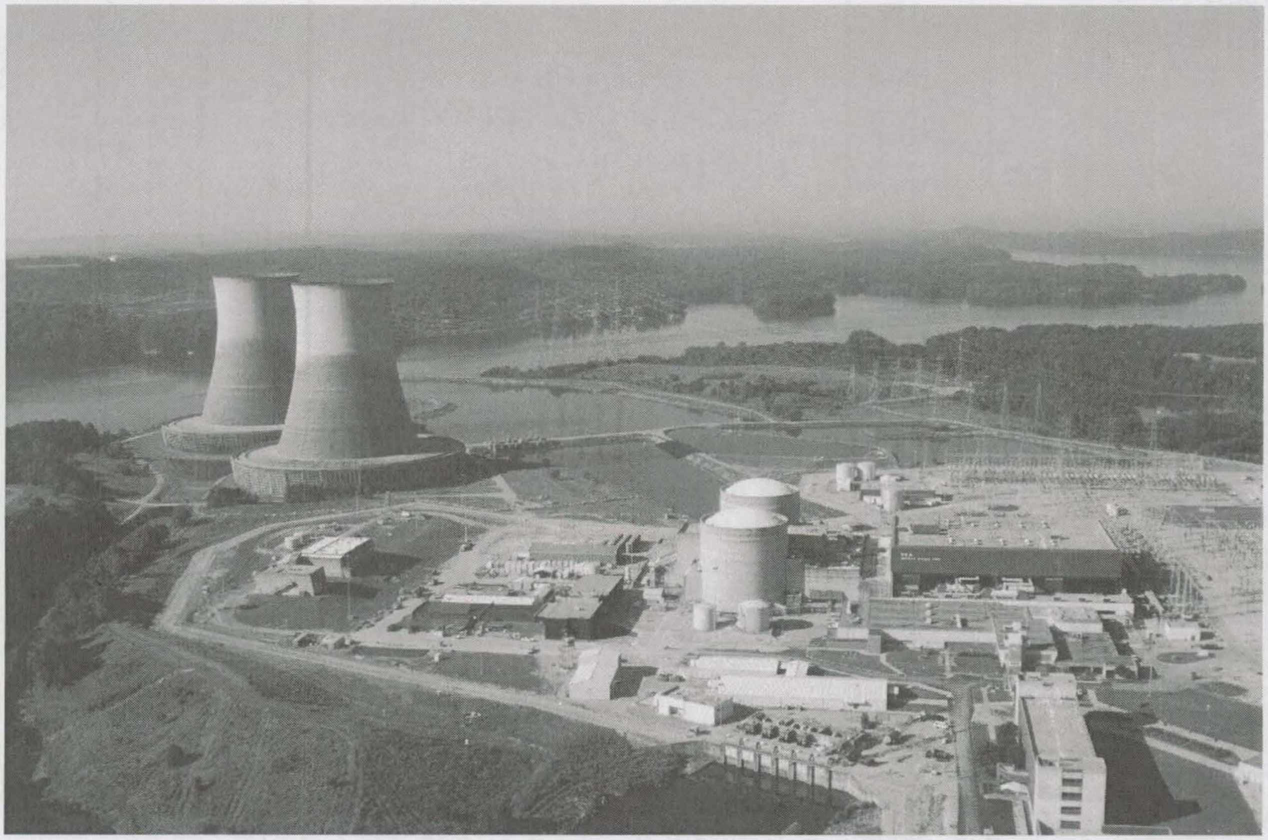
1. Concentrations and usage are expressed for the active ingredient(s) shown on the first page of this plan.
2. Maximum Daily Usage provides an indication of loading in the receiving stream. It is the maximum amount of active ingredients for the worst case scenario of flow and feed concentration being proposed plus a 10% margin of error. SQN will track daily usage and will request a change to this plan should an increase in maximum daily usage become necessary for the continued safe operation of the plant.
3. Towerbrom 960 is 96% active producing 57% free halogen (chlorine or bromine). Chlorine will be less than NPDES permit limits at NPDES discharge point (Outfall 101).
4. SQN uses the non-oxidizing biocide Spectrus CT 1300 for mollusk control.
5. Flogard MS6236 application to ERCW A & B is seasonal. It is applied 24 hours/day, 5 days/week from March - November. RCW application is 18-20 hours/day, 365 days/year.
6. Concentrations and usage are expressed for the active ingredient(s) shown on the first page of this plan.

Table 3. Calculations Showing Worst Case Scenario (final values rounded to the nearest 5 lbs)

MS6236	2.4 mg	1 lb	71,800 gal	3.785 l	60 min	24 hr	1.10	**2275 lbs/day Flogard MS6236**
2.4 ppm active	1	454,000 mg	min	gal	1 hr	day		
Spectrus BD1500[1]	2.5 mg	1 lb	71,800 gals	3.785 l	---	---	1.10	**= 50 lbs Spectrus BD 1500**
2.5 ppm active	1	454,000 mg		gal	---	---		
Towerbrom 960	1.5 mg	1 lb	71,800 gals	3.785 l	60	24 hr	1.10	**= 1425 lbs Towerbrom 960**
1.5 ppm active	1	454,000 mg	min	gal	1 hr	day		
Spectrus CT1300	3 mg	1 lb	21,000 gal	3.785 l	60 min	24 hr	1.10	**= 855 lbs (quat)**
3 ppm active	1	454,000 mg	min	gal	1 hr	day		

Evaluating the Presence and Maintenance of a Balanced Indigenous Population of Fish and Wildlife in the Tennessee River Downstream of TVA's Sequoyah Nuclear Plant

Soddy Daisy, Hamilton County, Tennessee



Tennessee Valley Authority

January 2025

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EXECUTIVE SUMMARY

This document presents results of biological monitoring conducted during summer and autumn 2022 as a means to evaluate the status of the aquatic community in the Tennessee River (Chickamauga Reservoir) downstream of TVA's Sequoyah Nuclear Plant thermal discharge. This report is intended to support continuance of the 316(a) alternate thermal limit (ATL) for the plant discharge based on successful demonstration, in accordance with Section 316(a) of the Clean Water Act, that a balanced indigenous population (BIP) of fish and wildlife was present and being maintained in the river downstream of the plant.

In evaluating the selected fish community metrics relevant to determination of the maintenance of a BIP of fish and wildlife, it is apparent that the fish community structure at the thermally affected downstream reach was similar to that at the unaffected upstream reach during 2022. RFAI data from the mid-2000s to 2017 indicated decreasing trends in certain aspects of fish communities at both upstream and downstream reaches. However, recent data from 2019 through 2022 suggest a potential rebound.

In evaluating the data in the context of EPA's interpretation of the regulatory definition of a BIP, TVA believes that a BIP is currently being demonstrated in Chickamauga Reservoir downstream of the SQN plant based on the most recent biological data collected in 2022 (see Section 3.0 of this report). The interpretation requires demonstration that the following attributes are present and being maintained in the waterbody:

1. The population is typically characterized by diversity at all trophic levels,
2. The population has the capacity to sustain itself through cyclic seasonal changes,
3. The necessary food chain species are present,
4. Pollution-tolerant species are not dominant, and
5. Indigenous species are appropriately represented.

Based on the findings reported herein, TVA believes that continuation of the current ATL of 30.5°C (86.9°F) at the end of the mixing zone for the Sequoyah Nuclear Plant discharge (Outfall 101) will nevertheless reasonably assure the protection and propagation of a BIP.

1.0 INTRODUCTION

This document presents results of biological monitoring conducted during summer and autumn 2022 as a means to evaluate the status of the aquatic community in the Tennessee River (Chickamauga Reservoir) downstream of the Tennessee Valley Authority's (TVA) Sequoyah Nuclear Plant (SQN) thermal discharge. This report is intended to support continuance of the alternate thermal limit (ATL) for the plant discharge (Outfall 101) in a renewed National Pollutant Discharge Elimination System (NPDES) permit for the facility (NPDES Permit No.: TN0026450) based on successful demonstration, in accordance with Section 316(a) of the Clean Water Act, that a balanced indigenous population (BIP) of fish and wildlife was present and being maintained in the river downstream of the plant.

This report is constructed to target § 316(a) regulatory requirements and the characteristic elements of a BIP. In the context of § 125, Subpart H, this report constitutes the § 316(a) "demonstration" the Director requires in considering whether to grant an ATL in the NPDES permit for a facility. The readers of this report are directed to Appendix A for the details of field study design, biological community sampling methods, and Reservoir Fish Assemblage Index methodology.

1.1 Facility Information

The SQN plant located in Hamilton County, Tennessee (Figure 1), employs two nuclear-powered steam generating units that were brought into operation sequentially in 1981 and 1982, respectively. Located on the right descending bank of Chickamauga Reservoir on the Tennessee River, the SQN plant withdraws cooling water from Chickamauga Reservoir via an intake channel and skimmer wall at Tennessee River mile (TRM) 484.8 (Figure 2). The facility employs a once-through (open cycle) condenser cooling water system and can also operate with cooling towers in helper mode. Heated effluent is discharged to Chickamauga Reservoir via Outfall 101 located at TRM 483.6 (Figure 2) as authorized by the NPDES permit.

When operating at design (nameplate) capacity (2,441 megawatts [MW]), the units require approximately 1.11 x 10^6 gallons per minute (gpm) or 1,602 million gallons per day (mgd) of condenser cooling water and reject 16.4 x 10^9 BTU per hour of waste heat. This waste heat increases the temperature of the cooling water by approximately 16.4 °C (29.5 °F) before it is discharged into the river. The actual condenser flow, and hence the change in temperature from ambient (ΔT), may vary somewhat with the circulating water pump head and the condenser efficiency.

Relevant plant operational data—mean daily temperatures at the CCW intake and discharge, mean daily flow through the CCW system, and mean daily power generation by the two nuclear units at SQN—were compiled from 2018 through 2022 and are included in Appendix B. Biological monitoring was conducted upstream and downstream of SQN during summer on August 21 and 22 and again during autumn on November 21 and 22, 2022.

1.2 Description of the Receiving Waterbody

Sequoyah Nuclear Plant is located on the right descending bank of Chickamauga Reservoir (TRM 484.5) approximately 18 miles northeast of Chattanooga, Tennessee, and 7 miles southwest of Soddy-Daisy, Tennessee (Figure 1). Chickamauga Reservoir was impounded in 1940 and at full pool covers approximately 36,240 acres.

In the vicinity of SQN, the reservoir consists of a shallow overbank area on the plant side which extends from TRM 484 downstream to TRM 481.8 and varies in depth from 2 to 20 ft and in width from 500 to 3,100 ft. This shallow area is bordered by a main river channel, which is about 900 feet (ft) wide and approximately 60 ft deep. Along this reach there are several small, shallow embayments.

Flow of the Tennessee River at SQN is controlled primarily by releases from Watts Bar Dam (WBH) upstream and Chickamauga Dam (CHH) downstream (flow is made up of approximately 23% WBH releases and 77% CHH releases), and to a lesser extent by the Hiwassee River, which enters the reservoir approximately 16 miles upstream of SQN at TRM 500 (Figure 1). The SQN plant is situated approximately 54.5 river miles downstream from WBH and 13.5 river miles upstream from CHH. Flow past the plant is highly variable, ranging from annual daily averages of 15,000 to 50,000 cfs (1977-2022). Daily average flows during 2022 were slightly lower than historical flows during January through May and October through November, and similar during the summer months.

1.3 Regulatory Basis

Sequoyah Nuclear Plant's NPDES permit, inclusive of the ATL, was recently renewed and issued on July 30, 2020 (effective date of August 1, 2020). The permit is valid for 5 years and is set to expire on July 31, 2025. The current status of a BIP in Chickamauga Reservoir is relevant to the continuation of the ATL in the next permit.

1.3.1 Applicable Thermal Criteria

The Tennessee Department of Environment and Conservation (TDEC) has specified "use classifications" for the state's surface waters and developed temperature criteria intended to support those uses (TDEC Rule 0400-40-04 and 0400-40-03.03, respectively). The Tennessee River at the location of SQN has been classified for the following uses: Municipal, Industrial, and Domestic Water Supply, Industrial Water Supply, Fish and Aquatic Life, Recreation, Irrigation, Livestock Watering and Wildlife, and Navigation. Except for Irrigation and Livestock Watering and Wildlife (qualitative criteria), temperature criteria relevant to warm-water conditions of the Tennessee River at SQN specify that:

"The maximum water temperature change shall not exceed 3°C [5.4°F] *relative to an upstream control point. The temperature of the water shall not exceed 30.5°C* [86.9°F] *and the maximum rate of change shall not exceed 2°C* [3.6°F] *per hour. The temperature of impoundments where*

stratification occurs will be measured at a depth of 5 feet, or mid-depth whichever is less, and the temperature in flowing streams shall be measured at mid-depth." [Rule 0400-40-03-.03]

The SQN plant's "once-through" cooling water system design utilizing cooling towers in helper mode provides for the most thermodynamically efficient method of generating electricity and as a result produces a heated discharge. As such, the thermal discharge typically exceeds TDEC's established temperature criteria, therefore, multiport diffusers with mixing zone are used to adequately mix the thermal effluent to meet the state water quality standard at the end of the mixing zone. In such cases, the TDEC rules specific to the Fish and Aquatic Life use classification provide that:

"*A successful demonstration as determined by the state conducted for thermal discharge limitations under Section 316(a) of the Clean Water Act, (33 U.S.C. §1326), shall constitute compliance...* [with the temperature criteria]."

TVA has previously madesuch successful demonstration for the SQN thermal discharge in support of mixing zone criteria as further discussed below.

1.3.2 Currently Permitted Conditions

Currently permitted thermal discharge limitations for SQN specify that the daily maximum temperature is not to exceed 30.5°C (86.9°F) at the end of the mixing zone (Page 3 of 31, NPDES permit TN0026450). This mixing zone criteria are based on a previous demonstration by TVA, in accordance with CWA §316(a) and TDEC Rule 0400-40-03-.03 noted above, that a balanced indigenous population (BIP) of fish, shellfish, and wildlife is supported in the Tennessee River potentially affected by the thermal discharge. The mixing zone criteria, as supported by the biological studies, also encompass other components of the TDEC temperature criteria, specifically the change in temperature from ambient/upstream conditions and rate of change in temperature. SQN has maintained a good compliance record with its mixing zone criteria throughout each NPDES permit term since first authorized in the late-1980s; ongoing biological monitoring has consistently demonstrated the mixing zone criteria are protective of aquatic communities in the river near the facility.

1.3.3 Criteria for Alternate Thermal Limits Under § 316(a)

The regulatory provisions that implement CWA §316(a) provide limited guidance on precisely what the demonstration study must contain to be considered adequate and do not identify precise criteria against which to measure whether a "*balanced and indigenous*" aquatic community is protected and maintained. Instead, the regulations provide broad guidelines.

Under the broad regulatory guidelines, the discharger must show that the ATL desired, "*considering the cumulative impact of its thermal discharge together with all other significant impacts on the species affected,*" will "*assure the protection and propagation of a balanced, indigenous community of shellfish, fish and wildlife in and on the body of water into which the* *discharge is to be made* (40 CFR §125.73). Critical to the demonstration is the meaning of the term "balanced indigenous community". The rules provide the following definition:

> "The term "*balanced indigenous community*" is synonymous with the term balanced, indigenous population (i.e., BIP) in the Act and means a biotic community typically characterized by diversity, the capacity to sustain itself through cyclic seasonal changes, presence of necessary food chain species and by a lack of domination by pollution tolerant species. Such a community may include historically non-native species introduced in connection with a program of wildlife management and species whose presence or abundance results from substantial, irreversible environmental modifications" (40 CFR §125.73).

Pursuant to this regulatory definition, a successful demonstration must show that under the desired ATL, and in light of the cumulative impact of the thermal discharge together with all other significant impacts on the species affected, the following characteristics, which are indicative of a BIP, will continue to exist: (1) diversity, (2) the capacity of the community to sustain itself through cyclic seasonal changes, (3) presence of necessary food chain species, and (4) a lack of domination by pollution tolerant species.

There are several methodologies a discharger may pursue in making a §316(a) demonstration. Under the regulations, <u>new dischargers</u> must use predictive methods (e.g., laboratory studies, literature surveys, or modeling) to estimate an appropriate ATL that will assure the protection and propagation of a balanced, indigenous community prior to commencing the thermal discharge. However, <u>existing dischargers</u>, such as SQN, need not use predictive methods. For such dischargers, §316(a) demonstrations may be based upon the "*absence of prior appreciable harm*" to a balanced, indigenous community (see 40 CFR §125.73(c)(1)(i) and (ii)). Such demonstrations must show <u>either</u> that:

i) No appreciable harm has resulted from the thermal component of the discharge taking into account the interaction of such thermal component with other pollutants and the additive effect of other thermal sources to a balanced, indigenous community of shellfish, fish, and wildlife in and on the body of water into which the discharge has been made; <u>or</u>

ii) Despite the occurrence of such previous harm, the desired alternative effluent limitations (or appropriate modifications thereof) will nevertheless assure the protection and propagation of a balanced, indigenous community of shellfish, fish, and wildlife in and on the body of water into which the discharge is made.

Furthermore, in determining whether or not prior appreciable harm has occurred, the regulations provide that the permitting agency consider the length of time during which the applicant has been discharging and the nature of the discharge. The regulations do not define "*prior appreciable harm*." However, using the definition of "balanced, indigenous community," mixing zone criteria are generally granted under either of the following circumstances:

1. When a discharger shows that the characteristics of a BIP (i.e., diversity, the capacity to sustain itself through cyclic seasonal changes, presence of necessary food chain species, and a lack of domination by pollution tolerant species) exist. Stated another way, the existence of such characteristics essentially prove that the aquatic community has not been appreciably harmed; <u>or</u>

2. Despite any evidence of previous harm, the characteristics of a BIP, as stated above, will nevertheless be protected and assured under the ATL.

The standard to "assure" a BIP does not require a "no effects" determination, but rather "reasonable assurance" of the protection and propagation of a BIP[1].

1.3.4 Mixing Zone Requirements in Tennessee Rule 0400-40-.05

As noted above, §316(a) pertains to the Fish and Aquatic Life use classification and provides NPDES-permitted facilities a regulatory compliant means of demonstrating that promulgated temperature criteria may be more stringent than necessary to support a BIP. In such cases, less stringent thermal criteria (i.e., ATLs) are justified. However, other use classifications such as Domestic Water Supply and Recreation must be protected as well. Compliance with TDEC temperature criteria for these uses is typically determined after the discharge has had the opportunity to mix with the receiving water; that is, an allowable mixing zone is determined.

TDEC rules define the mixing zone as:

"*That section of a flowing stream or impounded waters in the immediate vicinity of an outfall where an effluent becomes dispersed and mixed.*" [0400-40-03-.04(12)]

The rules [0400-40-03-.05(2)] further provide that mixing zones are to be restricted in area and length and not:

1. prevent the free passage of fish or cause aquatic life mortality in the receiving waters;

2. contain materials in concentrations that exceed acute criteria beyond the zone immediately surrounding the outfall;

3. result in offensive conditions;

4. produce undesirable aquatic life or result in dominance of a nuisance species;

5. endanger the public health or welfare; or

[1] *See In re Dominion Energy Brayton Point, LLC*, 13 E.A.D. 407, 2007 WL 3324213, at *16 (EAB Sept. 27, 2007); *see also In re Public Service Company of New Hampshire et al. (Seabrook Station, Units 1 and 2)*, 1 E.A.D. 332, 1977 WL 22370, at *11-14 (EAB June 10, 1977).

6. adversely affect the reasonable and necessary uses of the area;

7. create a condition of chronic toxicity beyond the edge of the mixing zone;

8. adversely affect nursery and spawning areas; or

9. adversely affect species with special state or federal status.

While TVA's §316(a) demonstration study plan fully examines the effects of the thermal discharge on the aquatic life components of the mixing zone requirements, the potential effects to other non-aquatic life use classifications (items 3, 5, and 6 above) are generally not evaluated. Therefore, this plan has been revised herein to incorporate and/or collect additional information needed to address the reasonable potential for impairment of other non-aquatic life uses in the Tennessee River near the facility.

2.0 BIOLOGICAL STUDIES AND ASSESSMENTS

2.1 Previous § 316(a) Demonstration Study

TVA conducted comprehensive §316(a) demonstration-related studies of the SQN thermal effluent in the mid-1980s to support establishment of the current mixing zone criteria for the plant discharge (TVA 1989). The minimum average daily flow for the Tennessee River near SQN at the time of the early studies was 6,000 cfs.

The mid-1980s studies included extensive sampling of the aquatic community including:

- Phytoplankton,
- Periphyton,
- Aquatic macrophytes,
- Zooplankton,
- Benthic macroinvertebrates; and
- Fish populations.

Hydrothermal, water quality and other parameters also were evaluated.

Major findings of these studies included:

- Average dissolved concentration in the water column was similar immediately upstream and downstream of SQN.

- Analysis of the data indicate that the assemblages of phytoplankton, zooplankton, and macroinvertebrates were diverse and, in general, relatively abundant.

- Dominance of blue-green algae was similar upstream and downstream of SQN.

- The phytoplankton and zooplankton communities were found to be similar, or if different, not impacted by SQN operation, at all stations during 20 of the 27 survey months when the plant was in operation.

- Species richness in the benthic macroinvertebrate communities during pre-operational and operational monitoring was similar.

- No changes were documented in the aquatic macrophyte community that reflected effects of the thermal effluent.

- Fish species occurrence and abundance data indicated insignificant impacts. Avoidances of the plume could not be detected for any species of fish. One study found that sauger (*Sander canadensis*) were not concentrated in the thermal plume during winter months nor inhibited from movement past SQN. Results of gonadal inspections indicate that the heated discharge did not adversely affect fish reproduction.

- Other fisheries studies indicated that the thermal discharge resulted in no discernible increase in parasitism.

- No mortalities of threadfin shad due to cold shock following shutdown of SQN were observed or reported, and none are anticipated to occur in the future.

2.2 Contemporary Studies

In 2001, TVA and TDEC reached an agreement whereby results of TVA's River and Reservoir Monitoring program (f.k.a., "Vital Signs" program), designed to measure ecological and water quality health on a reservoir-wide basis, would be the accepted study design for measuring the presence and maintenance of a BIP to support § 316(a)-based ATLs (Appendix C). Study design at the time (starting in 2001) was based on measuring biotic integrity using multi-metric community structure assessment techniques and focused on fish community sampling in three zonal areas of the reservoir during autumn: the inflow, transitional and forebay zones. Seasonal assessments (summer & autumn) were conducted in 2011 and 2022 at the request of TDEC. Macroinvertebrate community sampling began in 2009. Biological sampling zones and collection methods are illustrated in Figures 3 and 4.

In 2009-2010, there was increasing regulatory interest at the federal level in having NPDES permit applicants update studies supporting ATLs and to better focus study design on the regulatory definition of a BIP as provided in 40 CFR §125.73. Accordingly, TVA developed Study Plans incorporating sampling locations closer to its power plants to supplement data collected in the three reservoir zonal areas, and included more traditional comparative analysis techniques in addition to the long-used multi-metric assessment techniques. New assessments of wildlife communities that could potentially be impacted by thermal discharges were also conducted.

The TVA's biological assessment data has consistently indicated that fish assemblages of Chickamauga Reservoir downstream of the SQN thermal discharge were similar to those of upstream reference locations. The findings have demonstrated, with acceptance by TDEC and EPA Region 4, the presence, protection, and maintenance of a BIP in Chickamauga Reservoir in support of continuing the ATL in the SQN NPDES permit.

2.3 Previously Accepted BIP Assessment Practice

As previously indicated, beginning in 2001 and up until about 2010, TVA's use of multi-metric assessment techniques was for the most part the accepted primary method of demonstrating a BIP for supporting the continuance of the existing ATL at SQN, and the status of the fish community was the primary community of interest (Appendix C).

TVA's multi-metric Reservoir Fish Assemblage Index (RFAI) attempts to address characteristics of a BIP in a holistic manner by measuring 12 population "metrics", scoring the metrics based on expectations of healthy populations in the region, and summing the scores to arrive at an overall RFAI score and subsequent rating. The maximum RFAI score attainable is 60. Ecological health ratings are then applied to the scoring ranges: 12-21 "Very Poor", 22-31 "Poor", 32-40 "Fair", 41-50 "Good", or 51-60 "Excellent". It has generally been accepted that an RFAI rating of "Fair" or better in the thermally affected area can be considered demonstration of a BIP, particularly where RFAI scores for unaffected upstream areas are similar. A difference of six points or less between the thermally affected area and unaffected upstream area indicates statistical similarity of the fish communities between the two sites.

Beginning in 2009 until the present, TVA has conducted autumn (and summer 2011 and 2022) monitoring of the benthic macroinvertebrate community in Chickamauga Reservoir, developing its Reservoir Benthic Index (RBI) of biotic integrity for Tennessee River reservoirs. Multi-metric assessment methods for evaluating ecological health of benthic communities in large river systems and/or artificial reservoir settings are not as well established as they are for wadeable streams, but nonetheless, provide valuable supplemental information in support of the fish community assessment. TVA's RBI is similarly calculated as the RFAI except that it uses seven metrics specific to the macroinvertebrate assemblage. Each metric is assigned a score based on reference conditions and then summed to produce an overall RBI score for each sample site. The maximum RBI score is 35. Ecological health ratings are then applied to scoring ranges: 7-12 "Very Poor", 13-18 "Poor", 19-23 "Fair", 24-29 "Good", or 30-35 "Excellent." A difference of four points or less between the thermally affected area and unaffected upstream area indicates statistical similarity of the benthic macroinvertebrate community between the two sites.

As stated by EPA Region 1 in the supporting documents for the draft Merrimack Station NPDES permit[2]: "Assessing changes in the resident fish community of a water body often provides the most conspicuous evidence of impacts to the overall aquatic community . . . ." The BIP determination in that proceeding (in 2011) relied largely on fish community data for the Hooksett

[2] EPA Region 1. 2011. Draft NPDES Permit for the PSNH Merrimack Station; Appendix D, page 36.

Pool portion of the Merrimack River, the receiving water for the Merrimack Station thermal discharge. However, EPA Region 1 also noted that a comprehensive § 316(a) demonstration is not just limited to fish; planktonic organisms, macroinvertebrates, "habitat formers" (e.g., aquatic vegetation), and wildlife are all important communities to be assessed, but importantly "at the level of detail appropriate to the facility's potential to impact these communities." Explaining further, EPA indicated "no hard and fast rule can be made as to the amount of data that must be furnished [for a successful § 316(a) demonstration] . . . and much depends on the circumstances of the particular discharge and receiving waters." [3]

2.3.1 Results of BIP Studies, 2000 – 2022

2.3.1.1 Reservoir Fish Assemblage Index (RFAI)

In 2000 (baseline), autumn RFAI scores were "48-Good" for the downstream site and "46-Good" for the upstream site, and in 2022, RFAI scores for summer were rated "39-Fair" for the downstream site and "41-Good" for the thermally unaffected site upstream of SQN (Figure 6). Additionally, RFAI scores for autumn 2022 were rated "46-Good" downstream and "47-Good" for the upstream location. Average RFAI scores for the period of 2000–2022 were "40-Fair" at the downstream site and "42- Good" at the upstream site. Score differences over the sample years have averaged about 3 points and recently (since 2007) have been six points or less (statistically similar) during each sample. Summer sampling at the same sites in 2011 resulted in RFAI scores that were equalto those during autumn 2011, with both sites receiving scores of "37-Fair" (Table 1).

Over the period of 2000–2022, averages of the following between the thermally affected downstream and upstream reference sites were highly similar (Table 2):

- Average numbers of species
  - Two more indigenous species upstream than downstream
  - One more centrarchid species upstream than downstream
  - Same number of intolerant species upstream as downstream
  - One more benthic invertivore species upstream than downstream
  - Same number of top carnivore species upstream as downstream

- Average proportions
  - Downstream site, as compared to upstream site:
    - Slightly lower for percent tolerant individuals (by ~1%)
    - Slightly higher for percent of sample dominated by one species (by ~2%)
    - Slightly higher for percent for non-native individuals (by ~2%)
    - Slightly lower percent top carnivore individuals (by ~2%)
    - Slightly lower for percent omnivore individuals (by ~1%)
    - Slightly lower for percent individuals with anomalies (by 0.2%)
- Catch rate
  - Average number of fish per effort was about 3 fish lower downstream

[3] *Seabrook*, 1977 EPA App. LEXIS 16, at *31; as cited in EPA Region 1. 2011. Draft NPDES Permit for the PSNH Merrimack Station; Appendix D, page 25.

2.4 Metric-by-Metric Comparison of 2022 Data between Sites and Comparison to 2000–2020 Data

To determine if there are any differences in the ecological health of the fish communities at the thermally affected downstream site and upstream reference site in 2022, this section presents results of 2022 monitoring from the two sites, focusing on the twelve metrics of the RFAI methodology. This section also includes a comparison of 2022 data with that of 2000-2021 to determine if there are any differences between current fish communities and historical.

2.4.1 Results of 2022 BIP Study

Table 2 presents RFAI scores and observed data values for the individual metrics of the RFAI during summer and autumn 2022. More detailed 2022 results including metric scores of the RFAI, and lists and abundances of fish species collected during 2022 can be found in Appendix E. Based on review of Table 2, the following observations can be made regarding the overall RFAI scores and fish community metrics for the downstream site:

- <u>Total RFAI scores</u> – Scores for 2022 were similar between downstream and upstream sites, during both autumn and summer sampling events. The score downstream during autumn 2022 was the second highest recorded at this reach since 2001 (Table 1). RFAI scores at both reaches have not been statistically different (i.e. "similar", or differed by six points or less; Appendix A). When compared between reaches, scores since 2000 have not been significantly different (P=0.17; Table 3).

- <u>Number of species (indigenous)</u> – There was a slight difference between reaches in numbers of indigenous species collected per effort during autumn (2) and summer (2) 2022. In comparison, both reaches observed 2 species above the 2000-2021 average in the summer sample and 3 species above average in the autumn sample (table 2). Total indigenous species upstream have been consistently higher (P=0.003) than those downstream since 2000, but only by an average of about two species (Table 3).

- <u>Number of centrarchid species (excluding black bass)</u> – The numbers of centrarchid species collected at both reaches have remained steady since 2000 and have only differed by more than two species during one sample (2015). Even so, numbers of centrarchid species have been significantly higher upstream (P=0.002) by an average difference of 0.9 species (table 3). This continued in both summer and autumn 2022, with six species collected upstream and downstream. The same six centrarchid species were observed in both reaches. (Appendix E).

- <u>Number of benthic invertivore species</u> – The same number of benthic invertivore species were collected at the upstream reach and downstream reach in summer 2022 and one more species collected at the upstream location (5) than the downstream reach (4) during autumn 2022. Average numbers of benthic invertivore species collected since 2000 differ by 0.5 at both reaches, and these have not been significantly different (P=0.06; Table 3).

- Number of intolerant species – Numbers of intolerant species have varied little among samples, ranging from collections of three to six up to eight species over the sample period. Species collected during 2022 fell within this range. Two more intolerant species was collected upstream (5) than downstream (3) during summer of 2022, and one more was collected upstream (7) than downstream (6) during autumn 2022. Numbers of intolerant species collected since 2000 have not been significantly different (P=0.31).

- Percent individuals as tolerant – Catch rates of tolerant fish in 2022 were the same at both upstream and downstream reaches (59%) during summer of 2022, and differed by 2% during autumn 2022. This percentage has showed little difference between upstream and downstream reaches since 2007 and has exhibited similar trends between reaches during most years, and averaging a 1% difference through time. As a result, percentages of tolerant individuals were not significantly different between reaches since 2000 (P=0.81).

- Percent of sample dominated by one species – Bluegill was the most prevalent species collected at both reaches during summer and autumn 2022. Their numbers increased at both reaches since 2008 and was the primary contributor to the historically high total number of individuals collected in 2022 (Appendix E). This percentage has varied widely at both reaches since 2000 but trended similarly, and as a result, no significant difference between reaches was observed (P=0.69; Table 3).

- Percent individuals as non-indigenous – Percentages have varied widely at both reaches since 2010 but have trended similarly (Figure 8). When compared among the sample years, the percentages of non-indigenous fishes have not been significantly different between reaches (P=0.46). The values for both reaches in summer and autumn 2022 were highly similar and slightly higher than respective historical averages during the summer sample while being slightly lower than those respective averages during autumn. The same non-indigenous species were collected in both reaches in 2022 (Appendix E).

- Number of top carnivore species – Numbers of top carnivore species collected since 2000 have not varied much ranging from 8 or 9 to 11 species at both reaches with the same number of species reported at both reaches in summer 2022 (11). Historically, there has been no difference in numbers of top carnivore species between reaches (P=0.13). Additionally, numbers of top carnivores and catch rates were not significantly different between reaches in 2022.

- Percent individuals as top carnivores – Percentages of top carnivores at both reaches in 2022 were within the historical ranges observed, and varied by 4.2% between upstream and downstream during summer 2022 and only 0.8% during autumn 2022. This percentage was consistently higher upstream from 2000 to 2007, similar between reaches the next eight samples, and higher downstream during 2019 through Summer 2022. Even with these trends, differences in percentages between reaches have been less than 10% during most sample years and have not been significantly different between reaches (P=0.29).

- Percent individuals as omnivores – Percentages of omnivores have generally followed the same patterns at both reaches among samples, and as a result, reaches have not differed (P=0.79) with respect to percentages of omnivores (Table 3). Including summer and autumn 2022, differences between reaches have been minimal, rising above 10% during only five of 19 sample years.

- Average number per effort – Catch rates at both reaches have been highly variable over the sample years, ranging from approximately 20 to 110 fish per effort at both reaches. Average catch rates were 3 fish per effort higher at the downstream reach during summer 2022 and 2 fish per effort higher upstream during autumn 2022. Catch rates have not been significantly different over the sample years (P=0.80).

- Percent of individuals with anomalies – The percent of individuals exhibiting anomalies has remained consistently low at both reaches, rarely rising above 2%. No difference in percent anomalies has existed between reaches (P=0.90).

In evaluating these metrics, it is apparent from the RFAI score and observed values for each of the twelve metrics that the fish community structure at the thermally affected downstream site in 2022 was similar to that in the unaffected area upstream and that BIP was maintained downstream of SQN.

When compared to previous years, RFAI scores and observed metric values from the mid-2000s to 2017 indicated decreasing trends in certain aspects of fish communities at both upstream and downstream reaches (Figure 5 and Table 2). However, recent scores and observed metric values from 2019-2021 and 2022 show a potential rebound. Analysis at the species level shows that these recent shifts are attributed mainly to increased abundance of bluegill and gizzard shad (both tolerant species) and the non-indigenous Mississippi silverside at both reaches (Appendix E). However, given this trend exists in both affected and unaffected areas, it is appropriate to conclude cause(s) as environmental and reservoir-wide, and not related to SQN's thermal effluent.

One potential cause for some, if not all, shifts in scores and observed values could be increased coverage of aquatic macrophytes at the sample reaches. The first result would be an inability to sample shoreline habitat historically sampled. Many top carnivore species are collected along rocky and woody substrate found along shoreline. Not being able to reach these habitats would reduce the numbers of top carnivores collected, decreasing their proportion in the samples.

The second result could be an assemblage shift to higher proportions of species associated with increased vegetation, one being bluegill. Many studies have documented the link between this species and increased submerged aquatic vegetation (Bettoli et al. 1993; Giblin 2017). Not being able to sample along the shoreline—only along edges of vegetation—would result in collections of large numbers of bluegill.

Unfortunately, no macrophyte coverage data exists, only anecdotal information. Attempts have been made to obtain these data for Chickamauga Reservoir, but it appears that no aquatic macrophyte data has been collected.

3.0 EPA-DEFINED ELEMENTS OF A BALANCED INDIGENOUS POPULATION

Specific definitional elements of a BIP have been provided in the public record by EPA Region 4 regarding the thermal discharge from another TVA power plant (Gallatin). Below, each element is described focusing, as has historically been done, on how fish populations in the Tennessee River downstream of SQN either achieve or do not achieve the expectations for the BIP element.

3.1 Focusing on the EPA Region 4 BIP Descriptions

EPA Region 4 has identified in past communications with TVA (and other electric utilities) the five essential elements that it has determined constitute a BIP based on interpretation of the regulations. In a letter from EPA to TDEC dated August 11, 2011, regarding its review of the Gallatin Fossil Plant NPDES permit renewal,[4] EPA included guidance on demonstrating a BIP. In the letter EPA states:

> The definition of "balanced, indigenous community" at 40 CFR § 125.71(c) contains several key elements. To be consistent with the regulations, each of these key elements should be specifically addressed in the demonstration, and the Study Plan should be designed to generate information relevant to these elements. Those elements include: (1) "a population typically characterized by diversity at all trophic levels;" (2) "the capacity to sustain itself through cyclic seasonal changes;" (3) "presence of necessary food chain species;" (4) "non-domination of pollution-tolerant species;" and (5) "indigenous".

[4] Letter dated August 11, 2011 from Christopher B. Thomas, Chief, Pollution Control & Implementation Branch, Water Protection Branch, EPA Region 4 to Paul E. Davis, Director, Division of Water Pollution Control, TDEC, regarding EPA review and comments on the draft NPDES permit for TVA's Gallatin Fossil Plant (NPDES TN0005428). Provided in Appendix F.

Further, EPA Region 4 provided helpful insight on each of the BIP elements identified in its letter to TDEC. Below each element is presented along with TVA's interpretation of the most current SQN biological data for Summer and Autumn 2022.

With regard to BIP element 1, EPA indicates:

> "A population typically characterized by diversity at all trophic levels" means that all of the major trophic levels present in the unaffected portion of the water body should be present in the heat-affected portions. The EPA recognizes that community structure differences will occur, however, the number of species represented in each trophic level in the unaffected portions should be reasonably similar in the heat-affected portions of the water body.

Trophic levels are usually interpreted as the typical ecological levels of producers (algae, macrophytes), herbivores (zooplankton, invertebrate grazers, and algae-eating fish), and predators (predatory invertebrates and fish). The presence of these trophic levels can be deduced from the feeding habits (guilds) of the fish sampled. The RFAI multi-metric analysis was designed to evaluate appropriate densities and diversity of these trophic states present in the fish community.

A list of benthic macroinvertebrates and corresponding densities from all summer and autumn samples upstream and downstream of SQN presented in Table 5 with functional feeding group designations. More detailed 2022 results, including results of statistical tests, metric scores of the RBI and lists and abundances of benthic macroinvertebrate species collected during summer and autumn 2022 can be found in Appendix E.

From review of Tables 4 and 5, TVA concludes:

Fish Community (Table 4)

- All expected major trophic levels present in the unaffected portion of the waterbody are present in the affected portion in summer and autumn 2022.

- The number of species representing each trophic guild in the affected reach was "reasonably similar" to that for the unaffected portions of the waterbody during both seasons. During summer 2022, five trophic guilds were represented equally between reaches while the insectivore guild only varied by two species. During autumn 2022, the trophic guilds were either represented equally between reaches or differed by only one or two species. This was supported by statistical tests performed on numbers of species and catch rates for each trophic guild which showed no differences between reaches (Appendix E).

- The most prevalent guilds in both reaches (by number of species) and during both seasons have been top carnivores (e.g., largemouth bass), insectivores (e.g., bluegill), and omnivores (e.g., gizzard shad). Most guilds have shown no consistent dominance between the reaches (Table 4), but benthic invertivores have been collected in significantly higher numbers upstream over the sample years (higher in 14 of the 19 sample years including both summer samples). The only guild to exhibit significant differences between reaches was insectivores ($P=0.04$). More insectivore species were collected upstream during 14 of the 21 sample events. Even with the significant difference, the difference in historical averages was only 1 species (Table 3) By numbers of individuals, omnivores and insectivores have almost always (13 of 17 samples) been more abundant in the upstream sampling reach than in the downstream reach, but the differences have not been significant ($P>0.05$). All other trophic guilds have shown no consistent dominance in abundance between reaches (Table 4).

- Trophic guild representation (number of species) in both reaches has remained steady since 2000, and both autumn and summer 2022 differed by only two species and each reach was represented by two to three species above average. (Table 4).

Macroinvertebrate Community (Table 5)

- All expected functional feeding groups were present upstream and downstream of SQN during both summer and autumn 2022.

- The number of macroinvertebrate taxa represented in each functional feeding group in the affected reach is "reasonably similar" to, if not more favorable than, that for the unaffected portions of the waterbody with downstream reach having higher numbers of taxa during most years sampled including summer and autumn 2022.

- The most dominant taxa groups during summer 2022 included "gathering/collector" (GC) and "scrapers" (SC). GC dominance was greater at the thermally affected downstream site and SC were the same at both reaches during the summer sample. Averages for other well-represented groups are generally greater downstream as well.

- Total densities of all taxa combined were generally higher at the thermally unaffected site from 2002 to 2006, and higher at the thermally affected site 2011 through 2022. The largest differences between sites were observed in the CG functional feeding group and is also higher at the downstream site. Average densities of other functional feeding groups were "reasonably similar" between sampling areas.

- Overall, increasing trends in number of species and mean densities were noted at both sampling areas, but to a greater degree at the downstream site, and were driven mostly by the PR and GC functional feeding groups.

With regard to BIP element 2, EPA indicates:

> "The capacity to sustain itself through cyclic seasonal changes" means that any additional thermal stress will not cause significant community instability during times of natural extremes in environmental conditions. Community data should be collected during normal seasonal extremes as well as during optimal seasonal conditions. Data should be compared between heat affected and unaffected portions of the receiving water body to account for normalcommunity changes correspondingwith a change in season.

To provide a detailed analysis of the seasonal maintenance of BIP in areas affected by the SQN thermal discharge, data from the summer 2022 sample was compared in Table 6 to autumn 2022. To maximize number of data points, values of metrics in Table 6 were computed for each electrofishing effort and compared using ANOVA and Tukey's Studentized Range Test.

Total scores of the multi-metric assessment were similar for both reaches during the two seasons. At the downstream reach, four metrics showed no difference between seasons: numbers of indigenous species, numbers of benthic invertivores species, number of intolerant species, and proportion of sample as omnivores.

Those indicating statistical differences between summer and autumn samples were abundance of indigenous fish, Percent individuals as omnivores, and percent of individuals as tolerant. The statistical differences of abundance of indigenous species and percent individuals as tolerant are directly related to the historic high abundance of bluegill observed in autumn of 2022, at both the upstream and downstream reaches. Percent as tolerant individuals was lower and more favorable during the summer sample. Numbers of non-indigenous species were collected at the downstream reach more consistently than upstream, but only by about 0.4 species per effort.

To assess maintenance of BIP of the benthic macroinvertebrate community through seasons, data were compared during summer and autumn 2022 in Table 7. The RBI scores downstream of the plant were equal, rated "Excellent" during both seasons, and scored higher than the upstream sampling area during both seasons, indicating the ability to sustain through seasonal changes.

With regard to BIP element 3, EPA indicates:

> "Presence of necessary food chain species" means that the necessary food webs remain intact so that communities will be sustaining. We believe that exhaustive food web studies are not necessary provided that invertebrate, fish and wildlife communities are otherwise healthy, i.e., represented by sufficiently high species diversity and abundance (appropriate for that portion of the receiving water body) for the identified trophic levels and sustaining through normal seasonal changes.

As noted previously, all major macroinvertebrate functional feeding groups present in the unaffected portion of the waterbody were present in the affected portion. The number of species representing each functional feeding group in the affected reach was "reasonably similar" to those in the unaffected reach, and prevalence (abundance) of the major functional feeding groups varied between the downstream and upstream sites over the sample history (Table 5). In addition, the downstream reaches have scored or averaged in the "Excellent" range during eight of ten sample years, including the last five.

For the fish community (Table 4), all major trophic levels present in the upstream reach were observed in the downstream reach, and collections were not different between reaches. When compared among all samples, most guilds showed no difference in numbers of species or abundance between reaches. Numbers of insectivore species was significantly higher upstream, but only by one species (Table 3). These results indicate that the long-term presence of necessary food chain items at the downstream reach has not been different from upstream.

With regard to BIP element 4, EPA indicates:

> "Non-domination of pollution-tolerant species" means that in the case of a thermal effluent community assemblages in heat affected portions of the water body dominated by heat-tolerant species do not constitute a BIP. The EPA recognizes that because all species have varying levels of thermal tolerance, communities in the heat affected portions of the receiving water body may possess altered assemblages in terms of species present and abundance. All community data should be collected, analyzed and presented to clearly demonstrate that affected communities have not shifted to primarily heat-tolerant assemblages.

Table 8 presents the numbers of indigenous fish species and individuals with upper incipient lethal limits (UILT) of 95 °F to 102 °F (considered "heat tolerant") collected upstream and downstream of SQN during summer 2011 and 2022 and autumn 2000 through 2022. Differences between reaches have mostly been small, differing by more than two species only once and with long term averages of 11 species for both reaches. As expected, a Wilcoxon Rank Sum statistical test performed on the datasets indicates that average numbers of species have not been statistically different between reaches (P=0.90). Additionally, average abundance of heat tolerant individuals has not been different (P=0.69) between reaches. These data indicate no expressed dominance of heat tolerant species in either reach and no historical shift in abundance between reaches.

Table 9 presents the relative abundance of heat tolerant and heat sensitive (UILT <91 °F) indigenous fish species collected upstream and downstream of SQN during summer 2011 and 2022 and autumn 2000 through 2022. In direct comparison, heat tolerant species make up a much greater proportion than heat sensitive species in both upstream and downstream sample reaches. There were no differences in relative abundances of heat tolerant (P=0.41) or heat sensitive (P=1.0) fish between reaches.

With regard to BIP element 5, EPA indicates:

> "Indigenous" has been further clarified in the regulations: "Such a community may include historically non-native species introduced in connection with a program of wildlife management and species whose presence or abundance results from substantial, irreversible environmental modifications. Normally, however, such a community will not include species whose presence is attributable to the introduction of pollutants that will be eliminated by compliance by all sources with section 301(b)(2) of the Act and may not include species whose presence or abundance is attributable to alternative effluent limitations imposed pursuant to section 316(a)." The EPA recognizes that non-indigenous species are present in most aquatic systems in the United States. All community data should be analyzed and presented to demonstrate that community assemblages in the heat-affected portions of the receiving water body are not significantly different from non-affected communities with regard to the number of non-indigenous species in the assemblages.

Table 11 presents the number of non-indigenous fish species and the number of individuals representing these species collected upstream and downstream of SQN during summer 2011 and 2022 and autumn 2000 through 2022. Though Chickamauga Reservoir represents an artificial, man-made feature, available data indicate there are very few non-indigenous fish species present in the reservoir around SQN, and similar numbers of species were collected in both reaches during summer and autumn samples. A Wilcoxon Rank Sum statistical test performed on the autumn 2022 dataset indicates that numbers of non-indigenous species and abundances were not different between reaches in 2022 (Appendix E) or long-term (autumn 2000-2022; P=0.61; P=0.90). Recent increases in abundance of individuals have been observed at across both reaches since 2011 (figure 8). These increases can be attributed primarily to one species, Mississippi silverside, which are known to school in large numbers. When encountered, these large numbers often result in "oversampling" by electrofishing efforts, causing misrepresentation of the species in relative proportions of the community. Thermal tolerance data for the non-indigenous species are presented in Table 12. Of the six non-indigenous species identified, UILT data designate striped bass and yellow perch as heat sensitive and common carp and goldfish as heat tolerant; data are not available for the remaining two species.

Further, there are no known species in the study area whose presence is attributable to the SQN thermal discharge or to any known pollutant.

3.2 Other Considerations for a Balanced Indigenous Population

As noted earlier from the EPA Region 1 Merrimack Station permitting, assessing changes and important trends in the resident fish community of a water body often provides the most conspicuous evidence of impacts to the overall aquatic community,[5] but information on other communities such as planktonic organisms, macroinvertebrates, "habitat formers" (e.g., aquatic vegetation), and wildlife also inform decision making with regard to the presence/absence of a BIP.

3.2.1 Macroinvertebrate Community

Because benthic macroinvertebrates are relatively immobile, negative impacts to aquatic ecosystems can be detected earlier in benthic macroinvertebrate communities than in fish communities. These data have been used historically to supplement multi-metric RFAI results to provide a more thorough examination of differences in aquatic communities upstream and downstream of thermal discharges.

However, as noted earlier, the downstream reaches have scored or averaged in the "Excellent" range during eight of ten sample years, including the last five (Figure 11). In addition, the status of the macroinvertebrate community structure based on specific metrics, as presented in Table 7, and summarized in previous Section 3.1 regarding BIP Elements 1 (diversity at all trophic levels), 2 (sustain through seasonal changes), and 3 (food chain species), demonstrate a seasonally abundant and diverse macroinvertebrate community present at both downstream and upstream sites.

In 2010, TVA contracted Third Rock Consultants to conduct a survey for freshwater mussels in the Chickamauga Reservoir within areas that may be affected by plant operations and areas outside of areas potentially affected by SQN (Third Rock 2010). The survey produced a total of 280 live specimens representing eleven species were collected from semi-quantitative transect lines, and qualitative and quantitative samples. No federally threatened or endangered, or state protected mussels were found during the survey. River substrates were noted as "unsuitable habitat," with varying degrees of silt over hard packed clay/sand.

In summary, ecological conditions of benthic macroinvertebrate communities, when compared between the downstream and upstream reaches, have been consistently "similar" or more favorable downstream since initiation of sampling and laboratory-processing of data in 2001. Results support the general conclusion that the SQN thermal effluent has had no adverse environmental impact on the benthic macroinvertebrate community downstream of the plant.

[5] EPA Region 1. 2011. Draft NPDES Permit for the PSNH Merrimack Station; page 36.

3.2.2 Threatened and Endangered Species

Table 13 provides a list of federal or state protected aquatic species with potential to occur in the Chickamauga Reservoir within a 10-mile radius of SQN. One fish species—laurel dace—is listed under federal protection, and two species of fish are under state protection or tracked within Tennessee: highfin carpsucker and lake sturgeon. The laurel dace is known from first and second order headwater tributaries and not large rivers, and has not been collected by TVA from 1993 to 2022 in the vicinity of SQN. It is highly unlikely this species would be collected in Chickamauga Reservoir given its preference for smaller stream habitat. One major change has been the delisting of the Snail darter. During the work to get this species de-listed it was determined that adults and spawning individuals inhabit sand and gravel shoals, large creeks and rivers, and in deeper portions of rivers and reservoirs where current is present. This habitat is rare in the vicinity of SQN, and as a result, no snail darters have been collected in RFAI samples.

One individual of lake sturgeon was collected during TVA's biological monitoring from 2000 to 2022 in the vicinity of SQN (in 2003). This species has been the focus of restoration efforts by state and federal fisheries managers in Tennessee and is known to occur in the Tennessee River system from Knoxville downstream to Guntersville, Alabama. The highfin carpsucker is also tracked at the state level and is deemed as in need of management. This species was collected only once in 1994 at TRM 490.5 (TVA Data); it is highly unlikely this species still occurs in Chickamauga Reservoir.

Additionally, TVA queried the U.S. Fish and Wildlife Service (USFWS) Environmental Conservation Online System (ECOS) and the USFWS Information for Planning and Consultation (IPAC) to supplement information on rare aquatic species and designated potentially occurring near SQN. The ECOS and IPAC systems utilize known federally listed species by county. These data inherently search broader areas than the TVA Database queries and, consequently, listed additional federally listed species as potentially occurring near the SQN project. While TVA recognizes these additional species may occur or have occurred in Hamilton County, Tennessee, we have determined that they would not be affected by SQN since they are either no longer occurring in the Tennessee River near SQN or occur in habitats outside of the affected SQN project area within Hamilton County.

Records of seven state- and federally-listed mussel species—dromedary pearlymussel, fanshell, orangefoot pimpleback pearlymussel, pink mucket, rough pigtoe, sheepnose, and shiny pigtoe pearlymussel—are believed to or known to occur from within a 10-mile radius of SQN. Three of these are extant records less than 25 years old, three have uncertain status, and one is a historical record greater than 25 years old (Table 13). However, as mentioned previously, no federally threatened or endangered, or State-protected mussels were found during the 2010 survey of the Tennessee River/Chickamauga Reservoir adjacent to SQN conducted by Third Rock (2010). River substrates were noted as "unsuitable habitat," with varying degrees of silt over hard packed clay/sand.

3.2.3 Wildlife Community

Beginning in 2011, visual wildlife surveys have been conducted to assess bird, reptile, and mammal populations around SQN. Numbers and categories of wildlife observed during 2011, 2013, 2015, 2020, and 2022 are presented in Table 14. Observations recorded during each year were primarily of birds, with similar species observed along each transect. Similar species and numbers of birds, mammals and reptiles were observed upstream and downstream along each bank during each year.

These observations suggest that a relatively healthy ecological community exists both upstream and downstream of SQN. However, because the typical behavior of reptiles, amphibians, and mammals limits visibility of these groups by visual survey methods, estimation of the presence and diversity of these taxa was also limited. It is important to note that the visual encounter survey provides a preliminary near shore wildlife assessment to determine if the thermally affected area downstream of a power plant has adversely affected the bird, reptile, amphibian or mammal communities. If such adverse environmental impact is suspected, more sampling strategies that could provide more quantitative data will be proposed to more accurately estimate the presence and diversity of these groups.

3.2.4 Aquatic Habitat

The type, quality, and abundance of aquatic habitats dictate the diversity and abundance of organisms present in aquatic systems. To minimize bias in biological assessments, it is important to adequately describe/characterize shoreline and pelagic habitats in reference and "affected" reaches when attempting to discern potential impacts to biological systems from pollutant sources. Habitat Formers

Habitat formers are mentioned in EPA's § 316(a) guidance document (EPA 1977) as an element of investigation in § 316(a) demonstrations. In freshwater systems, aquatic macrophytes, submerged and emergent, are the most obvious habitat formers and can be critical to the structure and function of ecological systems.

In the case of the anthropogenically modified Chickamauga Reservoir, important habitat formers such as aquatic macrophytes were not present in abundance in the system during TVA's shoreline habitat survey conducted in winter 2020. The survey did not identify aquatic macrophytes at either downstream and upstream biological monitoring reach (Tables 15 and 16). However, several species of aquatic macrophytes are known to occur in relatively high abundance across the overbanks and shallow waters of Chickamauga reservoir during the summer months. It is likely that these habitat formers were not visible during the assessment period due to winter level reservoir draw downs or natural die offs.

3.2.4.1 Physical Habitat

TVA collects shoreline and river bottom habitat data upstream and downstream of SQN (Figure 12) every five years to characterize habitats important to fish. The objective is to find comparable habitats at the upstream and downstream sampling reaches to, as much as possible, minimize any habitat differences that might bias interpretation of the results of the thermal study.

Within the sample area upstream of SQN, the average Shoreline Aquatic Health Index (SAHI) score for the left descending bank was 25 and right descending bank was 22. The shoreline sections at the downstream reach scored similarly between shorelines: 23 on the left descending bank and 20 on the right descending bank. Scores at both downstream and upstream reaches rated in the "Fair" range. No aquatic macrophytes were observed at either reach (Tables 14 and 15).

Figures 13 through 20 depict proportions of substrate types observed along each transect sampled for river bottom substrate. Seven substrate types were identified at both reaches; sand and clay were only observed at the reach upstream of SQN. Silt and mollusk shell were the most prevalent substrates in both reaches making up a combined 77% at the upstream reach and 93% downstream (Table 17).

3.2.5 Representative Important Species

In its processing of the Merrimack Station NPDES permit and associated review of § 316(a) studies, EPA Region 1 states: "*[W]hile it is appropriate to identify and focus on representative important species for 'predictive' § 316(a) demonstrations, non-predictive (i.e., retrospective, or 'Type I') demonstrations, which are designed to assess prior appreciable harm, should not be restricted to assessing the status of representative important species. In fact, EPA's Draft 1977 316(a) Technical Guidance recommends that references to Representative Important Species be eliminated from Type I demonstrations* [emphasis added] *(EPA 1977a)…[W]hen assessing community-wide impacts, there is no reason to exclude any resident species that was present prior to the increase in discharges of heated effluent to Hooksett Pool.*"[6]

[6] See EPA Region 1. 2011. Draft NPDES Permit for the PSNH Merrimack Station; Appendix D, page 36. https://www3.epa.gov/region1/npdes/merrimackstation/pdfs/MerrimackStationAttachD.pdf

Representative Important Species (RIS) are defined in EPA guidance as those species which are representative in terms of their biological requirements of a balanced, indigenous community of fish, shellfish, and wildlife in the body of water into which the discharge is made (EPA 1977). In agreement with EPA Region 1's interpretation of the § 316(a) guidance with regard to Type I (non-predictive) demonstrations, all species collected by TVA in RFAI sampling around SQN, including non-indigenous species, were considered to be RIS and were included in the data analyses.

3.2.6 Zone of Passage

TVA collected depth profiles of temperature from the river surface to the bottom at points along transects to characterize and map the SQN thermal plume. Transects were located upstream of the discharge in an area not affected by the thermal plume (ambient), proximate to the thermal discharge point, and at various locations downstream of the discharge concentrated in the near field area of the plume where the change in plume temperature was expected to be most rapid. The total number of transects needed to fully characterize and delineate the plume was determined in the field.

As part of its § 316(a) demonstration studies conducted for SQN in 2022, TVA collected temperature data profiles in the thermally influenced portion of the Chickamauga Reservoir and compared these to profiles collected upstream of the SQN plant in the unaffected portion of the river. Measurements were collected in the summer and autumn of 2022.

On the date of the autumn 2022 survey, ambient water temperature profiles were collected approximately 2 river miles upstream of the SQN plant at TRM 485.4, and profiles to represent thermal discharge temperatures were collected at TRM 483.7. Profiles were also collected at TRM 482.8, TRM 482.0 and at TRM 481.6. Similarly, on the date of the Summer 2022 survey, an ambient water temperature profile was collected upstream of SQN at TRM 485.4, with representative thermal discharge profiles taken at TRM 483.7. However, the additional profile locations differed due to the detection of thermal plume temperatures and were collected at TRM 483.1, TRM 482.7, TRM 482.0, and TRM 481.2. These data indicated that the thermal plume (water temperatures greater than 2 °C or 3.6 °F above ambient temperatures) was predominately detected in the mid-channel and right descending bank from the discharge transect 1.8 miles downstream and was confined to the top 4 m at all three transects below the discharge during the summer sample. The thermal plume was not detected on the date of the Autumn 2022 sample (Table 18).

All profiles used to characterize the thermal plume make clear that it is confined to the upper strata of the Tennessee River, indicating that an adequate zone of passage exists in the lower strata for fish to traverse the area of the reservoir around the plant.

3.2.6.1 Field Measurements Relative to Zone of Passage

Water temperature, conductivity, dissolved oxygen, and pH were measured along vertical depth profiles at nine locations within each RFAI sample reach (Table 19). Water temperatures observed within the upstream reach on the day of the 2022 summer sample ranged from 78.9 to 80.5 °F, compared to a range of 79.9 to 84.2 °F in the downstream reach. Dissolved oxygen concentrations were similar at both upstream and downstream locations with the downstream reach ranging from 5.0 to 6.46 mg/L compared to a range of 4.6 to 8.2 mg/L at the upstream reach.

During the autumn 2022 sample, water temperatures observed within the upstream reach varied little with a range from 51.6 to 55.0 °F, compared to a similar range with slightly elevated temperatures of 52.8 to 55.8 °F in the downstream reach. Dissolved oxygen concentrations were favorable at both upstream and downstream locations ranging from 9.1 to 9.9 mg/L. The pH remained within the state criterion of 6.5-9.0 s.u. across all reaches and sampling dates. These results indicate that a sufficient zone of passage past SQN existed for fish and other aquatic life during autumn 2022.

Daily average water temperatures in the reach downstream of SQN during 2022 did not exceed the current thermal variance of 90 °F.

3.2.7 Water Supply and Recreational Use Support Evaluation

TVA is aware of one domestic water supply intake located within approximately 10 river miles downstream of the SQN thermal discharge: Eastside Utility District Intake at TRM 473.0 (Figure 1). As discussed previously, the thermal plume did not extend beyond the lower boundary of the downstream sample reach (approximately TRM 482); this location is nearly nine miles upstream of this intake. Therefore, water temperatures in the vicinity of this intake were not affected by the SQN thermal plume.

4.0 DISCUSSION and CONCLUSIONS

A number of factors drive variability in these data creating a challenge for interpretation with regard to the thermal effects of the SQN discharge on the aquatic community downstream of the plant. Inter-annual variations occur naturally in biological systems in response to food availability, predation, and ambient environmental conditions including river flow meteorological conditions; these factors may or may not be equally expressed upstream and downstream of the plant. As described in Section 3.2.4, the artificial nature of reservoirs in general, along with differences in river bottom habitat between the downstream and upstream reaches, also contribute to the challenge. Contributions of these individual factors to variation observed in the data are difficult to tease apart from plant-related thermal impacts, except during extremes of drought and during low flows.

Nonetheless, it seems apparent from the period of record data that the biological community downstream has overall been similar to the biological community upstream based on RFAI scores. Importantly, the RFAI index incorporates § 316(a) definitional elements such as diversity (number of species), trophic levels (categorization by feeding guild), presence of necessary food chain species, non-domination of pollution-tolerant species, and representation of indigenous species. Further, the repetitive sampling and scoring across many years provides a measure of sustainability (and trends).

In evaluating the selected fish community metrics of the RFAI, it is apparent that the fish community structure at the thermally affected downstream reach was similar to that of the thermally unaffected upstream site in summer and autumn 2022. When compared to the 2000–2021 averages, the 2022 data indicate similarity or improvement at both reaches in all twelve metrics.

In evaluating the data in the context of EPA's interpretation of the regulatory definition of a BIP, TVA believes that a BIP is currently being demonstrated in Chickamauga Reservoir based on the most recent biological data collected in 2022. As such, TVA believes that continuation of the current ATL of daily maximum temperature of 30.5 °C (86.9 °F) at the end of the mixing zone will reasonably assure the protection and propagation of a BIP.

Should TDEC determine that a BIP does not currently exist, TDEC has the authority under the § 316(a) regulations to approve TVA's requested ATL on the basis that: 1) a BIP was maintained for decades up and until 2022 and 2) there is reasonable assurance that a BIP will be supported going forward. Such assurance can be confirmed via additional biological monitoring with supporting thermal modeling as a continued condition of the renewed permit. Again, absolute certainty[7] is not required in approving an ATL.

4.1 Relationship to Clean Water Act Section 316(b)

TDEC issued the renewed NPDES permit for SQN on July 30, 2020. Included in the permit renewal application materials submitted on June 29, 2018, were reports required under §

122.21(r)(2)-(13), the results of which were to inform the Commissioner's decisions about the Best Technology Available (BTA) for reducing entrainment of fish eggs and larvae through the SQN cooling water system. Upon review of these results by TDEC and USFWS, it was determined that SQN's cooling water intake structure represented BTA. However, TDEC still believes that 316(a) sampling should be continued during the current permit cycle in summer at least once and compared to historical autumn sampling data.

Additional § 316(a) related studies of the SQN thermal discharge effects conducted in parallel with the study requirements of § 316(b) over the next permit cycle will allow for the Commissioner's holistic assessment of the impact of SQN operations on the aquatic community from thermal discharge and cooling water intake perspectives, and inform decision making for regulatory compliance with both regulations in the subsequent NPDES permit.

[7] See EPA Region 1. 2011. Draft NPDES Permit for the PSNH Merrimack Station; Appendix D, page 25. https://www3.epa.gov/region1/npdes/merrimackstation/pdfs/MerrimackStationAttachD.pdf

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FIGURES

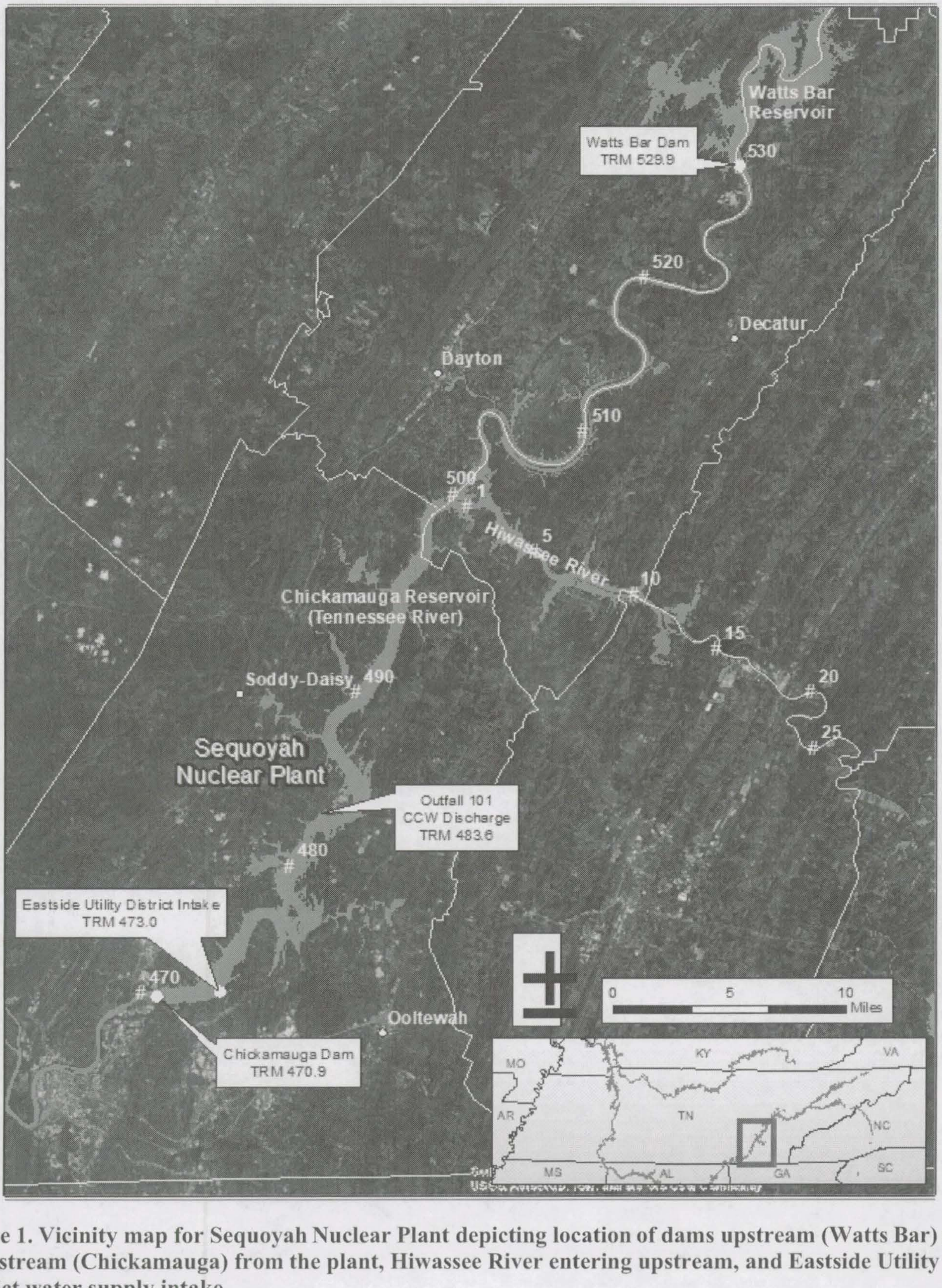


Figure 1. Vicinity map for Sequoyah Nuclear Plant depicting location of dams upstream (Watts Bar) and downstream (Chickamauga) from the plant, Hiwassee River entering upstream, and Eastside Utility District water supply intake

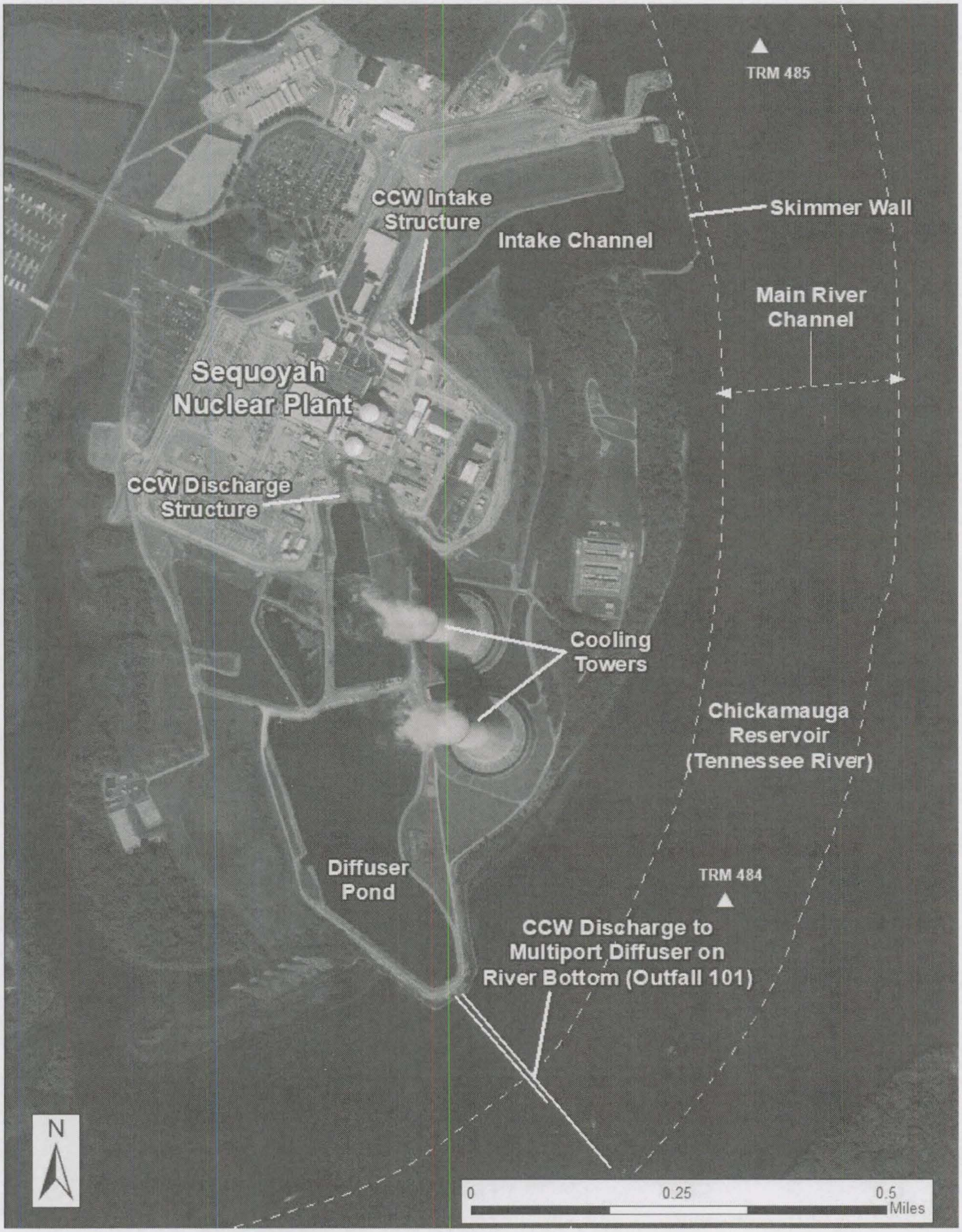


Figure 2. Location of Condenser Circulating Water (CCW) intake, cooling towers, and NPDES-permitted multiport diffuser discharge (Outfall 101) at Sequoyah Nuclear Plant

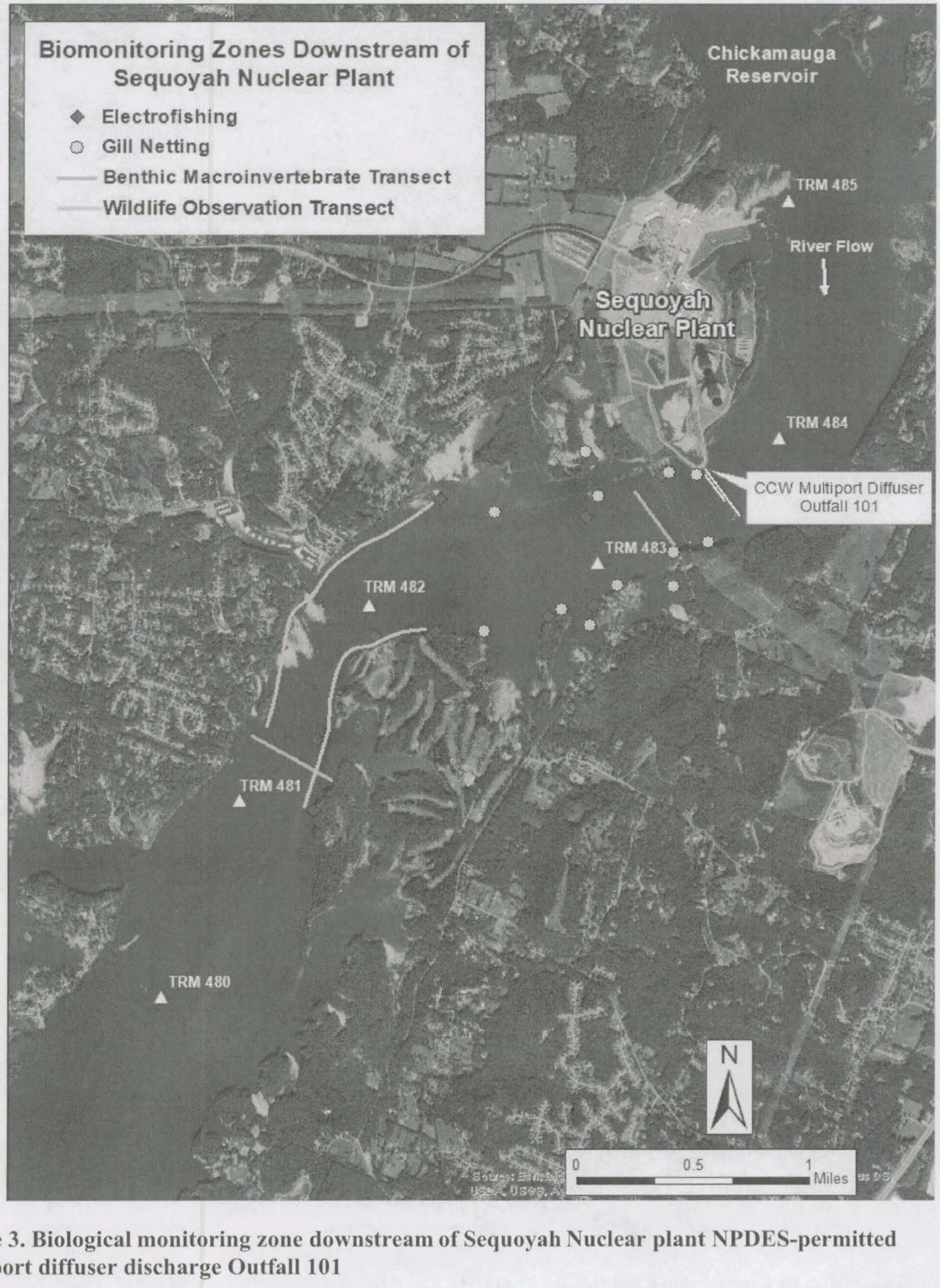


Figure 3. Biological monitoring zone downstream of Sequoyah Nuclear plant NPDES-permitted multiport diffuser discharge Outfall 101

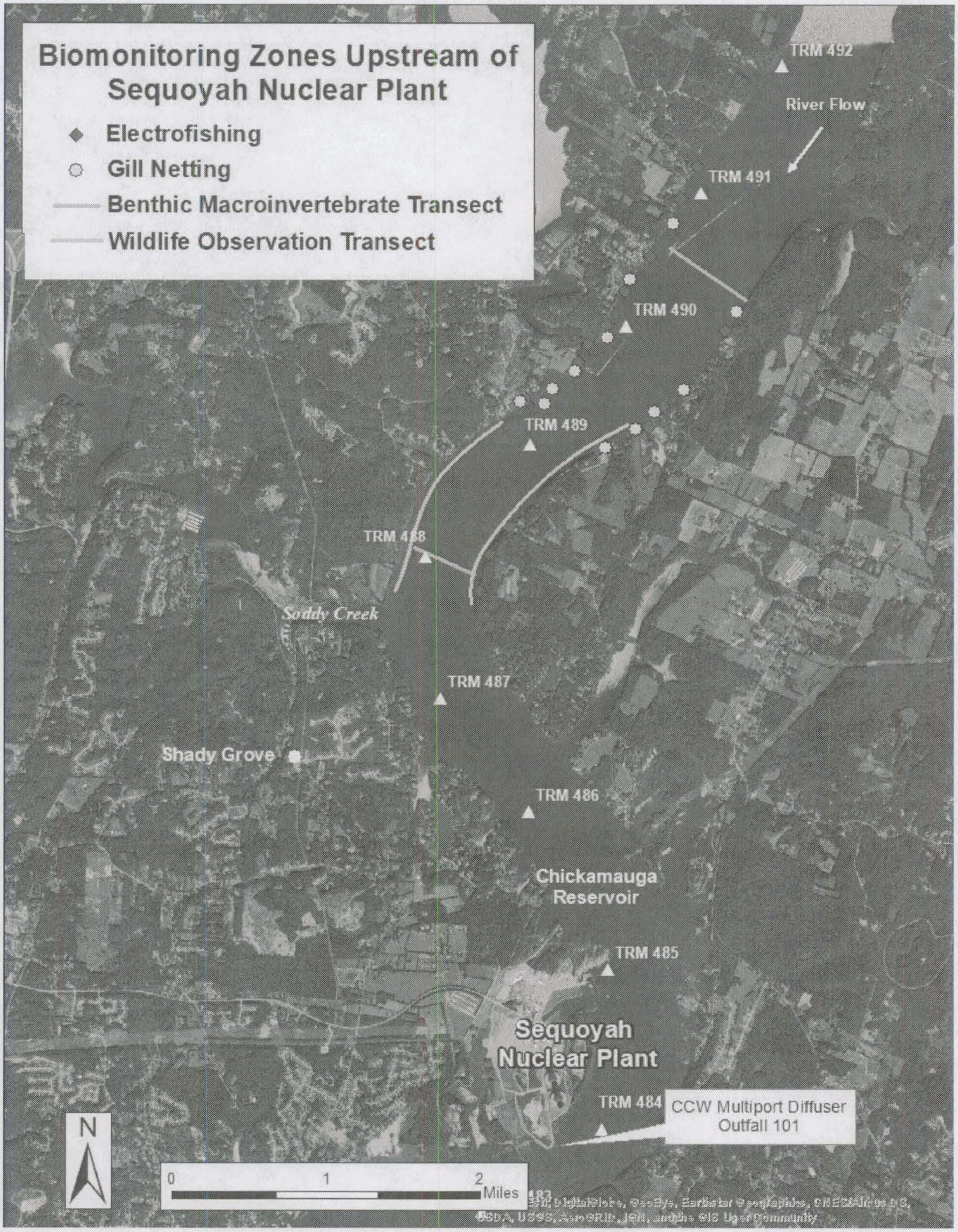


Figure 4. Biological monitoring zone upstream of Sequoyah Nuclear plant NPDES-permitted multiport diffuser discharge Outfall 101

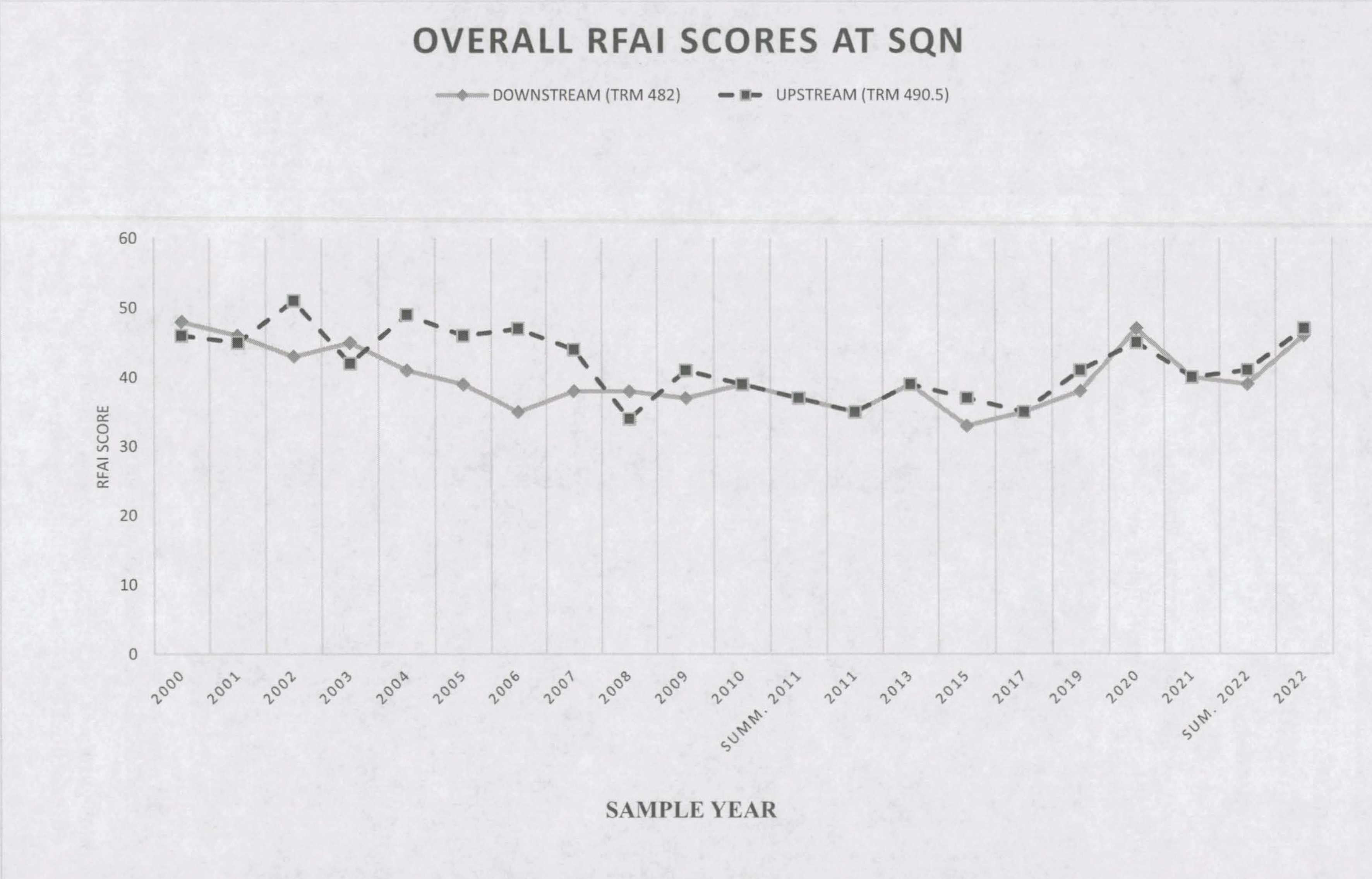


Figure 5. Reservoir Fish Assemblage Index (RFAI) scores and ratings from sites located directly upstream and downstream of Sequoyah Nuclear plant (SQN; TRM 484) conducted during summer 2011 and autumn 2000-2011, 2013, 2015, 2017, and 2019-2022 and as part of the Reservoir Ecological Health Monitoring Program in Chickamauga Reservoir

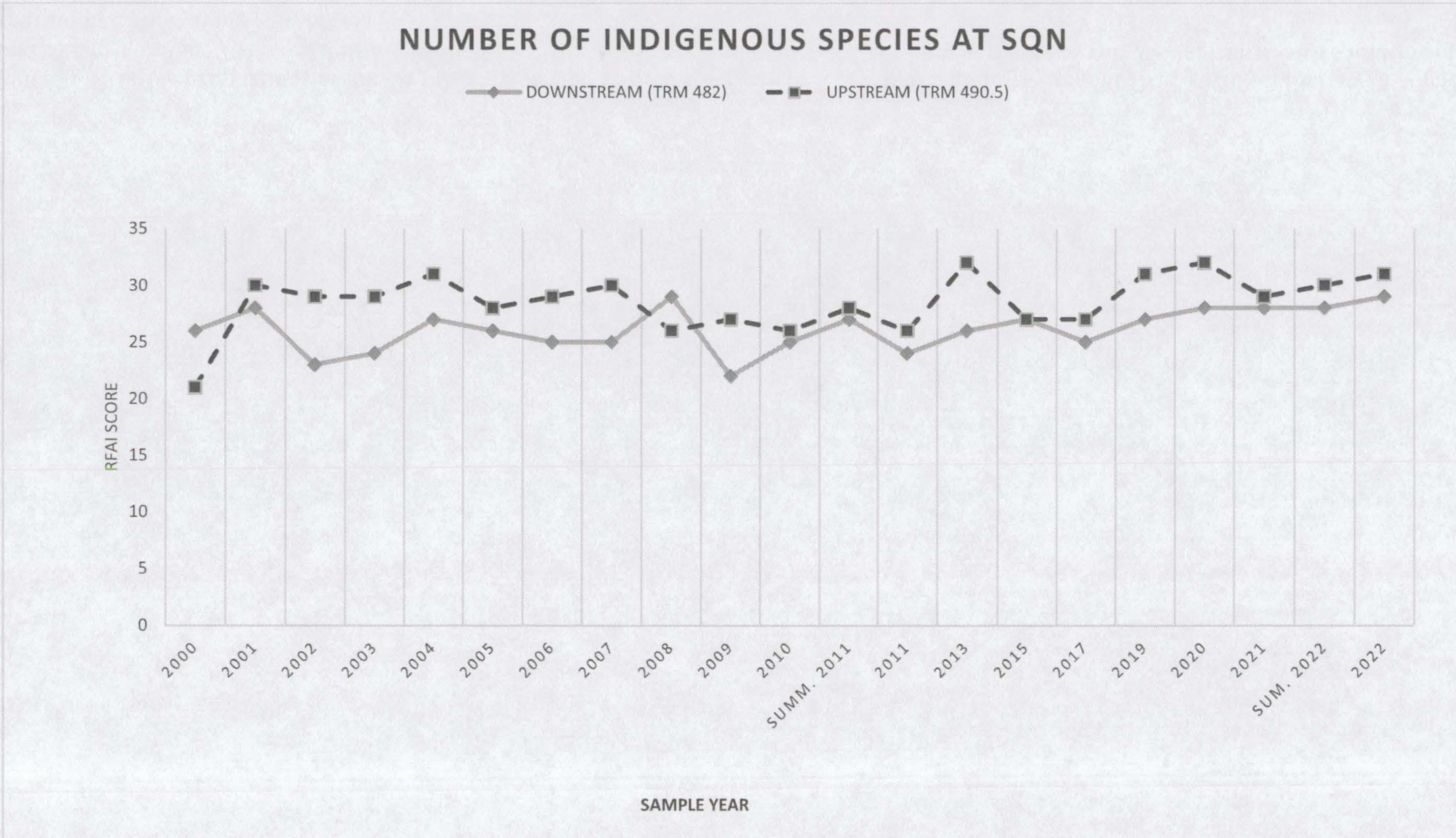


Figure 6. Numbers of indigenous species collected at sites upstream (TRM 490.5) and downstream (TRM 482.0) of Sequoyah Nuclear Plant during summer 2011 and autumn 2000-2011, 2013, 2015, 2017, and 2019-2022 as part of the Reservoir Ecological Health Monitoring Program in Chickamauga Reservoir

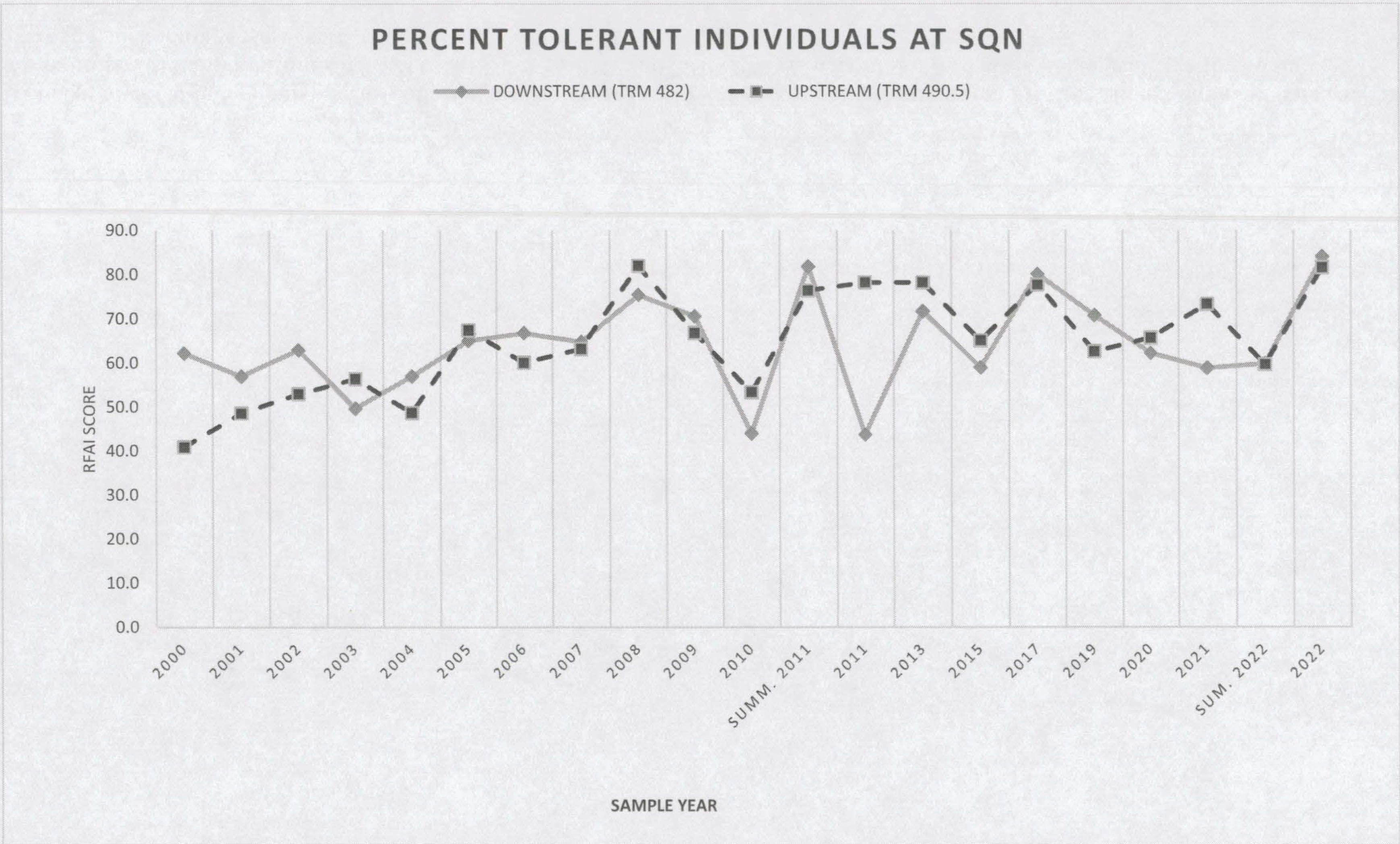


Figure 7. Relative proportions of tolerant fishes collected at sites upstream (TRM 490.5) and downstream (TRM 482.0) of Sequoyah Nuclear Plant during summer 2011 and autumn 2000-2011, 2013, 2015, 2017, and 2019-2022 as part of the Reservoir Ecological Health Monitoring Program in Chickamauga Reservoir

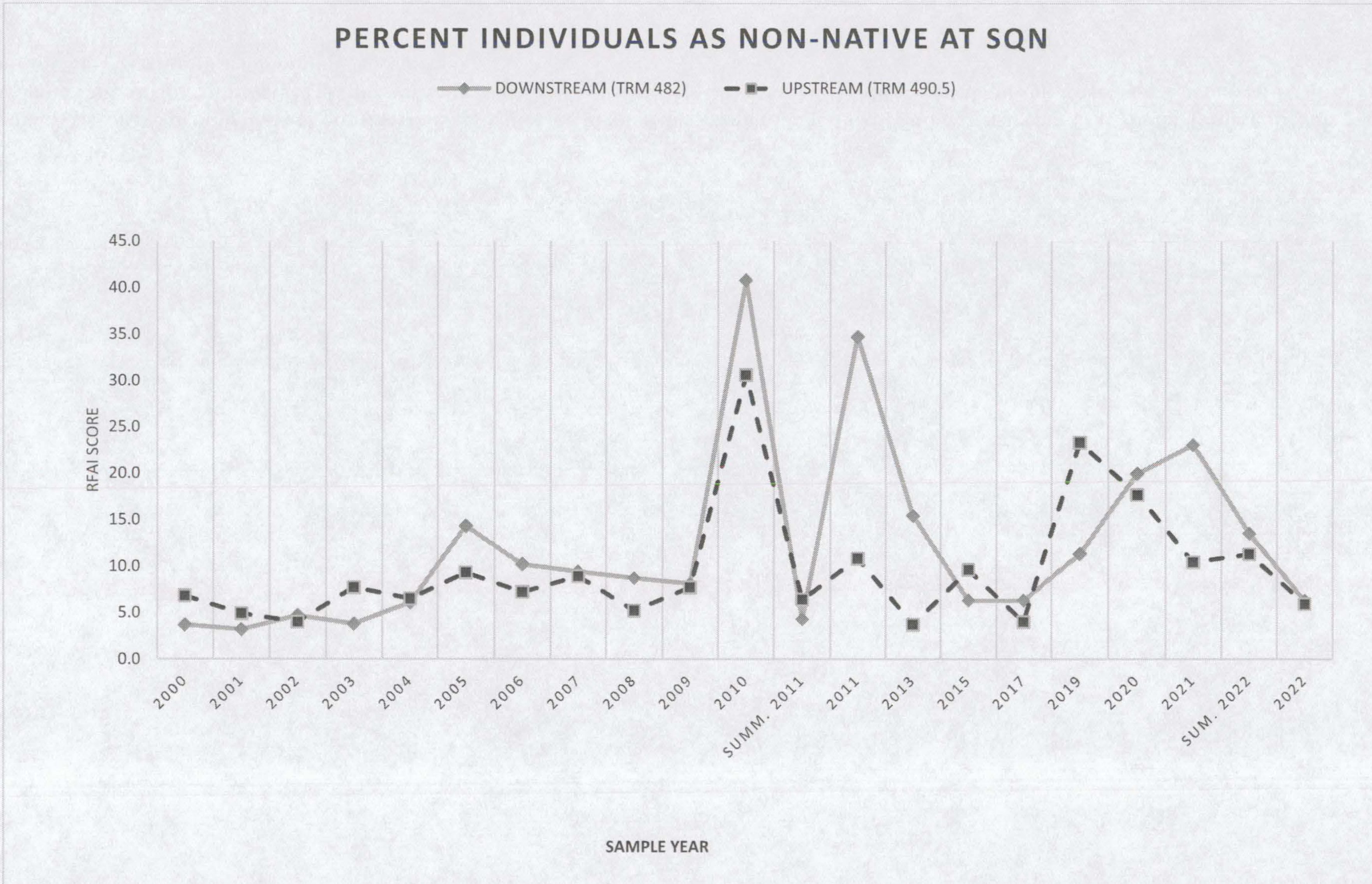


Figure 8. Relative proportions of non-indigenous fishes collected at sites upstream (TRM 490.5) and downstream (TRM 482.0) of Sequoyah Nuclear Plant during summer 2011 and autumn 2000-2011, 2013, 2015, 2017, and 2019-2022 as part of the Reservoir Ecological Health Monitoring Program in Chickamauga Reservoir

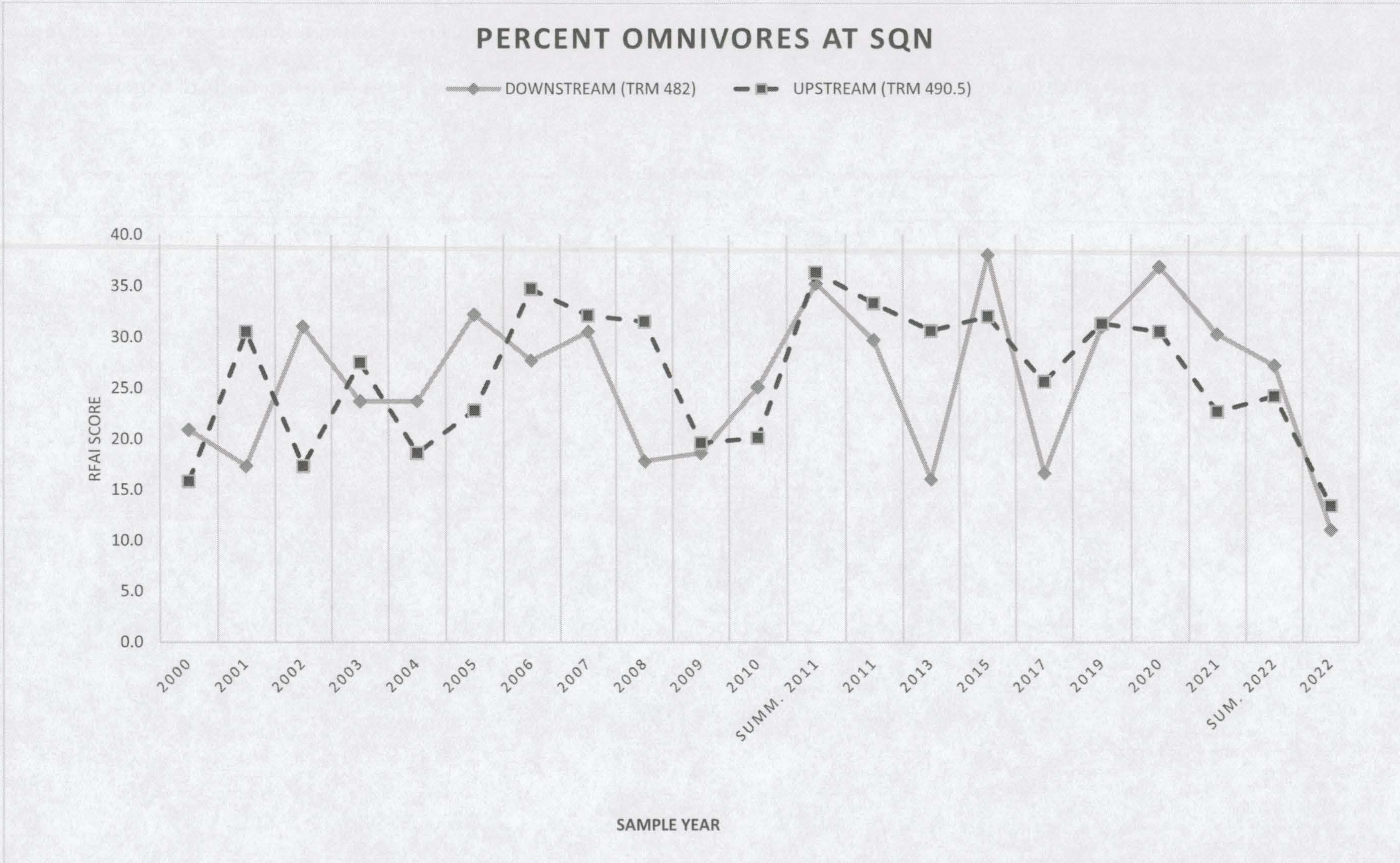
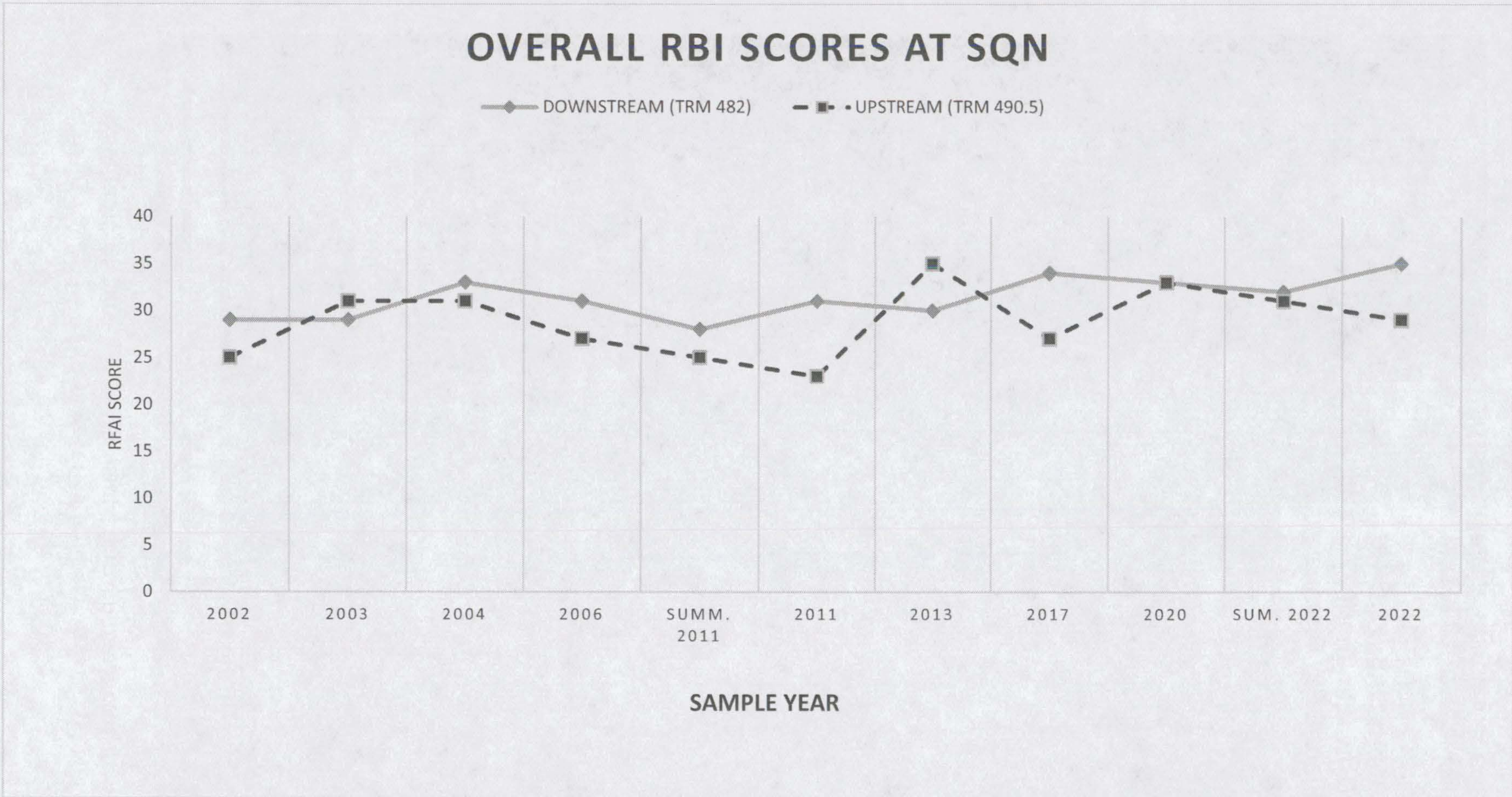


Figure 9. Relative proportions of omnivore fishes collected at sites upstream (TRM 490.5) and downstream (TRM 482.0) of Sequoyah Nuclear Plant during summer 2011 and autumn 2000-2011, 2013, 2015, 2017, and 2019-2022 as part of the Reservoir Ecological Health Monitoring Program in Chickamauga Reservoir



*Downstream transects located at TRM 482.0 during 2001-2004 and 2006 and TRMs 483.4 and 481.3 during 2011, 2013, 2015, 2017, 2020, and 2022 ^RBI scores for 2011, 2013, 2017, 2020, and 2022 are averages of scores for the two downstream transects and based on lab-processed data

Figure 10. Reservoir Benthic Index (RBI) scores^ and ratings from sites located directly upstream and downstream* of Sequoyah Nuclear plant (SQN; TRM 484) conducted during summer 2011 and autumn 2001-2004, 2006, 2011, 2013, 2017, 2020, and 2022 as part of the Reservoir Ecological Health Monitoring Program in Chickamauga Reservoir

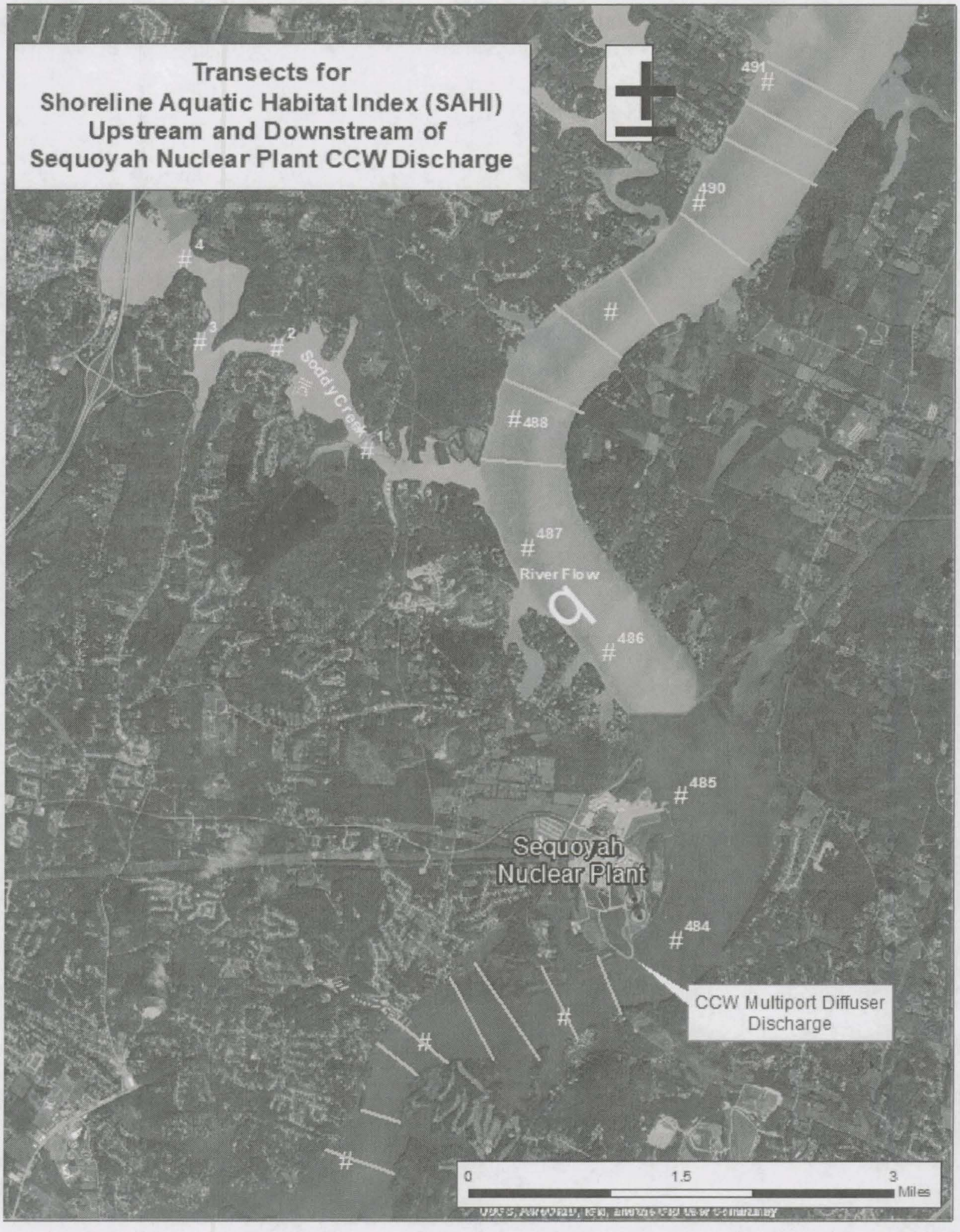


Figure 11. Transects established upstream and downstream of Sequoyah Nuclear plant for the integrative multi-metric aquatic shoreline and river bottom habitat assessment

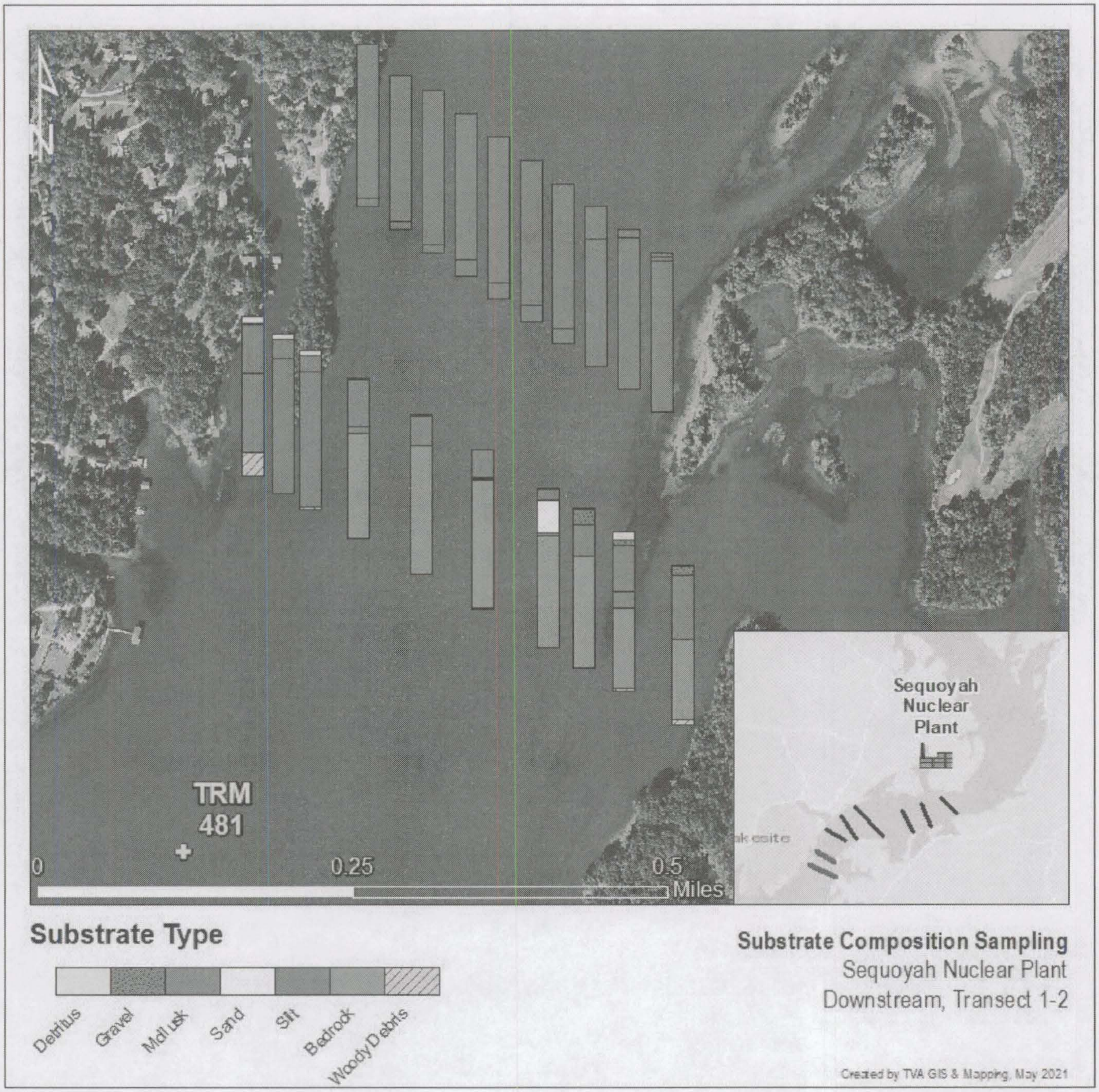


Figure 12. Substrate composition at ten equally spaced points per transect (Transects 1 and 2 shown) across the Tennessee River (Chickamauga Reservoir) downstream of SQN, autumn 2020

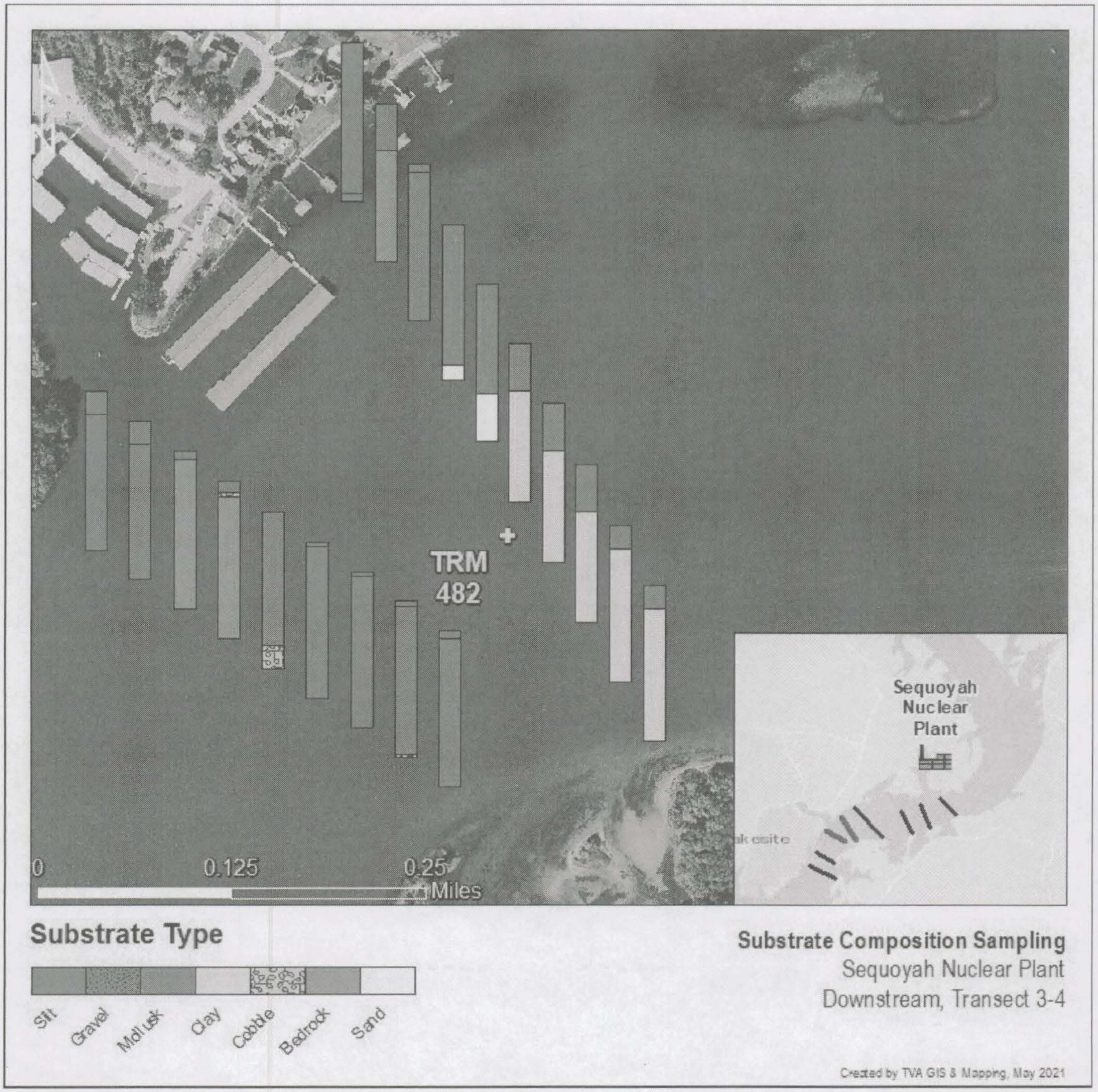


Figure 13. Substrate composition at ten equally spaced points per transect (Transects 3 and 4 shown) across the Tennessee River (Chickamauga Reservoir) downstream of SQN, autumn 2020

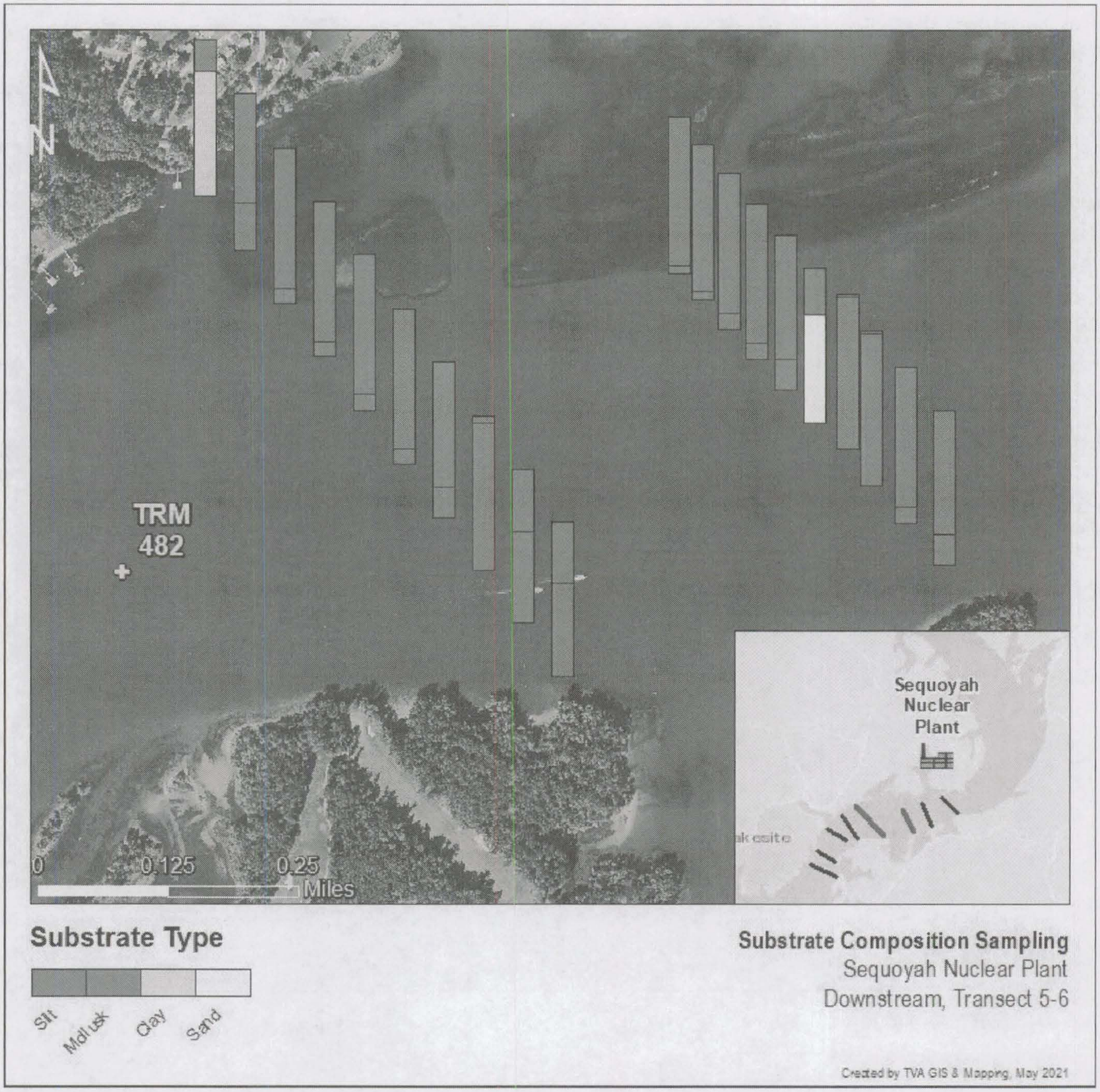


Figure 14. Substrate composition at ten equally spaced points per transect (Transects 5 and 6 shown) across the Tennessee River (Chickamauga Reservoir) downstream of SQN, autumn 2020

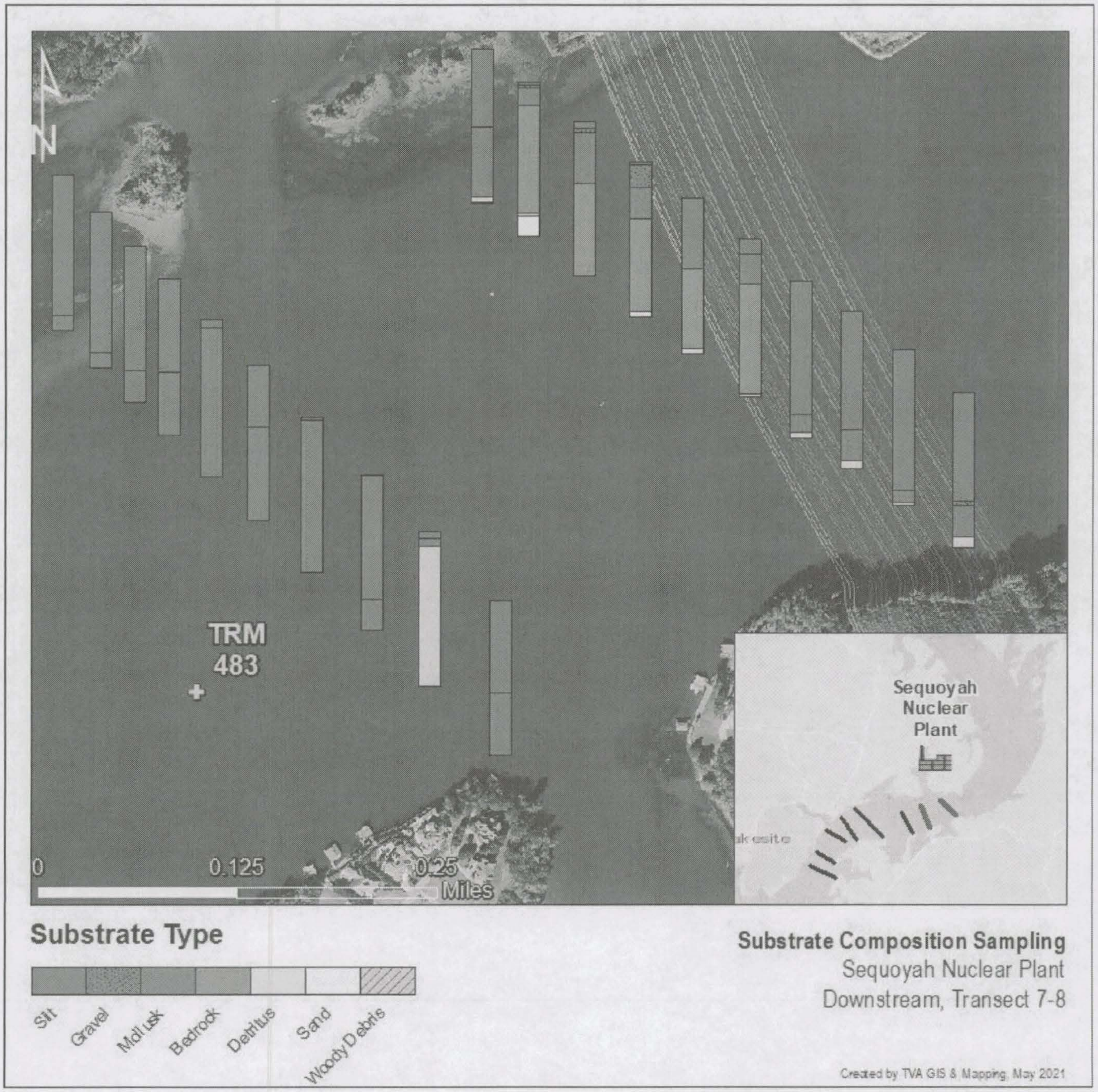


Figure 15. Substrate composition at ten equally spaced points per transect (Transects 7 and 8 shown) across the Tennessee River (Chickamauga Reservoir) downstream of SQN, autumn 2020

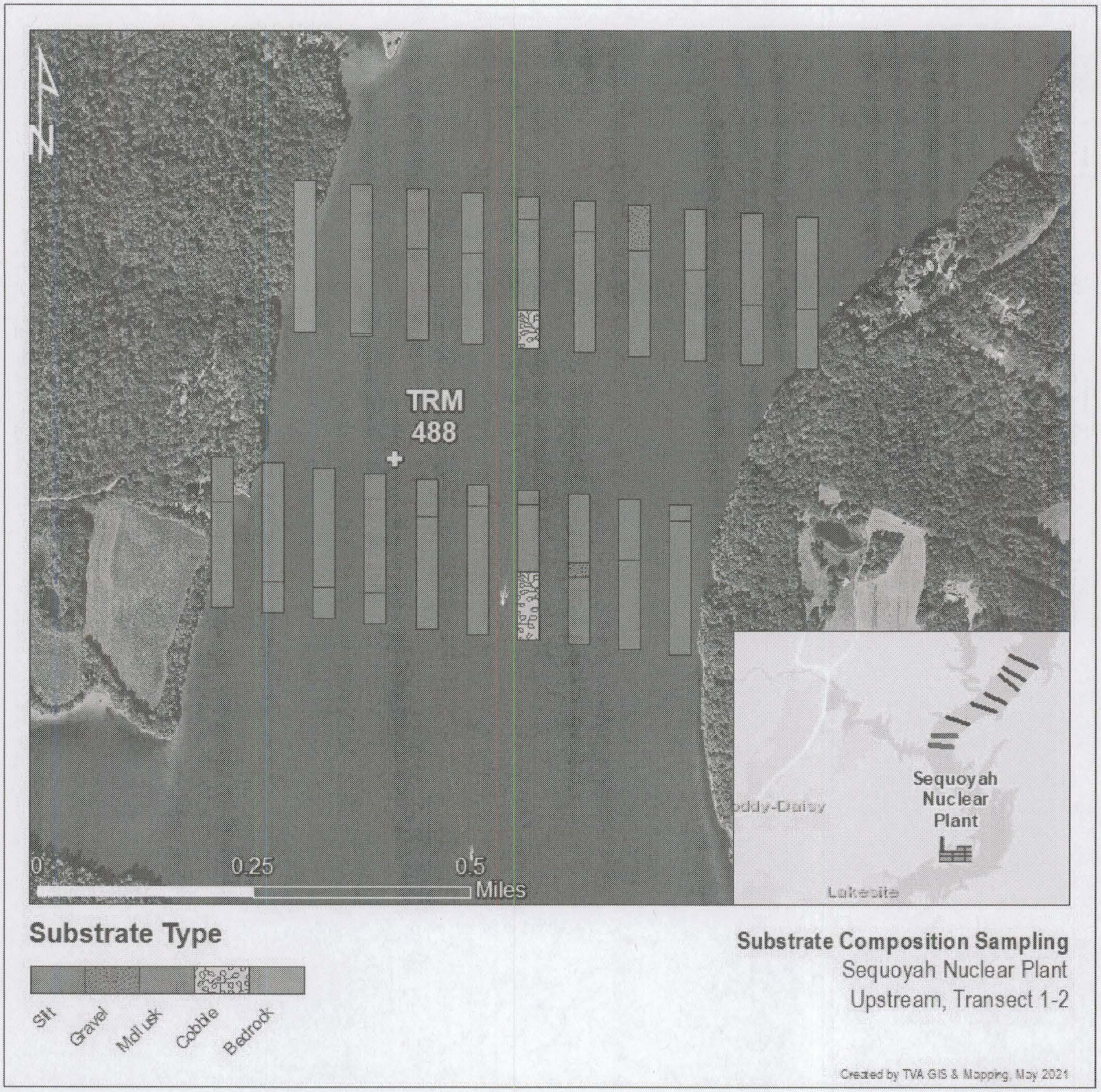


Figure 16. Substrate composition at ten equally spaced points per transect (Transects 1 and 2 shown) across the Tennessee River (Chickamauga Reservoir) upstream of SQN, autumn 2020

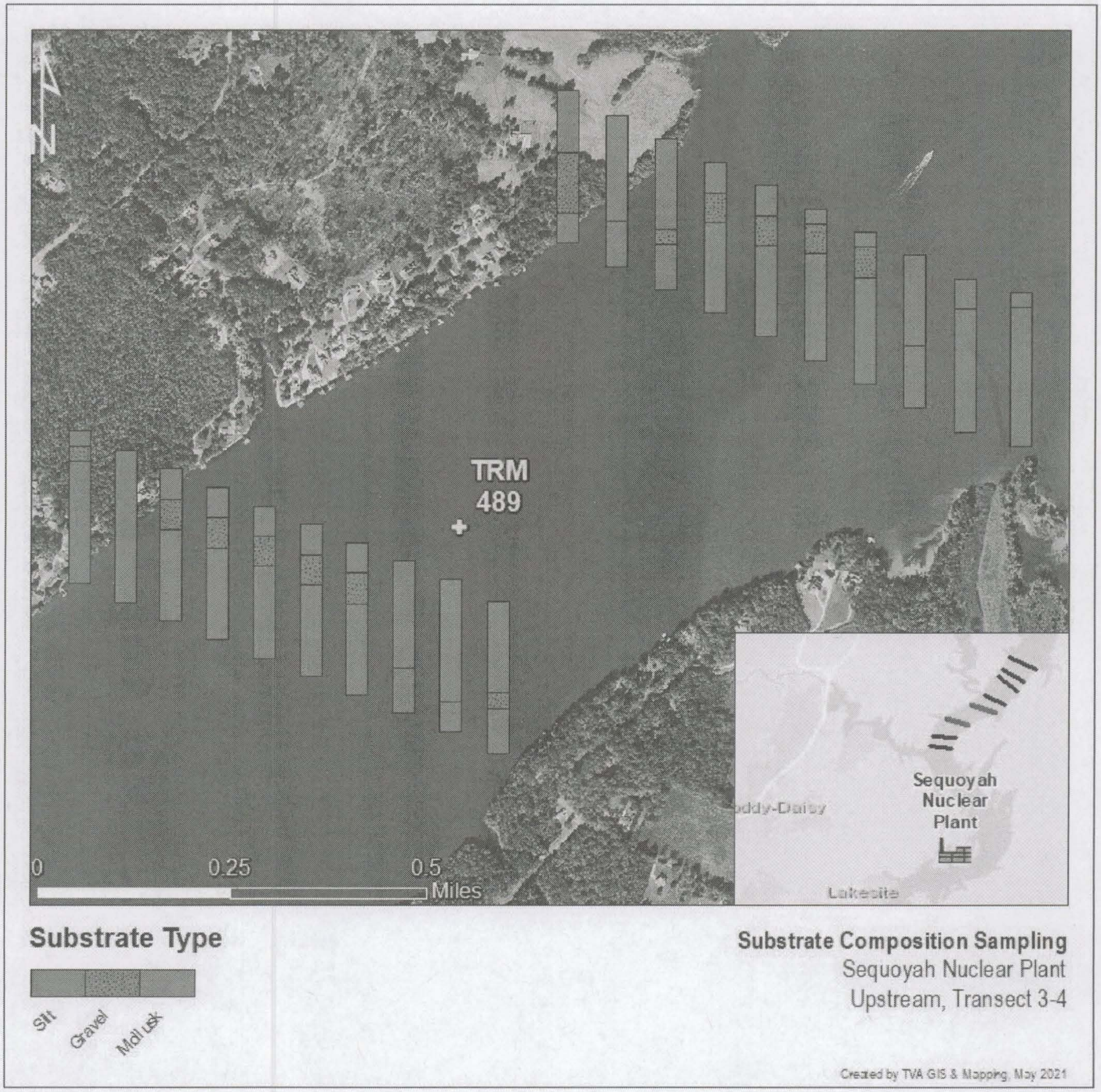


Figure 17. Substrate composition at ten equally spaced points per transect (Transects 3 and 4 shown) across the Tennessee River (Chickamauga Reservoir) upstream of SQN, autumn 2020

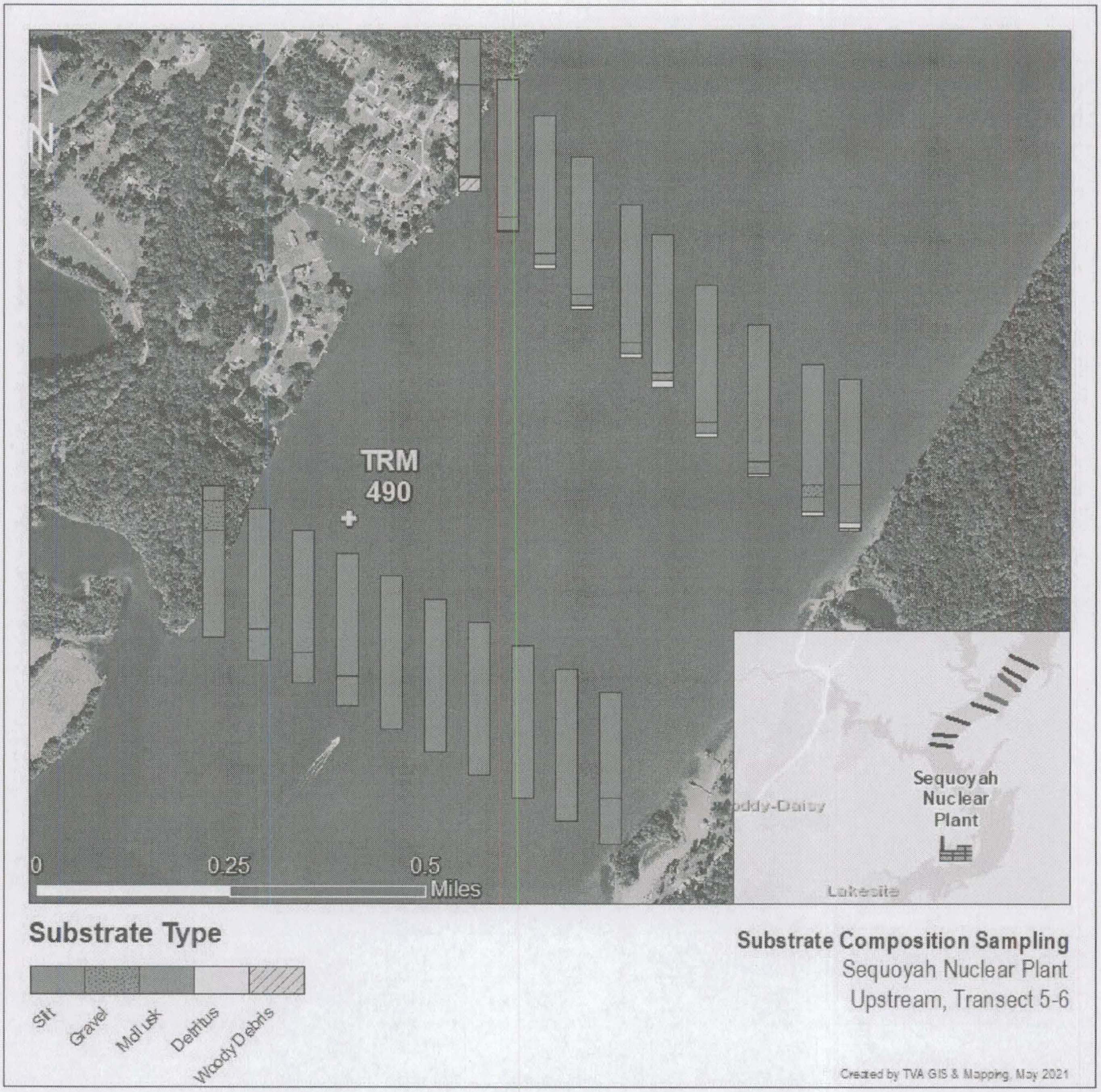


Figure 18. Substrate composition at ten equally spaced points per transect (Transects 5 and 6 shown) across the Tennessee River (Chickamauga Reservoir) upstream of SQN, autumn 2020

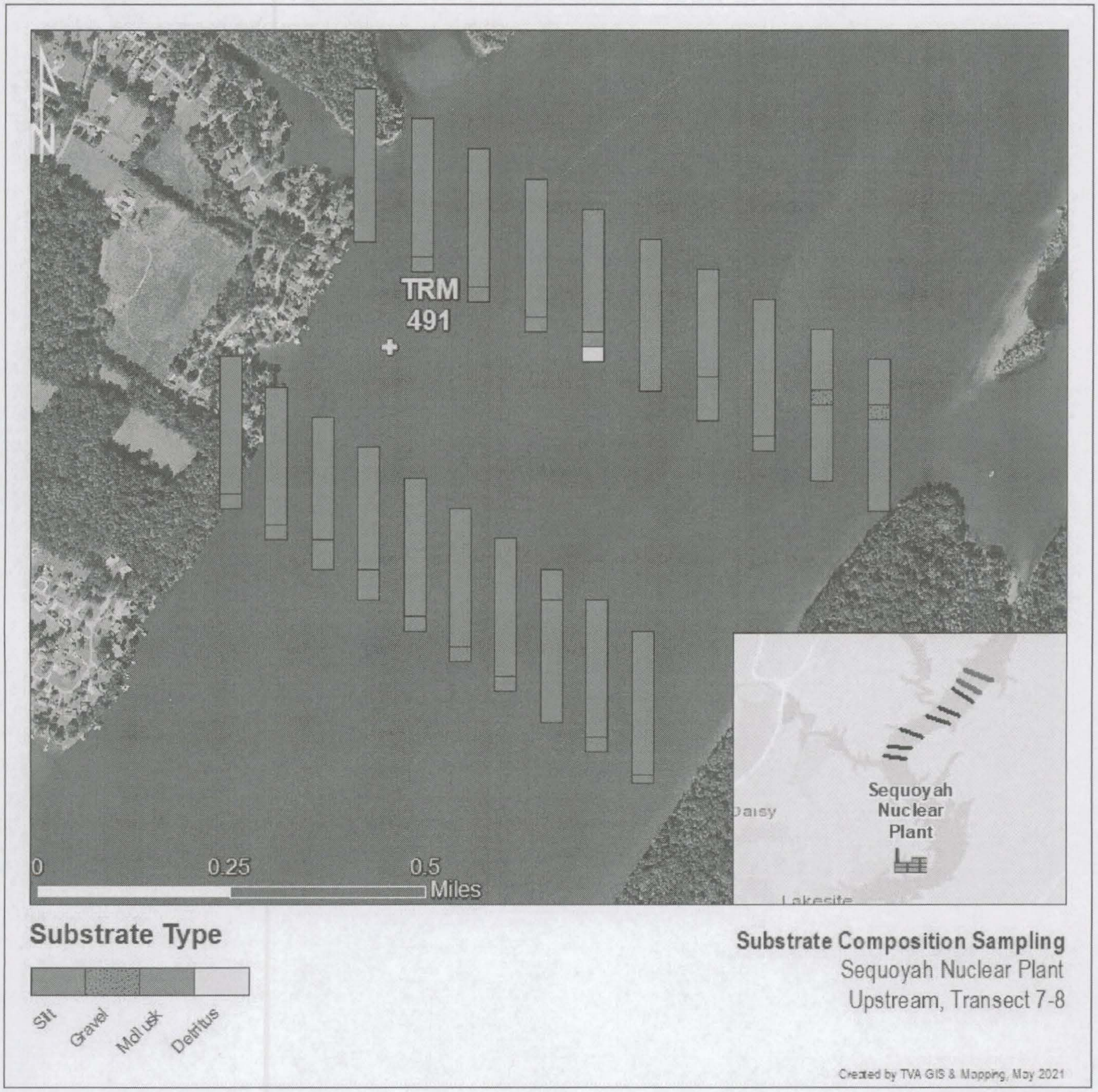


Figure 19. Substrate composition at ten equally spaced points per transect (Transects 7 and 8 shown) across the Tennessee River (Chickamauga Reservoir) upstream of SQN, autumn 2020

TABLES

Table 1. Seasonal Reservoir Fish Assemblage Index (RFAI) scores from fish community monitoring at sites located directly upstream and downstream of Sequoyah Nuclear Plant (TRM 484) on Chickamauga Reservoir during summer 2011 and 2022 and autumn 2000-2011, 2013, 2015, 2017, 2019-2022

	RFAI Scores		
Year	**Downstream (TRM 482.0)**	**Upstream (TRM 490.5)**	**Difference**
2000	48	46	2
2001	46	45	1
2002	43	51	8
2003	45	42	3
2004	41	49	8
2005	39	46	7
2006	35	47	12
2007	38	44	6
2008	38	34	4
2009	37	41	4
2010	39	39	0
Summer 2011	37	37	0
2011	35	35	0
2013	39	39	0
2015	33	37	4
2017	35	35	0
2019	38	41	3
2020	47	45	2
2021	40	40	0
Summer 2022	39	41	2
2022	46	47	1
2000-2021 Autumn Average	**39.8**	**42.0**	**3.6**

***12-21 "Very Poor"; 22-31 "Poor"; 32-40 "Fair"; 41-50 "Good"; 51-60 "Excellent"**

Table 2. Comparison of RFAI scores and metrics (gears combined) for fish collected upstream (TRM 490.5) and downstream (TRM 482.0) of Sequoyah Nuclear Plant during summer (SUM.) 2011 and autumn (AUT.) 2000-2011, 2013, 2015, 2017, 2019-2022

Metrics	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	SUM. 2011	2011	2013	2015	2017	2019	2020	2021	SUM. 2022	2022	2000-2021 AUT. AVG	2000-2021 AUT. RANGE
DOWNSTREAM (TRM 482.0)																							
RFAI Score	48	46	43	45	41	39	35	38	38	37	39	37	35	39	33	35	38	47	40	39	46	40	33 - 48
1. Number of species	26	28	23	24	27	26	25	25	29	22	25	27	24	26	27	25	27	28	28	28	29	26	22 - 29
2. Number of centrarchid species (excluding *Micropterus* spp.)	6	6	6	5	5	7	5	5	6	4	6	7	6	7	4	6	6	5	6	6	6	6	4 - 7
3. Number of benthic invertivore sp.	2	3	3	3	3	3	3	3	3	3	3	3	3	4	3	2	4	4	4	3	4	3	2 - 4
4. Number of intolerant species	5	5	5	5	5	5	3	4	5	4	5	5	4	6	3	3	4	6	4	3	6	5	3 - 6
5. Percent tolerant individuals	62.2	56.9	62.9	49.6	56.9	65.0	66.7	64.7	75.3	70.5	43.9	81.7	43.6	71.6	58.9	80.0	70.7	62.1	58.7	59.7	83.8	62.2	43.6 - 80.0
6. Percent dominance by 1 species	35.3	32.8	27.1	20.9	26.3	26.6	29.5	26.8	50.1	45.3	40.0	42.7	33.5	45.0	27.4	55.5	33.4	16.7	19.5	26.3	68.5	32.9	16.7 - 55.5
7. Percent non-native species	3.7	3.2	4.7	3.8	6.1	14.3	10.2	9.4	8.7	8.1	40.8	4.3	34.7	15.4	6.3	6.3	11.3	19.9	23.0	13.5	6.2	12.8	3.2 - 40.8
8. Number of top carnivore species	9	11	10	11	10	10	8	9	11	8	10	10	9	9	11	11	9	11	10	11	10	10	8 - 11
9. Percent top carnivores	14.4	21.4	21.0	15.8	14.1	12.5	11.1	16.2	10.5	16.5	9.4	11.0	5.2	7.7	21.8	11.4	13.6	17.6	15.8	17.7	7.9	14.2	5.2 - 21.8
10. Percent omnivores	20.9	17.3	31.0	23.7	23.7	32.2	27.7	30.5	17.8	18.6	25.1	35.2	29.7	16.0	38.0	16.6	31.0	36.8	30.3	27.2	11.0	25.9	16.0 - 38.0
11. Average number per run	37.1	49.8	27.4	33.4	42.8	43.6	42.2	31.5	55.4	49.6	64.9	42.0	109.3	60.2	22.8	40.8	36.8	40.5	37.7	39.4	114.2	45.9	22.8 - 109.3
12. Percent anomalies	1.7	1.3	0.8	0.4	1.3	0.7	0.4	1.0	1.7	1.0	0.7	1.0	0.5	0.9	0.9	0.9	1.4	1.4	1.9	0.9	1.0	1	0.4 - 1.9
UPSTREAM (TRM 490.5)																							
RFAI Score	46	45	51	42	49	46	47	44	34	41	39	37	35	39	37	35	41	45	40	41	47	42	34 - 51
1. Number of species	21	30	29	29	31	28	29	30	26	27	26	28	26	32	27	27	31	32	29	30	31	28	21 - 32
2. Number of centrarchid species (excluding *Micropterus* spp.)	6	7	7	7	7	6	6	7	7	5	6	6	6	7	7	7	7	6	6	6	6	7	5 - 7
3. Number of benthic invertivore sp.	2	3	5	3	4	4	4	3	3	3	3	4	3	4	4	3	4	6	5	3	5	4	2 - 6
4. Number of intolerant species	5	5	6	5	5	7	5	4	3	4	5	6	3	5	4	3	6	8	6	5	7	5	3 - 8
5. Percent tolerant individuals	40.8	48.5	52.9	56.3	48.6	67.3	60.0	63.1	81.9	66.7	53.3	76.3	78.1	78.1	65.0	77.6	62.5	65.6	73.2	59.6	81.5	63.3	40.8 - 81.9
6. Percent dominance by 1 species	18.6	20.9	28.6	22.2	23.8	33.5	32.7	28.1	47.3	37.3	31.7	36.8	40.0	41.9	23.2	45.0	21.5	27.3	42.3	29.8	63.2	31.4	18.6 - 47.3
7. Percent non-native species	6.8	4.9	4.0	7.7	6.5	9.3	7.2	8.9	5.2	7.7	30.6	6.4	10.8	3.7	9.6	4.0	23.3	17.7	10.4	11.3	5.9	9.9	3.7 - 30.6
8. Number of top carnivore species	10	10	10	11	11	9	10	11	9	10	11	10	11	10	11	11	11	10	9	11	12	10	9 - 11
9. Percent top carnivores	39.3	29.4	23.1	17.4	26.1	19.4	19.1	25.1	9.7	14.9	7.5	8.8	8.2	7.9	18.3	13.5	9.8	10.2	10.6	13.5	8.7	17.2	7.5 - 39.3
10. Percent omnivores	15.8	30.5	17.3	27.5	18.6	22.8	34.7	32.1	31.5	19.6	20.1	36.3	33.3	30.6	32.0	25.6	31.3	30.5	22.7	24.2	13.4	26.5	15.8 - 34.7
11. Average number per run	18.7	39.8	50.4	34.7	37.1	30.1	39.5	45.8	59.0	97.0	92.0	54.7	79.0	46.5	20.4	37.0	45.0	59.8	48.0	36.2	115.8	48.9	18.7 - 97.0
12. Percent anomalies	2.6	0.8	0.6	2.5	1.1	0.5	0.3	1.1	0.9	1.8	0.4	0.5	0.3	0.5	3.3	2.1	1.3	0.7	1.4	0.9	0.7	1.2	0.3 - 3.3

Table 3. Statistical analyses of RFAI scores, observed values for each RFAI metric, and species and abundances of trophic guilds and tolerant fish collected upstream (TRM 409.5) and downstream (TRM 482.0) of Sequoyah Nuclear Plant during autumn 2000 through 2022

	Mean		Standard Deviation			
	Upstream (TRM 490.5)	Downstream (TRM 482.0)	Upstream (TRM 490.5)	Downstream (TRM 482.0)	P-value	Significant Difference?
RFAI Score	42.3	40.1	5.0	4.5	0.17	No
1. Number of species	28.5	26.0	2.7	2.0	0.003	Yes
2. Number of centrarchid species (excluding Micropterus spp.)	6.5	5.6	0.6	0.8	0.002	Yes
3. Number of benthic invertivore species	3.7	3.2	1.0	0.6	0.06	No
4. Number of intolerant species	5.1	4.6	1.4	1.0	0.31	No
5. Percent tolerant individuals	64.3	63.4	12.1	10.8	0.81	No
6. Percent dominance by one species	33.1	34.7	11.4	13.2	0.69	No
7. Percent non-indigenous species	9.7	12.4	7.0	10.5	0.46	No
8. Number of top carnivore species	10.4	9.8	0.8	1.0	0.13	No
9. Percent top carnivores	16.7	13.9	8.7	4.7	0.29	No
10. Percent omnivores	25.8	25.2	6.7	7.6	0.79	No
11. Average number per run	52.4	49.5	26.1	24.4	0.80	No
12. Percent anomalies	1.2	1.0	0.9	0.4	0.90	No
Number of insectivore species	7.6	6.8	1.3	1.2	0.04	Yes
Number of omnivore species	5.2	5.3	1.1	0.7	0.96	No
Number of planktivore species	0.9	0.8	0.3	0.4	0.39	No
Number of benthic invertivore individuals	39.0	26.1	23.7	13.1	0.05	No
Number of insectivore individuals	601.9	565.7	432.0	436.1	0.74	No
Number of omnivore individuals	330.6	288.8	145.5	142.1	0.25	No
Number of planktivore individuals	28.0	32.5	53.5	99.3	0.64	No
Number of top carnivore individuals	206.7	171.1	83.0	49.6	0.23	No
Total number of individuals	1208.1	1084.4	576.3	486.4	0.56	No
Number of tolerant species	9.3	9.2	1.1	1.0	0.81	No
Number of tolerant individuals	872.3	781.8	528.4	451.2	0.76	No

β - Comparing two population means from normally distributed independent samples. $n1=n2=15$, degree of freedom$=n1+n2-2=28$, $\alpha=0.05$, $t\alpha/2=2.048$. Ho: $\mu1=\mu2$; Ho rejected if $t>t\alpha/2$.

γ - Non-parametric Wilcoxon Rank Sum test on large independent samples. $\alpha=0.05$, $z\alpha/2=1.96$. Ho: two sampled populations have identical probability distributions. Ho rejected if $P<\alpha$ or $|z|>z\alpha/2$

Table 4. Numbers of indigenous species and individuals of each trophic guild represented in fish collected upstream (U; TRM 490.5) and downstream (D; TRM 482.0) of Sequoyah Nuclear Plant during summer (SUM.) 2011 and 2022, and autumn (AUT.) 2000-2011, 2013, 2015, 2017, 2019-2022

		Number of Species								Number of Individuals							
Year	Site	BI	HB	IN	OM	PK	PS	TC	Total	BI	HB	IN	OM	PK	PS	TC	Total
2000	D	2	--	9	5	--	1	9	26	11	--	533	185	--	1	127	**857**
	U	2	--	6	2	--	1	10	21	19	--	173	61	--	4	179	**436**
2001	D	3	--	7	6	1	--	11	28	18	--	710	231	3	--	327	**1,289**
	U	3	--	9	7	1	--	10	30	52	--	312	313	10	--	344	**1,031**
2002	D	3	--	6	4	--	--	10	23	19	--	273	207	--	--	143	**642**
	U	5	--	9	3	1	1	10	29	19	--	559	221	134	3	316	**1,252**
2003	D	3	--	6	4	--	--	11	24	34	--	444	203	--	--	134	**815**
	U	3	--	9	5	1	--	11	29	26	--	381	243	18	--	182	**850**
2004	D	3	--	6	6	1	1	10	27	28	--	575	248	16	1	179	**1,047**
	U	4	--	8	6	1	1	11	31	37	--	425	182	5	2	249	**900**
2005	D	3	--	7	5	1	--	10	26	23	--	407	375	26	--	146	**977**
	U	4	--	9	5	1	--	9	28	21	--	340	174	7	--	159	**701**
2006	D	3	--	8	5	1	--	8	25	25	--	512	296	5	--	130	**968**
	U	4	--	8	5	1	1	10	29	21	--	310	348	60	1	228	**968**
2007	D	3	--	7	5	1	--	9	25	15	--	333	254	3	--	161	**766**
	U	3	--	8	6	1	1	11	30	39	--	358	393	1	1	319	**1,111**
2008	D	3	--	9	5	1	--	11	29	23	--	829	262	23	--	185	**1,322**
	U	3	--	8	5	1	--	9	26	18	--	776	485	3	--	162	**1,444**
2009	D	3	--	5	5	1	--	8	22	16	--	663	227	3	--	203	**1,112**
	U	3	--	7	5	1	1	10	27	24	--	1191	475	205	2	372	**2,269**
2010	D	3	--	7	5	--	--	10	25	48	--	365	417	--	--	182	**1,012**
	U	3	--	6	5	1	--	11	26	108	--	861	476	1	--	203	**1,649**
Sum. 2011	D	3	--	7	6	1	--	10	27	19	--	506	378	2	--	117	**1,022**
	U	4	--	7	6	1	--	10	28	35	--	634	498	1	--	142	**1,310**
2011	D	3	--	6	5	1	--	9	24	21	--	382	809	439	--	163	**1,814**
	U	3	1	5	5	1	--	11	26	25	14	886	669	22	--	170	**1,786**
2013	D	4	--	7	5	1	--	9	26	22	--	905	236	3	--	124	**1,290**
	U	4	1	9	6	1	1	10	32	63	2	607	362	6	1	105	**1,146**
2015	D	3	--	5	7	1	--	11	27	36	--	118	216	54	--	137	**561**
	U	4	--	6	5	1	--	11	27	21	--	184	166	1	--	100	**472**
2017	D	2	--	5	6	1	--	11	25	16	--	675	156	6	--	134	**987**
	U	3	--	6	6	1	--	11	27	24	--	513	247	4	--	139	**927**
2019	D	4	--	7	6	1	--	9	27	65	--	376	247	5	--	164	**857**
	U	4	1	8	6	1	--	11	31	65	1	348	359	5	--	123	**901**
2020	D	4	--	6	6	1	--	11	28	30	--	235	365	11	--	206	**847**
	U	6	1	8	5	1	1	10	32	40	2	553	453	42	1	168	**1,259**
2021	D	4	--	8	5	1	--	10	28	32	--	266	278	2	--	159	**737**
	U	5	--	8	6	1	0	9	29	55	--	636	271	8	--	137	**1,107**
Sum. 2022	D	3	--	7	6	1	--	11	28	48	--	372	276	5	--	185	**886**
	U	3	--	9	6	1	--	11	30	158	--	335	201	1	--	130	**825**
2022	D	4	--	8	6	1	--	10	29	14	--	2148	276	18	--	247	**2703**
	U	5	1	8	5	--	--	12	31	64	1	2023	384	--	--	272	**2744**
AUT AVG	**D**	**3**	**--**	**7**	**5**	**0.8**	**0.1**	**10**	**26**	**27**	**--**	**478**	**290**	**33**	**0.1**	**167**	**994**
2000-2021	**U**	**4**	**0.2**	**8**	**5**	**0.9**	**0.4**	**10**	**28**	**38**	**1**	**523**	**328**	**30**	**0.8**	**203**	**1123**

BI-benthic invertivore; HB-herbivore; IN-insectivore; OM-omnivore; PK-planktivore; PS-parasitic; TC-top carnivore; D-downstream; U-upstream

Table 5. Numbers of indigenous taxa and total mean densities per square meter (m^2) of each functional feeding group[1] represented in benthic macroinvertebrate samples collected downstream ("Down"; TRMs 482.0, 481.3 and 483.4) and upstream ("Up"; TRM 490.5) of SQN for years sampled, 2002-2004, 2006, summer and autumn 2011, 2013, 2015, 2017, 2020, and 2022.

		2002		2003		2004		2006		Summer 2011			Autumn 2011			2013			2015			2017			2020			Summer 2022			Autumn 2022			AUT. Average 2002-2022	
		TRM 482.0	TRM 490.5	TRM 482.0	TRM 490.5	TRM 482.0	TRM 490.5	TRM 482.0	TRM 490.5	TRM 481.3	TRM 483.4	TRM 490.5	TRM 481.3	TRM 483.4	TRM 490.5*	TRM 481.3	TRM 483.4	TRM 490.5	TRM 481.3	TRM 483.4	TRM 490.5	TRM 481.3	TRM 483.4	TRM 490.5	TRM 481.3	TRM 483.4	TRM 490.5	TRM 481.3	TRM 483.4	TRM 490.5	TRM 481.3	TRM 483.4	TRM 490.5		
		D	U	D	U	D	U	D	U	D	D	U	D	D	U	D	D	U	D	D	U	D	D	U	D	D	U	D	D	U	D	D	U	D	U
	CF	1	1	3	1	2	2	3	2	6	4	2	3	6	3	4	4	3	8	4	2	5	5	3	5	6	3	3	7	2	5	7	3	4	2
	CG	5	4	6	3	5	3	7	3	10	17	8	11	16	11	20	20	8	12	18	10	18	14	4	13	16	10	12	19	9	9	13	9	13	7
	PA	0	1	0	0	0	0	0	0	0	1	0	0	1	0	1	1	0	1	0	0	1	1	0	1	2	0	1	1	0	0	0	0	1	0.1
# Species	PR	3	3	5	6	6	6	9	6	10	13	7	9	13	8	15	12	10	11	19	10	11	11	7	10	11	9	11	11	10	10	14	7	11	7
	SC	2	1	2	2	2	4	2	3	3	5	1	1	4	2	5	3	1	6	7	2	4	4	2	5	5	2	7	7	2	3	4	1	4	2
	SH	0	0	0	0	0	0	2	0	0	2	0	3	2	0	2	2	1	1	3	1	1	1	0	2	3	1	2	2	2	2	2	2	2	1
	PI	0	0	0	0	0	0	0	0	0	1	0	1	0	0	1	1	0	3	2	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0
	Sum	**11**	**10**	**16**	**12**	**15**	**15**	**23**	**14**	**29**	**43**	**18**	**28**	**42**	**24**	**48**	**43**	**23**	**42**	**53**	**25**	**40**	**36**	**16**	**36**	**43**	**25**	**36**	**47**	**25**	**30**	**40**	**22**	**34**	**19**
	CF	90	108	212	80	133	173	28	148	128	57	258	77	175	170	133	163	242	125	150	403	242	398	260	103	423	413	115	143	927	93	102	257	165	225
	CG	197	130	97	208	203	168	177	33	702	1280	155	183	2340	205	600	515	315	503	1423	327	627	462	133	742	1588	383	375	1705	267	537	402	233	662	214
	PA	0	2	0	0	0	0	0	0	0	13	0	0	13	0	2	2	0	2	0	0	2	5	0	3	15	0	2	15	0	0	0	0	3	0.2
Total Mean Density/m^2	PR	135	517	168	387	120	340	252	353	188	313	345	283	1192	317	910	1420	328	302	1052	387	758	862	333	525	1520	553	395	598	397	610	335	472	653	399
	SC	23	2	63	53	107	80	75	52	10	23	2	3	73	5	43	75	8	95	28	5	33	32	13	45	23	12	40	172	18	10	52	7	49	24
	SH	0	0	0	0	0	0	10	0	0	30	0	5	7	0	8	3	2	8	50	2	3	17	0	7	7	2	8	13	15	5	12	3	9	1
	PI	0	0	0	0	0	0	0	0	0	3	0	2	0	0	2	3	0	5	20	0	0	0	0	0	0	0	0	0	0	2	0	0	2	0
	Sum	**445**	**759**	**540**	**728**	**563**	**761**	**542**	**586**	**1028**	**1719**	**760**	**553**	**3800**	**697**	**1698**	**2181**	**895**	**1040**	**2723**	**1124**	**1665**	**1776**	**739**	**1425**	**3576**	**1363**	**935**	**2646**	**1624**	**1257**	**903**	**972**	**1543**	**862**
	% CF	20	14	39	11	24	23	5	25	12	3	34	14	5	24	8	7	27	12	6	36	15	22	35	7	12	30	12	5	57	7	11	26	13	25
	% CG	44	17	18	29	36	22	33	6	68	74	20	33	62	29	35	24	35	48	52	29	38	26	18	52	44	28	40	64	16	43	45	24	40	24
	% PA	0	0.3	0	0	0	0	0	0	0	1	0	0	0.3	0	0.1	0.1	0	0.2	0	0	0.1	0.3	0	0.2	0.4	0	0	1	0	0	0	0	0	0
% Composition	% PR	30	68	31	53	21	45	46	60	18	18	45	51	31	45	54	65	37	29	39	34	46	49	45	37	43	41	42	23	24	49	37	49	41	48
	% SC	5	0.3	12	7	19	11	14	9	1	1	0.3	1	2	1	3	3	1	9	1	0.4	2	2	2	3	1	1	4	7	1	1	6	1	5	3
	% SH	0	0	0	0	0	0	2	0	0	2	0	1	0.2	0	0.5	0.1	0.2	1	2	0.2	0.2	1	0	0.5	0.2	0.1	0.9	0.5	0.9	0.4	1.3	0.3	1	0.1
	% PI	0	0	0	0	0	0	0	0	0	0.2	0	0.4	0	0	0.1	0.1	0	0.5	1	0	0	0	0	0	0	0	0	0	0	0.2	0	0	0	0

Functional Feeding Groups: FC-filtering collector; GC-gathering collector; OM-omnivore; PA-parasitic; PR-predator; SC-scraper; SH-shredder

[2]Other: organisms whose trophic relationships do not fit into a single general category

*Represents data from two five-sample upstream transects collected at TRMs 488 and 490.5 during summer 2011

Table 6. Results of tests performed on means select RFAI metrics (gears combined) for fish collected downstream (TRM 482.0) and upstream (TRM 490.5) of Sequoyah Nuclear Plant during summer and autumn 2022

Metrics	Downstream (TRM 482.0)					Upstream (TRM 490.5)				
	Summer 2022	Autumn 2022	Z-statistic	P-Value	Significant?	Summer 2022	Autumn 2022	Z-statistic	P-Value	Significant?
RFAI Score	39	46	--	--	--	41	47	--	--	--
Number of Indigenous Spp.	11.4	10.8	-0.5448	0.5859	No	10.6	12.1	1.0623	0.2881	No
Abundance (# of indigenous individuals)	56.9	178.4	3.4227	0.0006	Yes	53.5	181.6	3.5883	0.0003	Yes
Bluegill Abundance	17.3	130.3	4.3156	<.0001	Yes	18.0	121.9	3.4442	0.0006	Yes
Number of Non-Indigenous Spp.	2.2	1.8	-0.9017	0.3672	No	1.9	1.5	-1.218	0.2232	No
Number of Benthic Invertivore Spp.	0.9	0.7	-0.4879	0.6256	No	1.3	1.5	0.6579	0.5106	No
Number of Intolerant Spp.	0.7	1.3	1.8715	0.0613	No	1.3	2.3	2.4673	0.0136	Yes
Percent Individuals as Omnivores	27.7	12.1	-2.8623	0.0042	Yes	23.3	12.6	-2.6964	0.0070	Yes
Percent Individuals as Tolerant	59.9	80.3	2.9038	0.0037	Yes	61.8	73.1	1.4103	0.1585	No

Table 7. Comparison of RBI metric ratings and total scores for laboratory-processed samples collected upstream and downstream of Sequoyah Nuclear Plant, Chickamauga Reservoir, summer and autumn 2022

	Summer						Autumn					
	Downstream TRM 481.3		Downstream TRM 483.4		Upstream TRM 490.5		Downstream TRM 481.3		Downstream TRM 483.4		Upstream TRM 490.5	
RBI Metrics	Obs	Score	Obs	Score	Obs	Score	Obs	Score	Obs	Score	Obs	Score
1. Average number of taxa	10.6	5	18.0	5	10.3	5	10.7	5	13.1	5	8.6	5
2. Proportion of samples with long-lived organisms	0.9	5	1.0	5	1.0	5	0.9	5	0.9	5	0.9	3
3. Average number of EPT taxa	1.3	5	1.9	5	1.2	3	1.2	5	1.2	5	1.4	3
4. Average proportion of oligochaete individuals	25.5	3	42.9	1	18.7	3	11.3	5	12.1	5	10.6	5
5. Average proportion of total abundance comprised by the two most abundant taxa	68.5	5	72.1	5	73.9	5	79.4	5	64.5	5	72.8	5
6. Average density excluding chironomids and oligochaetes	441.7	5	1076.7	5	1215.0	5	411.7	5	856.7	5	576.7	3
7. Zero-samples – proportion of samples containing no organisms	0	5	0	5	0	5	0	5	0	5	0	5
Benthic Index Score		**33**		**31**		**31**		**35**		**35**		**29**
Ecological Health Rating		**Excellent**		**Excellent**		**Excellent**		**Excellent**		**Excellent**		**Good**

*Reservoir Benthic Index Score Range: 7-12 ("Very Poor"), 13-18 ("Poor"), 19-23 ("Fair"), 24-29 ("Good"), 30-35 ("Excellent")
^RBI scores are averages of scores from the two downstream transects (TRMs 481.3 and 483.4)

Table 8. Numbers of indigenous fish species and individuals with upper incipient lethal limits (UILT) of 95 °F to 102 °F (considered heat-tolerant) collected upstream (TRM 490.5) and downstream (TRM 482.0) of Sequoyah Nuclear Plant during summer (Sum.) 2011 and 2022 and autumn 2000-2011, 2013, 2015, 2017, and 2019-2022

	Number of Species		Number of Individuals	
	Downstream	**Upstream**	**Downstream**	**Upstream**
2000	12	8	607	208
2001	13	13	853	517
2002	9	11	483	708
2003	10	11	484	504
2004	10	12	595	503
2005	11	10	670	493
2006	12	11	675	592
2007	11	13	532	678
2008	11	12	1,060	1,220
2009	10	11	834	1,519
2010	11	11	732	1,280
Sum. 2011	12	11	830	977
2011	10	9	1,155	1,505
2013	10	12	993	827
2015	12	10	315	281
2017	10	11	783	686
2019	12	11	486	455
2020	11	10	428	837
2021	11	11	339	705
Sum. 2022	12	12	486	434
2022	12	12	2,179	1,974
Autumn AVG	**11**	**11**	**748**	**815**

Note: UILTs known for 74% (45 of 61) of indigenous fish species (Table 10) collected in the vicinity of SQN during 2000-2011, 2013, 2015, 2017, and 2019-2022, and sourced from Yoder et al. (2006)

Table 9. Relative abundance of indigenous fish considered heat-tolerant (upper incipient lethal limits of 95-102°F) and heat-sensitive (upper incipient lethal limits ≤ 91°F) collected upstream (TRM 490.5) and downstream (TRM 482.0) of Sequoyah Nuclear Plant during summer (Sum.) 2011 and 2022 and autumn 2000-2011, 2013, 2015, 2017, and 2019-2022

	Relative Abundance of Heat-Tolerant Species		Relative Abundance of Heat-Sensitive Species	
Year	**Downstream**	**Upstream**	**Downstream**	**Upstream**
2000	70.8	47.7	13.1	12.8
2001	66.2	50.1	9.4	13.3
2002	75.2	56.5	6.5	7.3
2003	59.4	59.3	14	6.6
2004	56.8	55.9	18.9	10.0
2005	68.6	70.3	8.7	5.3
2006	69.7	61.2	7.6	3.8
2007	69.5	61.0	6.4	5.3
2008	80.2	84.5	2.4	0.8
2009	75.0	66.9	1.1	2.1
2010	72.3	77.6	6.0	7.2
Sum. 2011	81.2	74.6	3.1	7.4
2011	63.7	84.3	1.8	1.5
2013	77.0	72.2	4.7	7.3
2015	56.1	59.5	8.0	15.7
2017	79.3	74.0	1.7	6.1
2019	59.6	52.7	19.4	25.7
2020	52.8	68.0	26.9	11.3
2021	46.8	65.6	30.2	16.3
Sum. 2022	57.0	54.1	20.5	27.8
2022	81.4	72.5	6.9	17.8
Autumn AVG	**67.4**	**65.3**	**10.2**	**9.3**

Table 10. List of indigenous fish species occurring in the vicinity of Sequoyah Nuclear Plant based on sampling during 2000-2011, 2013, 2015, 2017, and 2019-2022, upper incipient lethal limits (UILT) from Yoder et.al. (2006), and thermal tolerance designations (heat-sensitive/ intermediate/ heat-tolerant) used to achieve results in Tables 10 and 11

Common Name	UILT (°F)	Thermal Tolerance Designation
American brook lamprey	85	Heat-sensitive
Logperch	87	Heat-sensitive
Spotted sucker	88	Heat-sensitive
Emerald shiner	90	Heat-sensitive
Bluntnose minnow	90	Heat-sensitive
Greenside darter	90	Heat-sensitive
Mooneye	90	Heat-sensitive
Dusky darter	91	Heat-sensitive
Northern hog sucker	91	Heat-sensitive
Sauger	91	Heat-sensitive
Walleye	91	Heat-sensitive
Warmouth	91	Heat-sensitive
White crappie	91	Heat-sensitive
Freshwater drum	92	Intermediate
Golden redhorse	92	Intermediate
Smallmouth redhorse	92	Intermediate
Striped shiner	92	Intermediate
Creek chub	93	Intermediate
Golden shiner	93	Intermediate
Black crappie	94	Intermediate
Largemouth bass	94	Intermediate
Redear sunfish	94	Intermediate
Skipjack herring	94	Intermediate
Smallmouth bass	94	Intermediate
Quillback	95	Heat-tolerant
Brook silverside	95	Heat-tolerant
River carpsucker	95	Heat-tolerant
Rock bass	95	Heat-tolerant
Highfin carpsucker	95	Heat-tolerant
Brown bullhead	95	Heat-tolerant
Gizzard shad	96	Heat-tolerant
Green sunfish	96	Heat-tolerant
White bass	96	Heat-tolerant
Longear sunfish	97	Heat-tolerant
Spotfin shiner	97	Heat-tolerant
Spotted bass	97	Heat-tolerant
Bluegill	98	Heat-tolerant
Yellow bullhead	98	Heat-tolerant
Blue catfish	99	Heat-tolerant

Table 10. (continued)

Common Name	UILT (°F)	Thermal Tolerance Designation
Smallmouth buffalo	99	Heat-tolerant
Bullhead minnow	99	Heat-tolerant
Flathead catfish	100	Heat-tolerant
Longnose gar	100	Heat-tolerant
Western mosquitofish	101	Heat-tolerant
Channel catfish	101	Heat-tolerant
Black buffalo	No UILT data	
Black redhorse	No UILT data	
Chestnut lamprey	No UILT data	
Lake sturgeon	No UILT data	
Largescale stoneroller	No UILT data	
River darter	No UILT data	
River redhorse	No UILT data	
Silver redhorse	No UILT data	
Smallmouth redhorse	No UILT data	
Snubnose darter	No UILT data	
Spotted gar	No UILT data	
Steelcolor shiner	No UILT data	
Stripetail darter	No UILT data	
Threadfin shad	No UILT data	
Whitetail shiner	No UILT data	
Yellow bass	No UILT data	

***Heat-sensitive – UILTs ≤ 91°F; Intermediate – UILTs 92–94°F; Heat-tolerant – UILTs ≥ 95–102°F**

Table 11. Numbers of non-indigenous fish species and individuals collected upstream (TRM 490.5) and downstream (TRM 482.0) of Sequoyah Nuclear Plant during summer 2011 and 2022, and autumn 2000-2011, 2013, 2015, 2017, and 2019-2022

	Number of Species		Number of Individuals	
	Downstream	**Upstream**	**Downstream**	**Upstream**
2000	4	4	33	32
2001	2	2	40	49
2002	3	4	31	51
2003	2	3	32	67
2004	3	5	65	60
2005	3	3	156	70
2006	2	2	108	71
2007	4	4	74	102
2008	4	3	121	76
2009	4	4	96	186
2010	4	4	662	703
Sum. 2011	4	4	45	88
2011	3	4	948	213
2013	4	4	232	43
2015	4	3	36	49
2017	4	4	66	41
2019	5	5	104	260
2020	5	5	202	264
2021	4	4	217	125
Sum. 2022	4	4	133	102
2022	4	4	178	171
Autumn AVG	**4**	**4**	**179**	**139**

Table 12. List of non-indigenous fish species occurring in the vicinity of Sequoyah Nuclear Plant based on seasonal sampling during summer 2011 and 2022 and autumn 2000-2011, 2013, 2015, 2017, and 2019-2022 and associated upper incipient lethal limits (UILT) from Yoder et.al. (2006)

Common Name	UILT (°F)	Thermal Tolerance Designation
Striped bass	90	Heat-sensitive
Yellow perch	91	Heat-sensitive
Common carp	99	Heat-tolerant
Goldfish	100	Heat-tolerant
Mississippi silverside	No UILT data	
Redbreast sunfish	No UILT data	

***Heat-sensitive – UILTs ≤ 91°F; Heat-tolerant – UILTs ≥ 95–101°F**

Table 13. Records of federal and state-listed aquatic animal species in the vicinity[1,2,3] of Sequoyah Nuclear Plant (TRM 484)

Source	Scientific Name	Common Name	Federal Status[4]	State Status[4]
TVA Natural Heritage Database[1]	**FISHES**			
	Carpiodes velifer	Highfin Carpsucker	–	NMGT
	Acipenser fulvescens	Lake Sturgeon	–	END
	Chrosomus saylori	Laurel Dace	LE	NMGT
	Percina tanasi	Snail Darter[5]	DL	THR
	MUSSELS			
	Dromus dromas	Dromedary Pearlymussel[5]	LE	END
	Cyprogenia stegaria	Fanshell[7]	LE	END
	Plethobasus cooperianus	Orangefoot Pimpleback Pearlymussel[5]	LE	END
	Lampsilis abrupta	Pink Mucket[7]	LE	END
	Pleurobema plenum	Rough Pigtoe[5]	LE	END
	Plethobasus cyphyus	Sheepnose[7]	LE	END
	Fusconaia subrotunda	Longsolid	THR	--
	Fusconaia cor	Shiny Pigtoe Pearlymussel[6]	LE	END
ECOS/IPAC[2]	**FISHES**			
	Chrosomus saylori	Laurel Dace	LE	
	Percina tanasi	Snail Darter	DL	
	MUSSELS			
	Fusconaia subrotunda	Longsolid	THR	
	Plethobasus cooperianus	Orangefoot Pimpleback Pearlymussel	LE	
	Cyprogenia stegaria	Fanshell	LE	
	Lampsilis abrupta	Pink Mucket Pearlymussel	LE	
	Quadrula intermedia	Cumberland Monkeyface Pearlymussel	LE	
	Epioblasma torulosa torulosa	Tubercled Blossom Pearlymussel	LE	
	Dromus dromas	Dromedary Pearlymussel	LE	
	Pleurobema plenum	Rough Pigtoe	LE	
TDEC[3]	**FISHES**			
	Percina tanasi	Snail Darter		THR
	Carpiodes velifer	Highfin Carpsucker		NMGT
	MUSSELS			
	Dromus dromas	Dromedary Pearlymussel		END
	Quadrula intermedia	Cumberland Monkeyface Pearlymussel		END
	Plethobasus cooperianus	Orangefoot Pimpleback Pearlymussel		END
	Lampsilis abrupta	Pink Mucket Pearlymussel		END
	Pleurobema plenum	Rough Pigtoe		END
	CRUSTACEANS			
	Stygobromus nortoni	Norton's Cave Amphipod		RNSL
	Cambarus extraneus	Chickamauga Crayfish		END

[1]TVA Natural Heritage Database returns records **within the 10-digit Hydrologic Unit watershed that encompasses** SQN intake, queried by Todd Amacker (TVA) on 1/10/2025

[2] U.S. Fish and Wildlife Service (USFWS) Environmental Conservation Online System (ECOS) and the Information for Planning and Consultation (IPAC) internet resource pages returns records **by county**

[3] Tennessee Department of Environment and Conservation "Rare Species by County" website returns records **by county**

[4] Status Codes: LE or END = Listed Endangered; LT or THR - Listed Threatened; D or NMGT = Deemed in need of management; PT = Proposed Threatened; RNSL = Rare, Not State Listed.

[5] H? = Uncertain status

[6] H = Historical record ≥ 25 years old

[7] E = Extant record ≤ 25 years old

Table 14. Wildlife observed during visual surveys conducted upstream (TRM 490.5) and downstream (TRM 482.0) of Sequoyah Nuclear Plant during summer 2011 and autumn 2011, 2013, 2015, and 2020

	TRM 490.5 RDB						TRM 490.5 LDB						TRM 482 RDB						TRM 482 LDB					
Sampling year	Sum. 11	Aut. 11	13	15	20	Aut. 22	Sum. 11	Aut. 11	13	15	20	Aut. 22	Sum. 11	Aut. 11	13	15	20	Aut. 22	Sum. 11	Aut. 11	13	15	20	Aut. 22
Birds																								
American coot					2	8						6		335			24	250		603	17		31	
American crow	4		1	1	2		1		1	1	4				3	1	2						3	
American goldfinch															1									
American widgeon														2										
Bald eagle						1																		2
Belted kingfisher	1				1			1		1	1	1		3		5		2	1	2	3	3	1	
Black-crowned night heron																				1				
Blue jay			1								2			1			1				1			
Blue-winged teal																					1			
Brown thrasher											2				1									
Carolina chickadee			2												5		1							
Carolina wren								1																1
Cattle egret																					1		1	
Cliff swallow	1				1		2						3						5			4		
Common loon																		2						
Double-crested cormorant			2	2	4				6	1			2	1		6	5			5	3	7	11	
Eastern bluebird						2																		
European starling											10								30		2		20	
Gadwall																				3				
Golden eagle									1															
Great blue heron	5	4	11	3	3	2	5	1	16	2	5	2	4	5	1	3	2	5	2	7	8	5	3	4
Grebe sp.						2												7						
Green heron									1										1					
Gull Sp.																		400						2
Green-winged teal																				2				
House sparrow						3						3			2									3
Junco									2															
Killdeer																				2				
Mallard			17	4	1									5			2	6		13		10		12
Mockingbird			1			1					3			1	7		3							1
Mourning dove					2					2														
Osprey	1		1										2								1		1	
Plover sp.												1												

Table 14. (continued)

Northern cardinal			1	5	3	1				1	1										1		1	
Pied-billed grebe														2						2				
Red-shouldered Hawk						1																		
Red-tailed Hawk						1																		1
Red-winged blackbird							5																	
Rock dove															1									
Spotted sandpiper						2														2				
Tufted titmouse															1					3				1
Turkey vulture		2			1	3			2	19								100						
Unspecified duck		2															4	1						
Unspecified perching bird	4									4			6		8	1			3			3	2	
Western kingbird			5																				2	
White ibis																	1					6		
Wood duck			3	2										1					15					
Reptile/Amphibian																								
Map turtle			4						16						1						3			
Painted turtle			2					4																
Unspecified turtle				3	5						10					2		2				5		
																	2						5	
Mammals																								
Eastern grey squirrel						2					2		1		1		1		2				2	
White-tailed deer								4						4										
Total Birds	16	8	45	17	20	27	13	3	29	31	28	13	17	356	30	16	45	775	57	645	38	38	76	27
Bird Species	5	2	11	6	10	12	4	3	7	7	8	5	4	10	9	4	9	9	6	12	10	6	10	9
Total Rept/Amph	-	-	6	3	5	-	-	4	16	-	10	-	-	-	1	2	-	2	-	-	3	5	-	-
Rept/Amph Species	-	-	2	1	1	-	-	1	1	-	1	-	-	-	1	1	-	1	-	-	1	1	-	-
Total Mammals	-	-	-	-	-	1	-	4	-	-	2	-	1	4	1	-	1	-	2	-	-	-	2	-
Mammal Species	-	-	-	-	-	1	-	1	-	-	1	-	1	1	1	-	1	-	1	-	-	-	1	-

Table 15. Shoreline Aquatic Health Index scores for shoreline habitat assessments conducted within the Reservoir Fisheries Assemblage Index sample reach upstream of Sequoyah Nuclear plant (Figure 9) during autumn 2020

Left Descending Bank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Avg.**
Aquatic Macrophytes	0%	0%	0%	0%	0%	0%	0%	0%	0%
SAHI Variables									
Cover	5	3	5	3	3	3	3	3	4
Substrate	5	1	3	1	5	5	5	5	4
Erosion	1	3	1	3	3	5	1	1	2
Canopy Cover	5	5	5	3	1	5	5	5	4
Riparian Zone	5	5	5	3	1	5	5	5	4
Habitat	3	1	3	1	1	3	3	5	3
Slope	5	5	5	5	1	5	5	5	5
Total	**29**	**23**	**27**	**19**	**15**	**31**	**27**	**31**	**25**
Rating	**Good**	**Fair**	**Good**	**Fair**	**Poor**	**Good**	**Good**	**Good**	**Fair**
Right Descending Bank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Avg.**
Aquatic Macrophytes	0%	0%	0%	0%	0%	0%	0%	0%	0%
SAHI Variables									
Cover	3	5	3	1	3	5	5	5	4
Substrate	5	3	5	5	1	1	1	5	3
Erosion	1	1	1	1	3	3	3	1	2
Canopy Cover	5	5	3	5	3	3	3	3	4
Riparian Zone	3	5	1	5	5	1	1	1	3
Habitat	3	5	1	3	1	1	1	1	2
Slope	5	5	3	5	5	5	5	1	4
Total	**25**	**29**	**17**	**25**	**21**	**19**	**19**	**17**	**22**
Rating	**Fair**	**Good**	**Fair**	**Fair**	**Fair**	**Fair**	**Fair**	**Fair**	**Fair**

Scoring criteria: poor (7-16); fair (17-26); and good (27-35)

Table 16. Shoreline Aquatic Health Index scores for shoreline habitat assessments conducted within the Reservoir Fisheries Assemblage Index sample reach downstream of Sequoyah Nuclear plant (Figure 9) during autumn 2020

Left Descending Bank	1	2	3	4	5	6	7	8	Avg.
Aquatic Macrophytes									
SAHI Variables									
Cover	3	3	3	5	5	5	5	3	4
Substrate	1	1	1	3	1	3	5	1	2
Erosion	3	1	1	1	1	1	3	3	2
Canopy Cover	5	5	3	3	5	5	1	5	4
Riparian Zone	5	3	3	1	5	5	1	5	4
Habitat	3	3	3	5	5	3	1	1	3
Slope	5	5	5	5	5	5	1	5	5
Total	**25**	**21**	**19**	**23**	**27**	**27**	**17**	**23**	**23**
Rating	**Fair**	**Fair**	**Fair**	**Fair**	**Good**	**Good**	**Fair**	**Fair**	**Fair**

Right Descending Bank	1	2	3	4	5	6	7	8	Avg.
Aquatic Macrophytes									
SAHI Variables									
Cover	1	5	5	3	3	3	1	1	3
Substrate	3	1	1	3	3	5	3	1	3
Erosion	3	3	3	3	3	3	3	5	3
Canopy Cover	3	5	3	3	3	1	5	5	4
Riparian Zone	5	5	1	1	1	1	3	5	3
Habitat	1	1	3	3	1	1	1	1	2
Slope	3	5	3	3	3	1	5	3	3
Total	**19**	**25**	**19**	**19**	**17**	**15**	**21**	**21**	**20**
Rating	**Fair**	**Fair**	**Fair**	**Fair**	**Fair**	**Poor**	**Fair**	**Fair**	**Fair**

Scoring criteria: poor (7-16); fair (17-26); and good (27-35).

Table 17. Substrate percentages and average water depth (ft) per transect recorded upstream and downstream of Sequoyah Nuclear Plant (Figure 9), autumn 2020

Substrate Type	% Substrate per transect upstream of SQN								
	1	2	3	4	5	6	7	8	Avg
Mollusk	21.5	66.8	74.1	41.0	32.5	30.6	39.8	23.6	41.2
Silt	23.7	32.5	5.4	10.0	59.5	62.4	51.2	38.7	35.4
Bedrock	46.5	-	18.5	7.0	-	-	-	31.0	12.9
Clay	-	-	-	38.0	8.0	-	-	-	5.8
Sand	2.1	-	-	4.0	-	7.0	-	1.6	1.8
Detritus	2.0	-	-	-	-	-	9.0	2.7	1.7
Gravel	1.9	0.2	-	-	-	-	-	2.3	0.6
Cobble	-	0.5	2.0	-	-	-	-	-	0.3
Wood	2.3	-	-	-	-	-	-	0.1	0.3
Avg. depth (ft)	33.0	39.0	42.6	40.1	20.1	22.3	27.0	30.2	31.8
Actual depth range: 4.0 to 47.1 ft									

Substrate Type	% Substrate per transect downstream of SQN								
	1	2	3	4	5	6	7	8	Avg
Silt	41.5	37.3	42.0	32.0	82.0	81.0	81.5	78.0	59.4
Mollusk	53.0	47.2	46.0	55.0	16.0	14.6	18.5	19.0	33.7
Gravel	1.0	3.0	12.0	13.0	2.0	0.8	-	2.0	4.2
Bedrock	-	10.0	-	-	-	-	-	-	1.3
Cobble	4.5	2.5	-	-	-	-	-	-	0.9
Detritus	-	-	-	-	-	2.5	-	1.0	0.4
Wood	-	-	-	-	-	1.1	-	-	0.1
Avg. depth (ft)	25.9	27.9	32.5	29.4	23.1	25.0	25.8	20.9	26.3
Actual depth range: 2.9 to 67.5 ft									

STATE OF TENNESSEE
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
DIVISION OF WATER RESOURCES
Water-Based Systems
William R. Snodgrass - Tennessee Tower
312 Rosa L. Parks Avenue, 11th Floor
Nashville, TN 37243-1102

PERMIT CONTACT INFORMATION

Please complete all sections. If one person serves multiple functions, please repeat this information in each section.

PERMIT NUMBER: TN0026450 **DATE:** January 2024

PERMITTED FACILITY: Sequoyah Nuclear Plant (SQN) **COUNTY:** Hamilton

OFFICIAL PERMIT CONTACT:

(The permit signatory authority, e.g. responsible corporate officer, principle executive officer or ranking elected official)

Official Contact: Thomas B. Marshall	Title or Position: Vice President, SQN		
Mailing Address: Sequoyah Access Road, OPS 4A-SQN	City: Soddy Daisy	State: TN	Zip: 37379
Phone number(s): (423) 843-7001	E-mail: tbmarshall@tva.gov		

PERMIT BILLING ADDRESS (where invoices should be sent):

Billing Contact: Travis R. Markum	Title or Position: Environmental Scientist		
Mailing Address: Sequoyah Acess Road, OPS 5N-SQN	City: Soddy Daisy	State: TN	Zip: 37379
Phone number(s): (423) 843-6714	E-mail: trmarkum@tva.gov		

FACILITY LOCATION (actual location of permit site and local contact for site activity):

Facility Location Contact: Travis R. Markum	Title or Position: Environmental Scientist		
Facility Location (physical street address): Seqouyah Access Road	City: Soddy Daisy	State: TN	Zip: 37379
Phone number(s): (423) 843-6714	E-mail: trmarkum@tva.gov		
Alternate Contact (if desired): Beth A. Jenkins	Title or Position: Plant Manager		
Mailing Address: Sequoyah Acess Road, LP 4J-C	City: Soddy Daisy	State: TN	Zip: 37379
Phone number(s): (423) 843-6502	E-mail: bajenkins@tva.gov		

FACILITY REPORTING (Discharge Monitoring Report (DMR) or other reporting):

Cognizant Official authorized for permit reporting: Thomas B. Marshall	Title or Position: Vice President		
Mailing Address: Sequoyah Access Road, OPS 4A-SQN	City: Soddy Daisy	State: TN	Zip: 37379
Phone number(s): (423) 843-7001	E-mail: tbmarshall@tva.gov		
Fax number for reporting:	Does the facility have interest in starting electronic DMR reporting? Yes No Facility currently participates in electronic DMR reporting.		

To reiterate, in order to ensure that TVA's future Study Plan is adequate to demonstrate that the Gallatin Plant should get continuance of a Section 3 L6(a) variance during the term of its next NPDES permit, the EPA requests the opportunity to review a draft 316(a) plan prior to TVA commencing the study. Note that the above study elements are required for all facilities subject to a thermal variance. [f you have any questions, please contact Ms. Karrie-Jo Shell of my staff at (404) 562-9308.

d

Christopher B. Thomas, Chief
Pollution Control and Implementation Branch
Water Protection Division

cc: Ms. Linden P. Johnson
Manager, Water Permitting and Compliance
TVA - Environmental Affairs

e. "Indigenous" has been further clarified in the regulations: "Such a community may include historically non-native species introduced in connection with a program of wildlife management and species whose presence or abundance results from substantial, irreversible environmental modifications. Normally, however, such a community will not include species whose presence is attributable to the introduction of pollutants that will be eliminated by compliance by all sources with section 30l(b)(2) of the Act and may not include species whose presence or abundance is attributable to alternative effluent limitations imposed pursuant to section 316(a)." The EPA recognizes that non-indigenous species are present in most aquatic systems in the United States. All community data should be analyzed and presented to demonstrate that community assemblages in the heat-affected portions of the receiving water body are not significantly different from non-affected communities with regard to the number of non-indigenous species in the assemblages.

In addition to the foregoing components of the BIP definition, the Study Plan should also include provisions for the identification ofRIS (e.g., a list of threatened, endangered, thermally sensitive, or commercially or recreationally valuable species up- and downstream of the study area), as contemplated in 40 CFR § 125.72(b). 40 CFR § 125.71(b) defines RIS as "species which are representative, in terms of their biological needs, of a balanced, indigenous community of shellfish, fish and wildlife in the body of water into which a discharge of heat is made."

The following EPA comments should be specifically addressed in the study plan prior to TVA commencing sampling. The plan should:

i) include available information on wildlife in the receiving water body areas based on communications with the state's wildlife agency. See item a) above.

ii) include a diagram depicting the thermal plume under the worst case scenario and address the presence or absence of a zone of passage for which fish can travel around the thermal plume.

iii) provide information of which fish collected are either heat-sensitive or nuisance species. See item d) above.

iv) provide a list of any receiving water body species that are endangered or threaten **in** accordance with federal and state regulations.

v) select more appropriate sampling locations in order to avoid data that is difficult to interpret.

vi) analyze and present data to clearly demonstrate that affected communities have not shifted to primarily heat tolerant asst-mblages.

vii) analyze and present all data to demonstrate that community assemblages **in** the heat-affected portions of the receiving water body are not significantly different from non-affected communities with regard to the number of non-indigenous species in the assemblages.

viii) include recent data or information on benthic macroinvertebrates. See item a) above.

In keeping with the requirements of CWA Section 316, the plant needs to address the BIP's of the phyletic groups (amphibians, reptiles, birds, mammals) in the "wildlife" category. This group should be restricted to animals that are dependent on the receiving waters. For example, the blackbird population needs to be included but waterfowl or Kingfishers might be. Mammals that only drink from the receiving waters (i.e., whitetail deer) don't need to be included, but the beaver population might be. Once those BIPs are identified, the permittee should come up with a list of the wildlife species from all phyletic groups that may be affected by the temp changes in the receiving waters. The effects could be either direct or indirect depending on their dependence on the receiving water for habitat, food, etc. There may be several species of turtles present but some may be highly vulnerable and others not as much. The U.S. Fish and Wildlife Service and state wildlife agency can supply most, or all, of the information. Specifically, the plant should describe what effects the temperature changes might have on organisms that have habitats located near the point of discharge and depend on the receiving water body for survival. For example, amphibians can be affected directly in terms of survival and development of eggs and early life stages that are water dependent. Later, juvenile stages and adults could be affected by changes in prey items (food distribution) in the thermal affected area. All stages could be affected by increases in predation if warmer areas attract more predators. So for species for each group, the permittee needs to discuss the effects the thermal variance might have in regards to maintain a BIP of these organisms.

b. <u>"The capacity to sustain itself through cyclic seasonal changes"</u> means that any additional thermal stress will not cause significant community instability during times of natural extremes in environmental conditions. Community data should be collected during normal seasonal extremes as well as during optimal seasonal conditions. Data should be compared between heat affected and unaffected portions of the receiving water body to account for normal community changes corresponding with a change in season.

c. <u>"Presence of necessary food chain species"</u> means that the necessary food webs remain intact so that communities will be sustaining. We believe that exhaustive food web studies are not necessary provided that invertebrate, fish and wildlife communities are otherwise healthy, i.e., represented by sufficiently high species diversity and abundance (appropriate for that portion of the receiving water body) for the identified trophic levels and sustaining through normal seasonal changes.

d. <u>"Non-domination of pollution-tolerant species"</u> means that in the case of a thermal effluent, community assemblages in heat affected portions of the water body dominated by heat-tolerant species do not constitute a BIP. The EPA recognizes that because all species have varying levels of thermal tolerance, communities in the heat affected portions of the receiving water body may possess altered assemblages in terms of species present and abundance. All community data should be collected, analyzed and presented to clearly demonstrate that affected communities have not shifted to primarily heat tolerant assemblages.

by pollution tolerant species. Such a community may include historically non-native species introduced in connection with a program of wildlife management and species whose presence or abundance results from substantial, irreversible environmental modifications. Normally, however, such a community will not include species whose presence is attributable to the introduction of pollutants that will be eliminated by compliance by all sources with section 301(b)(2) of the Act: and may not include species whose presence or abundance is attributable to alternative effluent limitations imposed pursuant to section 316(a)."

The Environmental Appeals Board stated in its decision in In Re Dominion Energy Brayton Point, LLC, 12 Environmental Appeals Decision (E.A.D.) 490 (2006)("Brayton Point"), "this definition clearly envisions a consideration of more than the population of organisms currently inhabiting the water body. In this vein, although it permits inclusion of certain 'historically non-native species' that are currently present, it explicitly excludes certain currently present species whose presence or abundance is attributable to avoidable pollution or previously-granted section 316(a) variances."

Page 557 of the Brayton Point E.A.D. goes on to further state that a BIP "can be the indigenous population that existed prior to the impacts of pollutants, not solely the current populations of organisms."

To the question of how a permittee should identify a BIP in an area that has been altered by impacts from an existing thermal discharge, the Brayton Point E.A.D. points out that it may be appropriate to use a nearby water body unaffected by the existing thermal discharge as a reference area. Examination of an appropriate reference area may be applicable in this case.

The definition of"balanced, indigenous community" at 40 CFR § 125.71(c) contains several key elements. To be consistent with the regulations, each of these key elements should be specifically addressed in the demonstration, and the Study Plan should be designed to generate information relevant to these elements. Those elements include: (1) "a population typically characterized by diversity at all trophic levels;" (2) "the capacity to sustain itself through cyclic seasonal changes;" (3) "presence of necessary food chain species;" (4) "non-domination of pollution-tolerant species;" and (5) "indigenous." Each of these elements is discussed in more detail below:

a. "A population typically characterized by diversity at all trophic levels" means that all of the major trophic levels present in the unaffected portion of the water body should be present in the heat-affected portions. The EPA recognizes that community structure differences will occur, however, the number of species represented in each trophic level in the unaffected portions should be reasonably similar in the heat-affected portions of the water body. Sampling and analysis of fish and invertebrate communities should be done such that the major trophic levels are identified and represented by reasonably similar species distributions. Also, the study plan should be expanded to include some observations of wildlife (i.e., water fowl, mammals, amphibians, etc.) both upstream and immediately downstream of the discharge point that may be impacted by the thermal discharge.

1982 rule. These wastewaters discharge from CCR impoundments. Thus, BAT-based limits would currently need to be established through BPJ for discharges from CCR impoundments.

Based on our review of the fact sheet, it does not appear that the Tennessee Department of Environment and Conservation (TDEC) examined pollutants expected to be present in the discharge from the CCR impoundment (i.e., ash pond) to establish appropriate TBELs as required by CWA § 301(a)(l) and applicable federal regulations at 40 Code of Federal Regulations (CFR) § 125.3 (applicable to state NPDES permit programs per 40 CFR § 125.25). Therefore, TDEC should reconsider the guidance and tht: obligations under CWA § 301 in this pt:rmit reissuance by evaluating the costs for TVA to install, at a minimum, chemical precipitation or biological treatment for the ash pond discharge in order to reduce the etlluent discharge of metals. If the revised analysis still concludes that the existing pond is BAT, TDEC could establish TBELs that reflect the performance of the pond using reported t:ftluent characteristic data for metals contained in the facility's Discharge Monitoring Reports and/or recent permit application.

2. Section 316{a) Report and the Study Plan for the Subsequent Permit

The draft permit lacks detail and does not generate information sufficient to support a CWA Section 3l6(a) variance determination for the next permit cycle. The EPA's comments are submitted in order to ensure that the study plan to be developed during the next permit cycle will generate information sufficient to support a detennination of whether the TVA Gallatin Plant's thermal variance under Section 3 l6(a) of the CWA can be approved.

The EPA recognizes that, under 40 CFR § 125.73(c), existing sources seeking variance renewal are not typically required to conduct the same detailed, comprehensive studies required under§ l25.72(a) and (b). Also, under § I25.73, existing sources can base their demonstration on a lack of appreciable harm instead of completing predictive studies. However, under § 125.72(c), the type of detailed studies contemplated under§ 125.72(a) and (b) can be required whenever determined to be necessary. After examining the record of prior 3l6(a) variance determinations for the TVA Gallatin Plant, the EPA has concerns regarding the need for a more thorough examination and definition of the Balanced and Indigenous Population (BIP), the identification of Representative Important Species (RISs), and a closer examination of whether the variance is protective. Given the thinness of the available record to justify prior variance determinations, the EPA believes a more focused study is needed. The EPA acknowledges that TVA has in the past collected a substantial amount of data in support of its variance. TVA may use existing data in completing its study and may incorporate the existence of such data into the study plan design; however, the existing data needs to be evaluated and presented in the context of a BIP definition that the existing record does not adequately provide.

Section 316(a) of the CWA contains the term "BIP" but does not define it. However, 40 CFR § 125.71(c) defines the term "balanced, indigenous community"[1] as:

> "A biotic community typically characterized by diversity, the capacity to sustain itself through cyclic seasonal changes, presence of necessary food chain species and by a lack of domination

[1] "'Balanced, indigenous community" and BIP are equivalent terms.

Appendix F. Letter dated August 11, 2011 from Christopher B. Thomas, Chief, Pollution Control & Implementation Branch, Water Protection Branch, EPA Region 4 to Paul E. Davis, Director, Division of Water Pollution Control, TDEC, regarding EPA review and comments on the draft NPDES permit for TVA's Gallatin Fossil Plant (NPDES TN0005428)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 4
ATLANTA FEDERAL CENTER
61 FORSYTH STREET
ATLANTA, GEORGIA 30303-8960

AUG 1 1 2011

Mr. Paul E. Davis
Director, Division of Water Pollution Control
Tennessee Department of Environment
and Conservation
6th Floor, L & C Annex
401 Church Street
Nashville, Tennessee 37243-1534

Dear Mr. Davis:

On May 19, 2011, the Environmental Protection Agency received for renewal the draft National Pollutant Discharge Elimination System (NPDES) permit for the Tennessee Valley Authority (TVA) Gallatin Fossil Plant, NPDES permit number TN0005428, which expired on November 29, 2009, and is being administratively continued. In a letter to you dated June 14, 2011, we requested up to 90 days to review the proposed permit in accordance with Section IV.B.6.c. of the Tennessee/EPA Memorandum of Agreement. We have completed our review and offer the following comments:

1. Technology-Based Limits for the Ash Pond

The NPDES permit must include numeric technology-based effluent limits (TBELs) for the ash pond (outfall 001) as required by the Clean Water Act (CWA) and implementing regulations. The CWA Section 301(a)(1) requires that permits include limitations based on the application of statutorily prescribed levels of treatment ("technology-based effluent limitations"). Where the EPA has not promulgated technology-based effluent guidelines for a particular class or category of industrial discharger, or where the technology-based effluent guidelines do not address all waste streams or pollutants discharged by the industrial discharger, the permitting authority must establish TBELs on a case-by-case basis in individual NPDES permits, based on its best professional judgment or "BPJ."

In October 2009, the EPA completed a study of wastewater discharges from both Flue Gas Desulfurization (FGD) and Coal Combustion Residuals (CCR) impoundments (i.e., ash ponds). Findings indicate the need for revised effluent guidelines (EGL) for these wastestreams to due to the potential for metals to exist in relatively high concentrations. The Agency plans to promulgate a revised EGL in 2013. In order to address these discharges during the interim period, on June 7, 2010, the EPA issued guidance entitled "*National Pollutant Discharge Elimination System (NPDES) Permitting of Wastewater Discharges from Flue Gas Desulfurization (FGD) and Coal Combustion Residuals (CCR) Impoundments at Steam Electric Power Plants.*" The record for the 1982 ELG indicates that Best Available Technology (BAT) was not established for fly ash or bottom ash transporter water in the final

Table E-4 (continued)

Phylum (Subphylum) Class	Order	Family (Subfamily)	Scientific Name	Esimated Mean Density (per m²) Summer TRM 481.3 DS	Summer TRM 483.4 DS	Summer TRM 490.5 US	Autumn TRM 481.3 DS	Autumn TRM 483.4 DS	Autumn TRM 490.5 US	FFG	Invasive Species
	Odonata	Coenagrionidae	Coenagrionidae	–	–	–	–	2	–	Predator	–
	Trichoptera	Hydroptilidae	*Hydroptila* sp.	–	–	–	2	–	–	Piercer	–
		Leptoceridae	*Oecetis* sp.	20	23	8	12	12	8	Predator	–
		Polycentropodidae	*Cernotina* sp.	–	–	–	–	8	–	Predator	–
			Cyrnellus fraternus	2	58	–	5	52	–	Filterer	–
			Nyctiophylax sp.	–	–	2	–	–	–	Predator	–
	Coleoptera	Psephenidae	*Psephenus herricki*	2	–	–	–	–	–	Scraper	–
Mollusca											
Bivalvia	Unionoida	Unionidae	*Utterbackia imbecillis*	–	2	–	–	–	–	Filterer	–
	Veneroida	Corbiculidae	*Corbicula fluminea* <10mm	32	262	45	33	245	65	Filterer	X
			Corbicula fluminea >10mm	90	123	178	152	175	133	Filterer	X
		Dreissenidae	*Dreissena polymorpha*	–	–	–	–	13	–	Filterer	X
		Sphaeriidae	Sphaeriidae	–	2	–	15	17	147	Filterer	–
			Eupera cubensis	–	30	–	–	7	–	Filterer	–
			Musculium transversum	112	37	920	60	2	103	Filterer	–
			Pisidium sp.	–	10	7	3	–	2	Filterer	–
Gastropoda	Architaenioglossa	Viviparidae	*Callinina subpurpurea*	17	25	5	2	13	7	Scraper	–
			Campeloma decisum	2	3	–	–	–	–	Scraper	–
			Viviparus sp.	–	–	–	2	–	–	Scraper	–
	Basommatophora	Ancylidae	*Ferrissia rivularis*	–	–	–	–	2	–	Scraper	–
		Planorbidae	*Helisoma anceps*	–	–	–	–	2	–	Scraper	–
			Menetus dilatatus	–	2	–	–	–	–	Scraper	–
	Neotaenioglossa	Hydrobiidae	*Amnicola limosa*	2	3	–	–	–	–	Scraper	–
			Somatogyrus sp.	5	5	13	–	3	–	Scraper	–
		Pleuroceridae	*Elimia* sp.	2	–	–	–	–	–	Scraper	–
			Pleurocera sp.	–	2	–	–	–	–	Scraper	–
			Pleurocera canaliculata	12	48	–	7	32	–	Scraper	–
Number of Samples				**10**	**10**	**10**	**10**	**10**	**10**		
Mean Density / meter^2				**1057**	**3058**	**1848**	**1443**	**1337**	**1170**		
Taxa Richness				**37**	**49**	**27**	**32**	**46**	**23**		
Total area sampled (m^2)				**0.6**	**0.6**	**0.6**	**0.6**	**0.6**	**0.6**		

TRM - Tennessee River Mile
DS - Downstream; US - Upstream
FFG - Functional Feeding Groups

Table E-4 (continued)

Phylum (Subphylum) Class	Order	Family (Subfamily)	Scientific Name	Esimated Mean Density (per m^2)						FFG	Invasive Species
				Summer			Autumn				
				TRM 481.3 DS	TRM 483.4 DS	TRM 490.5 US	TRM 481.3 DS	TRM 483.4 DS	TRM 490.5 US		
Arthropoda (Hexapoda)	Diptera	Ceratopogonidae		–	–	–	3	–	–	Predator	–
Insecta		Chironomidae	*Ablabesmyia annulata*	17	10	27	20	5	7	Predator	–
			Ablabesmyia rhamphe gp.	7	28	–	–	25	–	Predator	–
			Axarus sp.	–	7	–	–	–	–	Gatherer	–
			Chironomus sp.	–	10	2	37	37	35	Gatherer	–
			Cladopelma sp.	–	2	–	–	–	–	Gatherer	–
			Cladotanytarsus sp.	–	2	–	–	–	–	Gatherer	–
			Coelotanypus sp.	223	113	275	462	60	390	Predator	–
			Conchapelopia sp.	–	–	–	2	–	–	Predator	–
			Corynoneura sp.	–	–	2	–	–	–	Gatherer	–
			Cricotopus sp.	–	–	–	3	2	–	Shredder	–
			Cryptochironomus sp.	–	13	7	25	13	2	Predator	–
			Dicrotendipes neomodestus	8	7	–	295	83	2	Gatherer	–
			Dicrotendipes simpsoni	–	22	2	–	22	–	Gatherer	–
			Dicrotendipes sp.	2	118	2	–	8	7	Gatherer	–
			Epoicocladius flavens	–	2	3	–	2	3	Gatherer	–
			Fissimentum sp.	3	–	–	3	–	–	Gatherer	–
			Glyptotendipes sp.	–	–	–	–	–	2	Shredder	–
			Microchironomus sp.	–	–	3	–	–	–	Gatherer	–
			Microtendipes pedellus gp.	2	–	–	5	17	5	Filterer	–
			Nanocladius sp.	2	2	–	–	–	–	Gatherer	–
			Nanocladius distinctus	–	3	–	–	3	–	Gatherer	–
			Parachironomus frequens	–	2	–	–	–	–	Predator	–
			Parachironomus sp.	12	18	–	–	–	–	Predator	–
			Polypedilum fallax gp.	–	2	–	–	–	–	Shredder	–
			Polypedilum flavum	–	–	2	2	–	–	Shredder	–
			Polypedilum halterale gp.	7	12	13	–	10	2	Shredder	–
			Polypedilum scalaenum gp.	2	–	–	–	–	–	Shredder	–
			Procladius sp.	12	12	55	8	17	22	Predator	–
			Pseudochironomus sp.	–	–	–	–	3	–	Gatherer	–
			Rheotanytarsus exiguus gp.	–	2	–	–	3	–	Filterer	–
			Stictochironomus caffrarius gp.	–	–	–	–	–	2	Gatherer	–
			Tanytarsus sp.	–	3	–	5	3	–	Filterer	–
	Ephemeroptera	Caenidae	*Caenis* sp.	2	8	–	5	–	2	Gatherer	–
		Ephemeridae	*Hexagenia* sp. <10mm	18	7	3	20	60	57	Gatherer	–
			Hexagenia sp. >10mm	17	22	10	13	7	7	Gatherer	–
		Leptohyphidae	*Tricorythodes* sp.	2	–	–	–	–	–	Gatherer	–

Table E-4. Ecological designations and mean densities per square meter of benthic macroinvertebrate taxa collected in samples downstream (TRMs 481.3 and 483.4) and upstream (TRM 490.5) of Sequoyah Nuclear Plant during summer and autumn 2022

Phylum (Subphylum) Class	Order	Family (Subfamily)	Scientific Name	Esimated Mean Density (per m^2) Summer TRM 481.3 DS	Summer TRM 483.4 DS	Summer TRM 490.5 US	Autumn TRM 481.3 DS	Autumn TRM 483.4 DS	Autumn TRM 490.5 US	FFG	Invasive Species
Nemertea				–	–	–	–	3	–	Predator	–
Platyhelminthes											
Trepaxonemata	Neoophora	Planariidae	*Girardia tigrina*	33	247	7	18	140	–	Predator	–
Annelida											
Hirudinea				18	–	–	5	–	–	Predator	–
	Arhynchobdellida	Erpobdellidae		–	3	–	–	2	–	Predator	–
	Rhynchobdellida	Glossiphoniidae	Glossiphoniidae	–	–	–	–	–	2	Predator	–
			Actinobdella inequiannulata	2	–	–	–	2	–	Predator	–
			Helobdella sp.	–	7	–	3	–	–	Predator	–
			Helobdella elongata	17	18	8	13	2	2	Predator	–
			Helobdella stagnalis	33	103	7	38	43	40	Predator	–
			Helobdella triserialis	2	15	–	–	–	–	Parasitic	–
			Placobdella montifera	2	–	2	–	2	–	Predator	–
Oligochaeta	Haplotaxida	Naididae									
		(Naidinae)		–	42	2	2	12	–	Gatherer	–
			Arcteonais lomondi	–	–	–	–	3	–	Gatherer	–
			Dero sp.	7	437	–	2	7	–	Gatherer	–
			Nais sp.	2	28	–	–	–	–	Gatherer	–
			Slavina appendiculata	–	8	–	–	2	–	Gatherer	–
			Stephensoniana sp.	–	83	–	–	–	–	Scraper	–
		(Pristininae)	*Pristina* sp.	2	32	–	–	2	–	Gatherer	–
		(Rhyacodrilinae)	*Branchiura sowerbyi*	–	27	2	2	2	–	Gatherer	X
		(Tubificinae whc)	immature Tubificinae whc	–	–	2	8	20	2	Gatherer	–
			Aulodrilus pigueti	23	18	–	–	–	–	Gatherer	–
		(Tubificinae whoc)	immature Tubificinae wohc	275	865	188	148	120	115	Gatherer	–
			Limnodrilus sp.	–	27	2	–	–	–	Gatherer	–
			Limnodrilus hoffmeisteri	12	27	47	–	–	–	Gatherer	–
	Enchytraeida	Enchytraeidae	Enchytraeidae	–	–	–	3	–	–	Gatherer	–
Arthropoda (Crustacea)	Isopoda	Asellidae	*Lirceus* sp.	–	2	–	–	–	–	Gatherer	–
Malacostraca	Amphipoda	Corophiidae	*Apocorophium lacustre*	–	–	–	–	2	–	Filterer	–
		Crangonyctidae	*Crangonyx* sp.	2	5	–	–	7	–	Gatherer	–
		Gammaridae	*Gammarus* sp.	–	5	–	–	5	–	Gatherer	–
		Hyalellidae	*Hyalella azteca*	–	–	–	–	–	3	Gatherer	–

Table E-3. Comparison of RBI metric ratings and total scores for laboratory-processed samples collected upstream and downstream of Sequoyah Nuclear Plant, Chickamauga Reservoir, summer and autumn 2022

	Summer						Autumn					
	Downstream TRM 481.3		Downstream TRM 483.4		Upstream TRM 490.5		Downstream TRM 481.3		Downstream TRM 483.4		Upstream TRM 490.5	
RBI Metrics	**Obs**	**Score**	**Obs**	**Score**	**Obs**	**Score**	**Obs**	**Score**	**Obs**	**Score**	**Obs**	**Score**
1. Average number of taxa	10.6	5	18.0	5	10.3	5	10.7	5	13.1	5	8.6	5
2. Proportion of samples with long-lived organisms	0.9	5	1.0	5	1.0	5	0.9	5	0.9	5	0.9	3
3. Average number of EPT taxa	1.3	5	1.9	5	1.2	3	1.2	5	1.2	5	1.4	3
4. Average proportion of oligochaete individuals	25.5	3	42.9	1	18.7	3	11.3	5	12.1	5	10.6	5
5. Average proportion of total abundance comprised by the two most abundant taxa	68.5	5	72.1	5	73.9	5	79.4	5	64.5	5	72.8	5
6. Average density excluding chironomids and oligochaetes	441.7	5	1076.7	5	1215.0	5	411.7	5	856.7	5	576.7	3
7. Zero-samples – proportion of samples containing no organisms	0	5	0	5	0	5	0	5	0	5	0	5
Benthic Index Score		**33**		**31**		**31**		**35**		**35**		**29**
Ecological Health Rating		**Excellent**		**Excellent**		**Excellent**		**Excellent**		**Excellent**		**Good**

Obs: Observed metric value

EPT: Ephemeroptera, Plecoptera, and Trichoptera

RBI: Reservoir Benthic Index

TRM: Tennessee River Mile

Ecological Health Ratings: 7-12 ("Very Poor"), 13-18 ("Poor"), 19-23 ("Fair"), 24-29 ("Good"), 30-35 ("Excellent")

Forebay criteria were used to score sites downstream of SQN, and transition criteria were used to score the site upstream of SQN

Table E-2. Species collected, ecological and recreational designation and corresponding electrofishing (EF) and gill net (GN) catch per unit effort downstream (TRM 482.0) of Sequoyah Nuclear Plant discharge – Summer 2022

Common Name	Scientific Name	Trophic Level	Native Species	Tolerance	Heat Sensitive Species	Comm. Valuable Species	Rec. Valuable Species	EF Catch Rate Per Run	EF Catch Rate Per Hour	EF Total Fish	GN Catch Rate Per Net Night	GN Total Fish	Total Fish Combined	Percent Composition
Spotted gar	Lepisosteus oculatus	TC	X	·	·	X	·	2.6	10	39	0.2	2	41	4.16
Longnose gar	Lepisosteus osseus	TC	X	TOL	·	X	·	·	·	·	0.1	1	1	0.10
Skipjack herring	Alosa chrysochloris	TC	X	INT	·	X	·	·	·	·	0.6	6	6	0.61
Gizzard shad	Dorosoma cepedianum	OM	X	TOL	·	X	·	1.2	4.62	18	6.1	61	79	8.01
Threadfin shad	Dorosoma petenense	PK	X	·	·	X	·	0.33	1.28	5	·	·	5	0.51
Common carp*	Cyprinus carpio	OM	·	TOL	·	X	·	0.87	3.33	13	0.2	2	15	1.52
Golden shiner	Notemigonus crysoleucas	OM	X	TOL	·	X	·	0.8	3.08	12	0.1	1	13	1.32
Spotfin shiner	Cyprinella spiloptera	IN	X	TOL	·	·	·	3.13	12.05	47	·	·	47	4.77
Bluntnose minnow	Pimephales notatus	OM	X	TOL	X	X	·	8.4	32.31	126	·	·	126	12.78
Smallmouth buffalo	Ictiobus bubalus	OM	X	·	·	X	·	0.07	0.26	1	0.1	1	2	0.20
Spotted sucker	Minytrema melanops	BI	X	INT	X	X	·	0.07	0.26	1	0.2	2	3	0.30
Blue catfish	Ictalurus furcatus	OM	X	·	·	X	X	·	·	·	0.7	7	7	0.71
Channel catfish	Ictalurus punctatus	OM	X	·	·	X	X	0.33	1.28	5	2.1	21	26	2.64
Flathead catfish	Pylodictis olivaris	TC	X	·	·	X	X	0.2	0.77	3	0.7	7	10	1.01
White bass	Morone chrysops	TC	X	·	·	·	X	·	·	·	0.3	3	3	0.30
Yellow bass	Morone mississippiensis	TC	X	·	·	·	X	0.07	0.26	1	1.1	11	12	1.22
Warmouth	Lepomis gulosus	IN	X	·	X	·	X	0.07	0.26	1	·	·	1	0.10
Redbreast sunfish*	Lepomis auritus	IN	·	TOL	·	·	X	1.27	4.87	19	·	·	19	1.93
Green sunfish	Lepomis cyanellus	IN	X	TOL	·	·	X	0.13	0.51	2	·	·	2	0.20
Bluegill	Lepomis macrochirus	IN	X	TOL	·	·	X	17.13	65.9	257	0.2	2	259	26.27
Redear sunfish	Lepomis microlophus	IN	X	·	·	·	X	3.27	12.56	49	0.5	5	54	5.48
Spotted bass	Micropterus punctulatus	TC	X	·	·	·	X	0.47	1.79	7	4.1	41	48	4.87
Largemouth bass	Micropterus salmoides	TC	X	TOL	·	·	X	1.8	6.92	27	·	·	27	2.74
White crappie	Pomoxis annularis	TC	X	TOL	X	·	X	·	·	·	0.1	1	1	0.10
Black crappie	Pomoxis nigromaculatus	TC	X	·	·	·	X	0.27	1.03	4	1.9	19	23	2.33
Snubnose darter	Etheostoma simoterum	SP	X	·	·	·	·	0.47	1.79	7	·	·	7	0.71
Yellow perch*	Perca flavescens	IN	·	·	·	·	X	0.4	1.54	6	·	·	6	0.61
Logperch	Percina caprodes	BI	X	·	X	·	·	2.73	10.51	41	·	·	41	4.16
Walleye	Stizostedion vitreum	TC	X	·	X	·	X	·	·	·	0.3	3	3	0.30
Freshwater drum	Aplodinotus grunniens	BI	X	·	·	X	·	·	·	·	0.4	4	4	0.41
Brook silverside	Labidesthes sicculus	IN	X	INT	·	X	·	0.13	0.51	2	·	·	2	0.20
Mississippi silverside*	Menidia audens	IN	·	·	·	X	·	6.2	23.85	93	·	·	93	9.43
Total			**28**		**6**	**16**	**16**	**52.41**	**201.54**	**786**	**20**	**200**	**986**	**100.00**
Number Samples								**15**			**10**			
Species Collected								**25**			**20**			

An asterisk (*) denotes aquatic nuisance species. Trophic level: benthic invertivore (BI), herbivore (HB), insectivore (IN), omnivore (OM), planktivore (PK), parasitic (PS), specialized insectivore (SP), top carnivore (TC); Tolerance: tolerant species (TOL), intolerant species (INT); Comm.-Commercially, Rec.-Recreationally.

All species are considered representative important species. No species collected have a Federal Threatened or Endangered status.

Table E-2. Species collected, ecological and recreational designation and corresponding electrofishing (EF) and gill net (GN) catch per unit effort upstream (TRM 490.5) of Sequoyah Nuclear Plant discharge – Summer 2022

Common Name	Scientific Name	Trophic Level	Native Species	Tolerance	Heat Sensitive Species	Comm. Valuable Species	Rec. Valuable Species	EF Catch Rate Per Run	EF Catch Rate Per Hour	EF Total Fish	GN Catch Rate Per Net Night	GN Total Fish	Total Fish Combined	Percent Composition
Spotted gar	Lepisosteus oculatus	TC	X	-	-	X	-	0.27	1.06	4	0.2	2	6	0.66
Skipjack herring	Alosa chrysochloris	TC	X	INT	-	X	-	-	-	-	0.7	7	7	0.77
Gizzard shad	Dorosoma cepedianum	OM	X	TOL	-	X	-	4.67	18.57	70	2.7	27	97	10.72
Threadfin shad	Dorosoma petenense	PK	X	-	-	X	-	0.07	0.27	1	-	-	1	0.11
Common carp*	Cyprinus carpio	OM	-	TOL	-	X	-	1	3.98	15	0.7	7	22	2.43
Golden shiner	Notemigonus crysoleucas	OM	X	TOL	-	X	-	1.07	4.24	16	-	-	16	1.77
Spotfin shiner	Cyprinella spiloptera	IN	X	TOL	-	-	-	0.4	1.59	6	-	-	6	0.66
Bluntnose minnow	Pimephales notatus	OM	X	TOL	X	X	-	4.8	19.1	72	-	-	72	7.96
Smallmouth buffalo	Ictiobus bubalus	OM	X	-	-	X	-	0.07	0.27	1	-	-	1	0.11
Spotted sucker	Minytrema melanops	BI	X	INT	X	X	-	0.4	1.59	6	0.1	1	7	0.77
Blue catfish	Ictalurus furcatus	OM	X	-	-	X	X	-	-	-	0.3	3	3	0.33
Channel catfish	Ictalurus punctatus	OM	X	-	-	X	X	0.13	0.53	2	0.6	6	8	0.88
Flathead catfish	Pylodictis olivaris	TC	X	-	-	X	X	0.4	1.59	6	0.4	4	10	1.10
White bass	Morone chrysops	TC	X	-	-	-	X	-	-	-	0.1	1	1	0.11
Yellow bass	Morone mississippiensis	TC	X	-	-	-	X	0.27	1.06	4	2.1	21	25	2.76
Warmouth	Lepomis gulosus	IN	X	-	X	-	X	0.13	0.53	2	-	-	2	0.22
Redbreast sunfish*	Lepomis auritus	IN	-	TOL	-	-	X	1.47	5.84	22	-	-	22	2.43
Green sunfish	Lepomis cyanellus	IN	X	TOL	-	-	X	0.13	0.53	2	-	-	2	0.22
Bluegill	Lepomis macrochirus	IN	X	TOL	-	-	X	17.53	69.76	263	0.7	7	270	29.83
Longear sunfish	Lepomis megalotis	IN	X	INT	-	-	X	0.6	2.39	9	-	-	9	0.99
Redear sunfish	Lepomis microlophus	IN	X	-	-	-	X	1.53	6.1	23	1.3	13	36	3.98
Smallmouth bass	Micropterus dolomieu	TC	X	INT	-	-	X	0.13	0.53	2	0.3	3	5	0.55
Spotted bass	Micropterus punctulatus	TC	X	-	-	-	X	0.73	2.92	11	1.4	14	25	2.76
Largemouth bass	Micropterus salmoides	TC	X	TOL	-	-	X	1.4	5.57	21	1.1	11	32	3.54
Hybrid bass	Hybrid micropterus sp.	TC	X	-	-	-	X	0.07	0.27	1	-	-	1	0.11
Black crappie	Pomoxis nigromaculatus	TC	X	-	-	-	X	-	-	-	0.8	8	8	0.88
Stripetail darter	Etheostoma kennicotti	SP	X	-	-	-	-	0.07	0.27	1	-	-	1	0.11
Snubnose darter	Etheostoma simoterum	SP	X	-	-	-	-	0.33	1.33	5	-	-	5	0.55
Yellow perch*	Perca flavescens	IN	-	-	-	-	X	0.8	3.18	12	-	-	12	1.33
Logperch	Percina caprodes	BI	X	-	X	-	-	9.33	37.14	140	-	-	140	15.47
Sauger	Stizostedion canadense	TC	X	-	X	-	X	-	-	-	0.1	1	1	0.11
Walleye	Stizostedion vitreum	TC	X	-	X	-	X	-	-	-	0.1	1	1	0.11
Freshwater drum	Aplodinotus grunniens	BI	X	-	-	X	-	0.07	0.27	1	0.2	2	3	0.33
Brook silverside	Labidesthes sicculus	IN	X	INT	-	X	-	0.13	0.53	2	-	-	2	0.22
Mississippi silverside*	Menidia audens	IN	-	-	-	X	-	3.07	12.2	46	-	-	46	5.08
Total			**31**		**6**	**15**	**19**	**51.07**	**203.21**	**766**	**13.9**	**139**	**905**	**100.00**
Number Samples								**15**			**10**			
Species Collected								**29**			**19**			

An asterisk (*) denotes aquatic nuisance species. Trophic level: benthic invertivore (BI), herbivore (HB), insectivore (IN), omnivore (OM), planktivore (PK), parasitic (PS), specialized insectivore (SP), top carnivore (TC); Tolerance: tolerant species (TOL), intolerant species (INT); Comm.-Commercially, Rec.-Recreationally.
All species are considered representative important species. No species collected have a Federal Threatened or Endangered status.

Table E-2. Species collected, ecological and recreational designation and corresponding electrofishing (EF) and gill net (GN) catch per unit effort downstream (TRM 482.0) of Sequoyah Nuclear Plant discharge – Autumn 2022

Common Name	Scientific Name	Trophic Level	Native Species	Tolerance	Heat Sensitive Species	Comm. Valuable Species	Rec. Valuable Species	EF Catch Rate Per Run	EF Catch Rate Per Hour	EF Total Fish	GN Catch Rate Per Net Night	GN Total Fish	Total Fish Combined	Percent Composition
Spotted gar	Lepisosteus oculatus	TC	X	·	·	X	·	0.8	2.78	12	·	·	12	0.42
Skipjack herring	Alosa chrysochloris	TC	X	INT	·	X	·	0.07	0.23	1	0.5	5	6	0.21
Gizzard shad	Dorosoma cepedianum	OM	X	TOL	·	X	·	6.47	22.45	97	0.7	7	104	3.64
Threadfin shad	Dorosoma petenense	PK	X	·	·	X	·	1.2	4.17	18	·	·	18	0.63
Common carp*	Cyprinus carpio	OM	·	TOL	·	X	·	2.47	8.56	37	0.4	4	41	1.44
Golden shiner	Notemigonus crysoleucas	OM	X	TOL	·	X	·	0.87	3.01	13	·	·	13	0.46
Bluntnose minnow	Pimephales notatus	OM	X	TOL	X	X	·	8.4	29.17	126	·	·	126	4.41
Northern hog sucker	Hypentelium nigricans	BI	X	INT	X	·	·	0.13	0.46	2	·	·	2	0.07
Smallmouth buffalo	Ictiobus bubalus	OM	X	·	·	X	·	·	·	·	0.1	1	1	0.04
Spotted sucker	Minytrema melanops	BI	X	INT	X	X	·	0.4	1.39	6	0.2	2	8	0.28
Blue catfish	Ictalurus furcatus	OM	X	·	·	X	X	0.07	0.23	1	1.1	11	12	0.42
Channel catfish	Ictalurus punctatus	OM	X	·	·	X	X	0.8	2.78	12	0.5	5	17	0.60
Flathead catfish	Pylodictis olivaris	TC	X	·	·	X	X	0.07	0.23	1	0.5	5	6	0.21
White bass	Morone chrysops	TC	X	·	·	·	X	0.2	0.69	3	0.1	1	4	0.14
Yellow bass	Morone mississippiensis	TC	X	·	·	·	X	0.47	1.62	7	0.7	7	14	0.49
Rock bass	Ambloplites rupestris	TC	X	INT	·	·	X	0.07	0.23	1	·	·	1	0.04
Warmouth	Lepomis gulosus	IN	X	·	X	·	X	2.13	7.41	32	0.1	1	33	1.16
Redbreast sunfish*	Lepomis auritus	IN	.	TOL	·	·	X	3.93	13.66	59	·	·	59	2.07
Green sunfish	Lepomis cyanellus	IN	X	TOL	·	·	X	0.4	1.39	6	·	·	6	0.21
Bluegill	Lepomis macrochirus	IN	X	TOL	·	·	X	130.27	452.31	1954	0.1	1	1955	68.50
Longear sunfish	Lepomis megalotis	IN	X	INT	·	·	X	0.33	1.16	5	·	·	5	0.18
Redear sunfish	Lepomis microlophus	IN	X	·	·	·	X	5.73	19.91	86	0.3	3	89	3.12
Spotted bass	Micropterus punctulatus	TC	X	·	·	·	X	1.93	6.71	29	2.1	21	50	1.75
Largemouth bass	Micropterus salmoides	TC	X	TOL	·	·	X	5.93	20.6	89	·	·	89	3.12
Black crappie	Pomoxis nigromaculatus	TC	X	·	·	·	X	1.47	5.09	22	0.6	6	28	0.98
Stripetail darter	Etheostoma kennicotti	SP	X	·	·	·	·	0.13	0.46	2	·	·	2	0.07
Snubnose darter	Etheostoma simoterum	SP	X	·	·	·	·	2.53	8.8	38	·	·	38	1.33
Yellow perch*	Perca flavescens	IN	.	·	·	·	X	2.07	7.18	31	·	·	31	1.09
Logperch	Percina caprodes	BI	X	·	X	·	·	0.07	0.23	1	·	·	1	0.04
Walleye	Stizostedion vitreum	TC	X	·	X	·	X	·	·	·	1.5	15	15	0.53
Freshwater drum	Aplodinotus grunniens	BI	X	·	·	X	·	0.07	0.23	1	0.2	2	3	0.11
Brook silverside	Labidesthes sicculus	IN	X	INT	·	X	·	1.2	4.17	18	·	·	18	0.63
Mississippi silverside*	Menidia audens	IN	.	.	·	X	·	3.13	10.88	47	·	·	47	1.65
Total			**29**		**6**	**15**	**17**	**183.81**	**638.19**	**2,757**	**9.7**	**97**	**2,854**	**100.00**
Number Samples								**15**			**10**			
Species Collected								**31**			**17**			

An asterisk (*) denotes aquatic nuisance species. Trophic level: benthic invertivore (BI), herbivore (HB), insectivore (IN), omnivore (OM), planktivore (PK), parasitic (PS), specialized insectivore (SP), top carnivore (TC); Tolerance: tolerant species (TOL), intolerant species (INT); Comm.-Commercially, Rec.-Recreationally.

All species are considered representative important species. No species collected have a Federal Threatened or Endangered status.

Table E-2. Species collected, ecological and recreational designation and corresponding electrofishing (EF) and gill net (GN) catch per unit effort upstream (TRM 490.5) of Sequoyah Nuclear Plant discharge – Autumn 2022

Common Name	Scientific Name	Trophic Level	Native Species	Tolerance	Heat Sensitive Species	Comm. Valuable Species	Rec. Valuable Species	EF Catch Rate Per Run	EF Catch Rate Per Hour	EF Total Fish	GN Catch Rate Per Net Night	GN Total Fish	Total Fish Combined	Percent Composition
Spotted gar	Lepisosteus oculatus	TC	X	·	·	X	·	0.07	0.21	1	·	·	1	0.03
Skipjack herring	Alosa chrysochloris	TC	X	INT	·	X	·	·	·	·	1.5	15	15	0.52
Gizzard shad	Dorosoma cepedianum	OM	X	TOL	·	X	·	2.27	7.28	34	0.3	3	37	1.28
Largescale stoneroller	Campostoma oligolepis	HB	X	·	·	·	·	0.07	0.21	1	·	·	1	0.03
Common carp*	Cyprinus carpio	OM	·	TOL	·	X	·	0.27	0.86	4	·	·	4	0.14
Golden shiner	Notemigonus crysoleucas	OM	X	TOL	·	X	·	0.13	0.43	2	·	·	2	0.07
Spotfin shiner	Cyprinella spiloptera	IN	X	TOL	·	·	·	0.07	0.21	1	·	·	1	0.03
Bluntnose minnow	Pimephales notatus	OM	X	TOL	X	X	·	22.13	71.09	332	·	·	332	11.47
Northern hog sucker	Hypentelium nigricans	BI	X	INT	X	·	·	0.07	0.21	1	·	·	1	0.03
Spotted sucker	Minytrema melanops	BI	X	INT	X	X	·	2.33	7.49	35	0.5	5	40	1.38
Smallmouth redhorse	Moxostoma breviceps	BI	X	·	·	X	·	0.07	0.21	1	·	·	1	0.03
Golden redhorse	Moxostoma erythrurum	BI	X	·	·	X	·	0.07	0.21	1	0.1	1	2	0.07
Blue catfish	Ictalurus furcatus	OM	X	·	·	X	X	0.07	0.21	1	0.3	3	4	0.14
Channel catfish	Ictalurus punctatus	OM	X	·	·	X	X	0.07	0.21	1	0.7	7	8	0.28
Flathead catfish	Pylodictis olivaris	TC	X	·	·	X	X	0.07	0.21	1	0.4	4	5	0.17
White bass	Morone chrysops	TC	X	·	·	·	X	·	·	·	0.4	4	4	0.14
Yellow bass	Morone mississippiensis	TC	X	·	·	·	X	·	·	·	4	40	40	1.38
Rock bass	Ambloplites rupestris	TC	X	INT	·	·	X	0.07	0.21	1	·	·	1	0.03
Warmouth	Lepomis gulosus	IN	X	·	X	·	X	5	16.06	75	·	·	75	2.59
Redbreast sunfish*	Lepomis auritus	IN	.	TOL	·	·	X	4.67	14.99	70	·	·	70	2.42
Green sunfish	Lepomis cyanellus	IN	X	TOL	·	·	X	0.27	0.86	4	·	·	4	0.14
Bluegill	Lepomis macrochirus	IN	X	TOL	·	·	X	121.87	391.43	1828	0.1	1	1829	63.18
Longear sunfish	Lepomis megalotis	IN	X	INT	·	·	X	1.07	3.43	16	·	·	16	0.55
Redear sunfish	Lepomis microlophus	IN	X	·	·	·	X	3.07	9.85	46	1	10	56	1.93
Smallmouth bass	Micropterus dolomieu	TC	X	INT	·	·	X	0.8	2.57	12	0.1	1	13	0.45
Spotted bass	Micropterus punctulatus	TC	X	·	·	·	X	2.2	7.07	33	3.1	31	64	2.21
Largemouth bass	Micropterus salmoides	TC	X	TOL	·	·	X	4.93	15.85	74	0.5	5	79	2.73
Black crappie	Pomoxis nigromaculatus	TC	X	·	·	·	X	0.4	1.28	6	0.7	7	13	0.45
Snubnose darter	Etheostoma simoterum	SP	X	·	·	·	·	2.73	8.78	41	·	·	41	1.42
Yellow perch*	Perca flavescens	IN	·	·	·	·	X	3	9.64	45	0.1	1	46	1.59
Logperch	Percina caprodes	BI	X	·	X	·	·	1.33	4.28	20	·	·	20	0.69
Sauger	Stizostedion canadense	TC	X	·	X	·	X	·	·	·	0.2	2	2	0.07
Walleye	Stizostedion vitreum	TC	X	·	X	·	X	·	·	·	1.6	16	16	0.55
Brook silverside	Labidesthes sicculus	IN	X	INT	·	X	·	0.07	0.21	1	·	·	1	0.03
Mississippi silverside*	Menidia audens	IN	·	·	·	X	·	3.4	10.92	51	·	·	51	1.76
Total			**31**		**7**	**14**	**19**	**182.64**	**586.47**	**2,739**	**15.6**	**156**	**2,895**	**100.00**
Number Samples								**15**			**10**			
Species Collected								**30**			**18**			

An asterisk (*) denotes aquatic nuisance species. Trophic level: benthic invertivore (BI), herbivore (HB), insectivore (IN), omnivore (OM), planktivore (PK), parasitic (PS), specialized insectivore (SP), top carnivore (TC); Tolerance: tolerant species (TOL), intolerant species (INT); Comm.-Commercially, Rec.-Recreationally.

All species are considered representative important species. No species collected have a Federal Threatened or Endangered status.

Table E-1 Continued.

Autumn 2022		TRM 482			TRM 490.5		
Metric		Obs		Score	Obs		Score
10. Percent omnivores	Electrofishing	**10.40%**		**2.5**	**13.70%**		**2.5**
		Blue catfish	<0.1%		Blue catfish	<0.10%	
		Bluntnose minnow	4.60%		Bluntnose minnow	12.10%	
		Channel catfish	0.40%		Channel catfish	<0.10%	
		Common carp	1.30%		Common carp	0.10%	
		Gizzard shad	3.50%		Gizzard shad	1.20%	
		Golden shiner	0.50%		Golden shiner	0.10%	
	Gill Netting	**28.90%**		**1.5**	**8.30%**		**2.5**
		Blue catfish	11.30%		Blue catfish	1.9	
		Channel catfish	5.20%		Channel catfish	4.5	
		Common carp	4.10%		Gizzard shad	1.9	
		Gizzard shad	7.20%				
		Smallmouth buffalo	1.00%				
		Blue catfish	11.30%				
C. Fish abundance and health							
11. Average number per run	Electrofishing	**183.80**		**1.5**	**182.60**		**1.5**
	Gill Netting	**9.70**		**0.5**	**15.60**		**1.5**
12. Percent anomalies	Electrofishing	**1.00**		**2.5**	**0.70**		**2.5**
	Gill Netting	**1.00**		**2.5**	**1.90**		**2.5**
Overall RFAI Score				**46 Good**			**47 Good**

Table E-1 Continued.

Autumn 2022 Metric		TRM 482 Obs		Score	TRM 490.5 Obs		Score
8. Number of top carnivore species	Combined	**10**		**5**	**12**		**5**
		Black crappie			Black crappie		
		Flathead catfish			Flathead catfish		
		Largemouth bass			Largemouth bass		
		Rock bass			Rock bass		
		Skipjack herring			Sauger		
		Spotted bass			Skipjack herring		
		Spotted gar			Smallmouth bass		
		Walleye			Spotted bass		
		White bass			Spotted gar		
		Yellow bass			Walleye		
					White bass		
					Yellow bass		
B. Trophic composition							
9. Percent top carnivores	Electrofishing	**6.00%**		**1.5**	**4.70%**		**0.5**
		Black crappie	0.80%		Black crappie	0.20	
		Flathead catfish	<0.01%		Flathead catfish	<0.01	
		Largemouth bass	3.20%		Largemouth bass	2.70	
		Rock bass	<0.01%		Rock bass	0.01	
		Skipjack herring	<0.01%		Smallmouth bass	0.40	
		Spotted bass	1.10%		Spotted bass	1.20	
		Spotted gar	0.40%		Spotted gar	<0.01	
		White bass	0.10%				
		Yellow bass	0.30%				
	Gill Netting	**61.90%**		**2.5**	**80.10%**		**2.5**
		Black crappie	6.20%		Black crappie	4.50%	
		Flathead catfish	5.20%		Flathead catfish	2.60%	
		Skipjack herring	5.20%		Largemouth bass	3.20%	
		Spotted bass	21.60%		Sauger	1.30%	
		Walleye	15.50%		Skipjack herring	9.60%	
		White bass	1.00%		Smallmouth bass	0.60%	
		Yellow bass	7.20%		Spotted bass	19.90%	
					Walleye	10.30%	
					White bass	2.60%	
					Yellow bass	25.60%	

Table E-1 Continued.

Autumn 2022		TRM 482			TRM 490.5		
Metric		Obs		Score	Obs		Score
5. Percent tolerant individuals	Electrofishing	**86.40%**		**0.5**	**85.80%**		**0.5**
		Bluegill	70.90%		Bluegill	66.70%	
		Bluntnose minnow	4.60%		Bluntnose minnow	12.10%	
		Common carp	1.30%		Common carp	0.10%	
		Gizzard shad	3.50%		Gizzard shad	1.20%	
		Golden shiner	0.50%		Golden shiner	0.10%	
		Green sunfish	0.20%		Green sunfish	0.10%	
		Largemouth bass	3.20%		Largemouth bass	2.70%	
		Redbreast sunfish	2.10%		Redbreast sunfish	2.60%	
					Spotfin shiner	<0.01%	
	Gill Netting	**12.40%**		**2.5**	**5.80%**		**2.5**
		Bluegill	1.00%		Bluegill	0.60%	
		Common carp	4.10%		Gizzard shad	1.90%	
		Gizzard shad	7.20%		Largemouth bass	3.20%	
6. Percent dominance by one species	Electrofishing	**70.90%**		**0.5**	**66.70%**		**0.5**
		Bluegill			Bluegill		
	Gill Netting	**21.60%**		**1.5**	**25.60%**		**1.5**
		Spotted bass			Yellow bass		
7. Percent non-indigenous species	Electrofishing	**6.30%**		**0.5**	**6.20%**		**0.5**
		Common carp	1.30%		Common carp	0.10%	
		Mississippi silverside	1.70%		Mississippi silverside	1.90%	
		Redbreast sunfish	2.10%		Redbreast sunfish	2.60%	
		Yellow perch	1.10%		Yellow perch	1.60%	
	Gill Netting	**4.10%**		**2.5**	**0.60%**		**2.5**
		Common carp			Yellow perch		

Table E-1 Continued.

Autumn 2022		TRM 482		TRM 490.5	
Metric		Obs	Score	Obs	Score
A. Species richness and composition					
1. Number of indigenous species (Tables 12 and 13)	Combined	**29**	**5**	**31**	**5**
2. Number of centrarchid species (less *Micropterus*)	Combined	**6** Black crappie Bluegill Green sunfish Longear sunfish Redear sunfish Warmouth	**5**	**6** Black crappie Bluegill Green sunfish Longear sunfish Redear sunfish Warmouth	**5**
3. Number of benthic invertivore species	Combined	**4** Freshwater drum Logperch Northern hog sucker Spotted sucker	**3**	**5** Golden redhorse Logperch Northern hog sucker Smallmouth redhorse Spotted sucker	**3**
4. Number of intolerant species	Combined	**6** Brook silverside Longear sunfish Northern hog sucker Rock bass Skipjack herring Spotted sucker	**5**	**7** Brook silverside Longear sunfish Northern hog sucker Rock bass Skipjack herring Smallmouth bass Spotted sucker	**5**

Table E-1 Continued.

Summer 2022 Metric		TRM 482 Obs		Score	TRM 490.5 Obs		Score
10. Percent omnivores	Electrofishing	**22.30%**		**2.5**	**23.00%**		**1.5**
		Bluntnose minnow	16.00%		Bluntnose minnow	9.40%	
		Channel catfish	0.60%		Channel catfish	0.30%	
		Common carp	1.70%		Common carp	2.00%	
		Gizzard shad	2.30%		Gizzard shad	9.10%	
		Golden shiner	1.50%		Golden shiner	2.10%	
		Smallmouth buffalo	0.10%		Smallmouth buffalo	0.10%	
	Gill Netting	**46.50%**		**0.5**	**30.90%**		**1.5**
		Blue catfish	3.50%		Blue catfish	2.20%	
		Channel catfish	10.50%		Channel catfish	4.30%	
		Common carp	1.00%		Common carp	5.00%	
		Gizzard shad	30.50%		Gizzard shad	19.40%	
		Golden shiner	0.50%				
		Smallmouth buffalo	0.50%				
C. Fish abundance and health							
11. Average number per run	Electrofishing	**52.40**		**0.5**	**51.10**		**0.5**
	Gill Netting	**20**		**1.5**	**13.90**		**1.5**
12. Percent anomalies	Electrofishing	**0.80%**		**2.5**	**1.20%**		**2.5**
	Gill Netting	**1.50%**		**2.5**	**0%**		**2.5**
Overall RFAI Score				**39 Fair**			**41 Good**

Table E-1. (Continued)

Summer 2022 Metric		TRM 482 Obs		Score	TRM 490.5 Obs		Score
8. Number of top carnivore species	Combined	**11**		**5**	**11**		**5**
		Black crappie			Black crappie		
		Flathead catfish			Flathead catfish		
		Largemouth bass			Largemouth bass		
		Longnose gar			Sauger		
		Skipjack herring			Skipjack herring		
		Spotted bass			Smallmouth bass		
		Spotted gar			Spotted bass		
		Walleye			Spotted gar		
		White bass			Walleye		
		White crappie			White bass		
		Yellow bass			Yellow bass		
B. Trophic composition							
9. Percent top carnivores	Electrofishing	**10.30%**		**2.5**	**6.40%**		**1.5**
		Black crappie	0.50%		Flathead catfish	0.80%	
		Flathead catfish	0.40%		Hybrid bass	0.10%	
		Largemouth bass	3.40%		Largemouth bass	2.70%	
		Spotted bass	0.90%		Smallmouth bass	0.30%	
		Spotted gar	5.00%		Spotted bass	1.40%	
		Yellow bass	0.10%		Spotted gar	0.50%	
					Yellow bass	0.50%	
	Gill Netting	**47.00%**		**1.5**	**52.50%**		**2.5**
		Black crappie	9.50%		Black crappie	5.80%	
		Flathead catfish	3.50%		Flathead catfish	2.90%	
		Longnose gar	0.50%		Largemouth bass	7.90%	
		Skipjack herring	3.00%		Sauger	0.70%	
		Spotted bass	20.50%		Skipjack herring	5.00%	
		Spotted gar	1.00%		Smallmouth bass	2.20%	
		Walleye	1.50%		Spotted bass	10.10%	
		White bass	1.50%		Spotted gar	1.40%	
		White crappie	0.50%		Walleye	0.70%	
		Yellow bass	5.50%		White bass	0.70%	
					Yellow bass	15.10%	

Table E-1 Continued.

Summer 2022 Metric		TRM 482 Obs		Score	TRM 490.5 Obs		Score
5. Percent tolerant individuals	Electrofishing	**66.30%**			**63.60%**		
		Bluegill	32.70%		Bluegill	34.30%	
		Bluntnose minnow	16.00%		Bluntnose minnow	9.40%	
		Common carp	1.70%		Common carp	2.00%	
		Gizzard shad	2.30%	**0.5**	Gizzard shad	9.10%	**0.5**
		Golden shiner	1.50%		Golden shiner	2.10%	
		Green sunfish	0.30%		Green sunfish	0.30%	
		Largemouth bass	3.40%		Largemouth bass	2.70%	
		Redbreast sunfish	2.40%		Redbreast sunfish	2.90%	
					Spotfin shiner	0.80%	
	Gill Netting	**34.00%**			**37.40%**		
		Bluegill	1.00%		Bluegill	5.00%	
		Common carp	1.00%		Common carp	5.00%	
		Gizzard shad	30.50%	**0.5**	Gizzard shad	19.40%	**0.5**
		Golden shiner	0.50%		Largemouth bass	7.90%	
		Longnose gar	0.50%				
		White crappie	0.50%				
6. Percent dominance by one species	Electrofishing	**32.70%**		**1.5**	**34.30%**		**1.5**
		Bluegill			Bluegill		
				0.5			
	Gill Netting	**30.50%**		**0.5**	**19.40%**		**1.5**
		Gizzard shad			Gizzard shad		
7. Percent non-indigenous species	Electrofishing	**16.70%**			**12.40%**		
		Common carp	1.70%		Common carp	2.00%	
		Mississippi silverside	11.80%	**0.5**	Mississippi silverside	6.00%	**0.5**
		Redbreast sunfish	2.40%		Redbreast sunfish	2.90%	
		Yellow perch	0.80%		Yellow perch	1.60%	
	Gill Netting	**1.00%**		5	**5.00%**		**1.5**
		Common carp			Common carp		

Table E-1. Observed values (Obs) and metric scores and total Reservoir Fish Assemblage Index scores upstream (TRM 490.5) and downstream (TRM 482) of Sequoyah Nuclear plant for samples collected during summer and autumn 2022

Summer 2022		TRM 482		TRM 490.5	
Metric		Obs	Score	Obs	Score
A. Species richness and composition					
1. Number of indigenous species (Tables 12 and 13)	Combined	**28**	**5**	**30**	**5**
2. Number of centrarchid species (less *Micropterus*)	Combined	**6** Black crappie Bluegill Green sunfish Redear sunfish Warmouth White crappie	**5**	**5** Black crappie Bluegill Green sunfish Longear sunfish Redear sunfish Warmouth	**5**
3. Number of benthic invertivore species	Combined	**3** Freshwater drum Logperch Spotted sucker	**1**	**3** Freshwater drum Logperch Spotted sucker	**1**
4. Number of intolerant species	Combined	**3** Brook silverside Skipjack herring Spotted sucker	**3**	**5** Brook silverside Longear sunfish Skipjack herring Smallmouth bass Spotted sucker	**5**

Figure E-2. Relative abundance of bluegill collected at sites upstream and downstream of SQN during 2000 through 2022

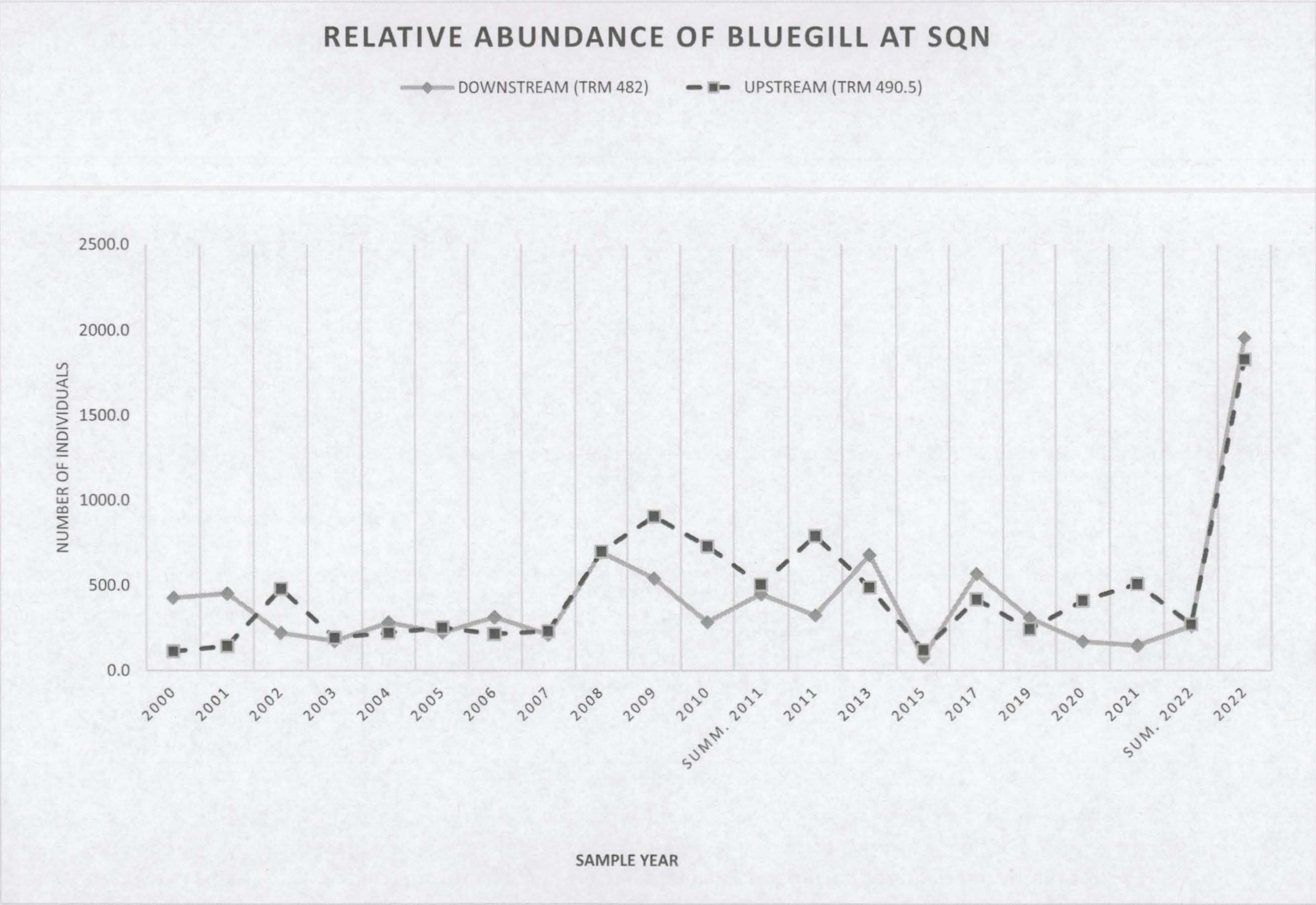
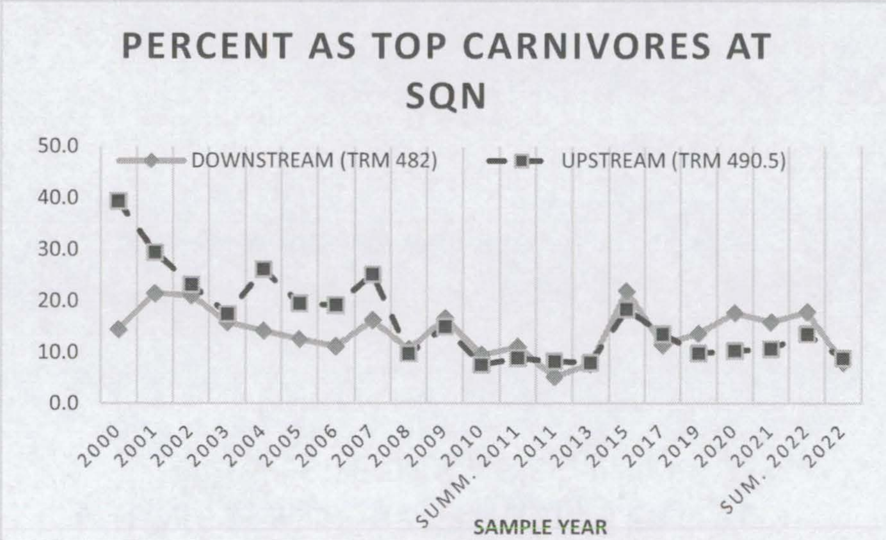
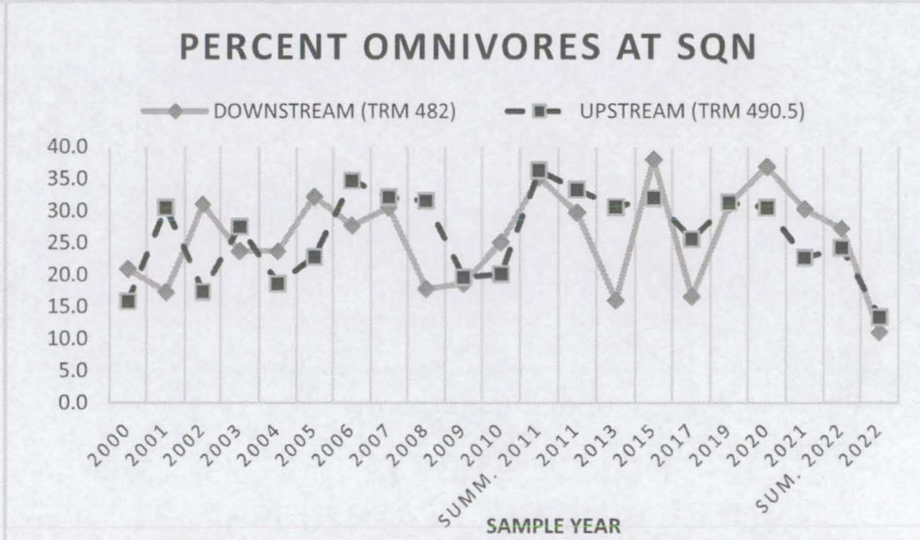
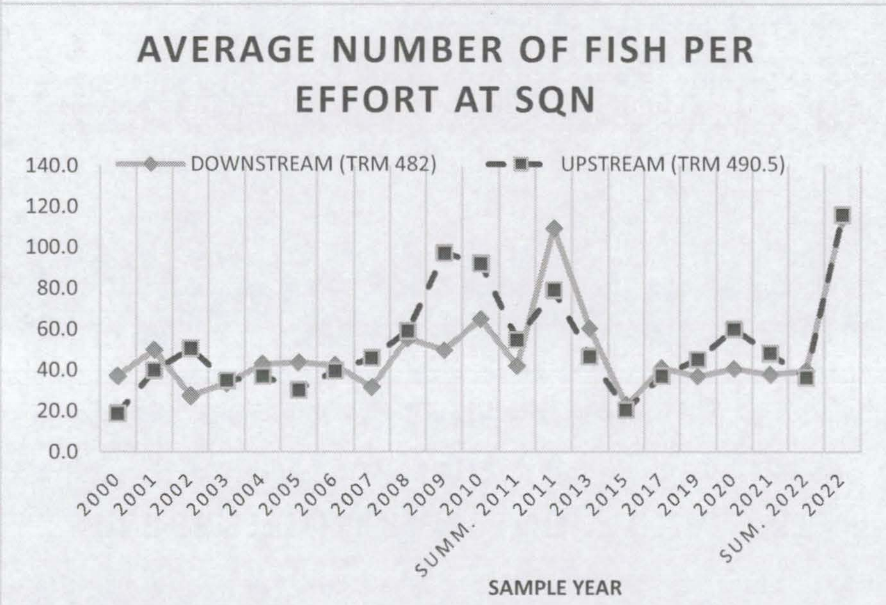


Figure E-1 (continued). Observed values for the twelve RFAI metrics from samples conducted upstream and downstream of SQN, 2000-2022







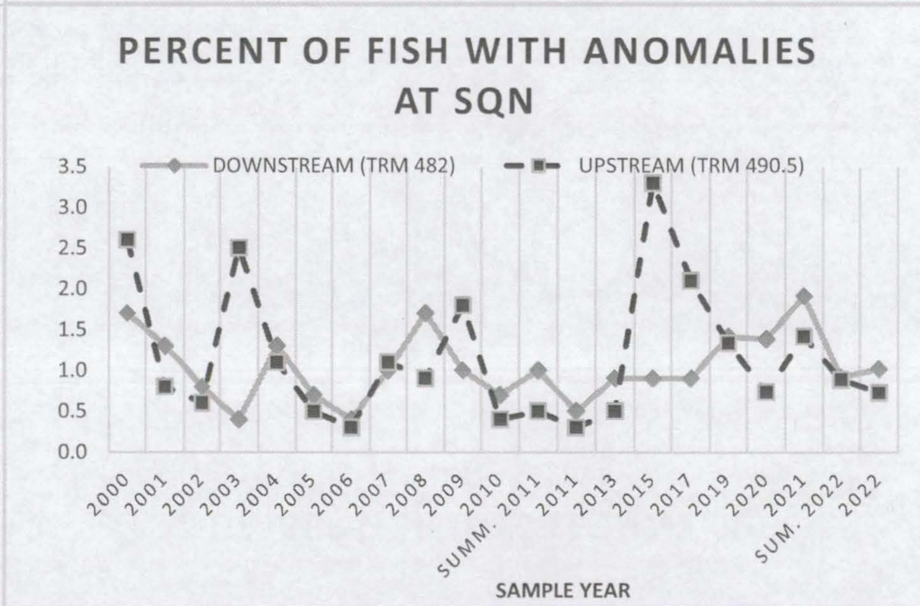
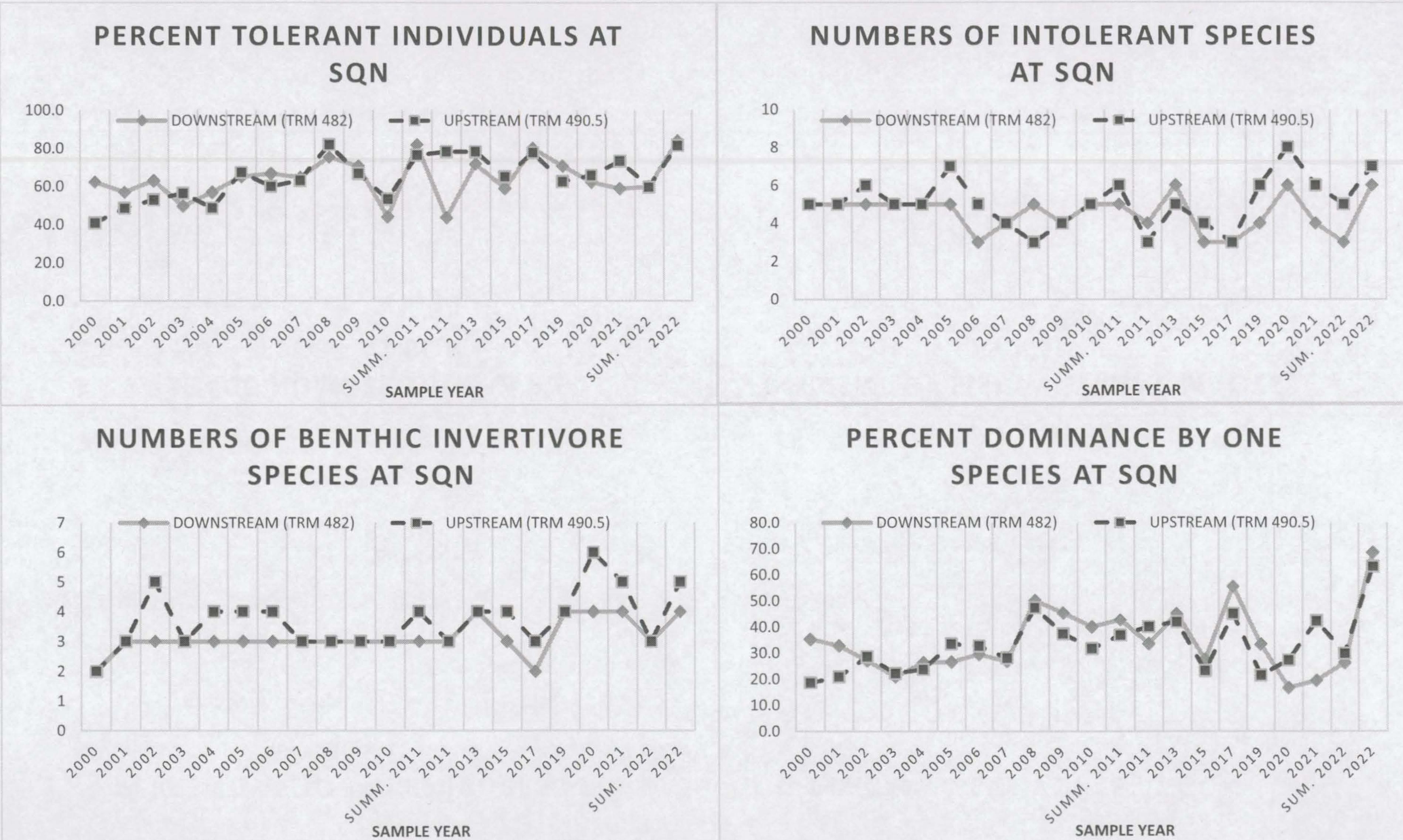


Figure E-1. Observed values for the twelve RFAI metrics from samples conducted upstream and downstream of SQN, 2000-2022



Appendix E. Results from fish community monitoring upstream (TRM 490.5) and downstream (TRM 482.0) of Sequoyah Nuclear Plant during 2000-2021, and summer and autumn 2022.

Figure E-1. Observed values for the twelve RFAI metrics from samples conducted upstream and downstream of SQN, 2000-2022

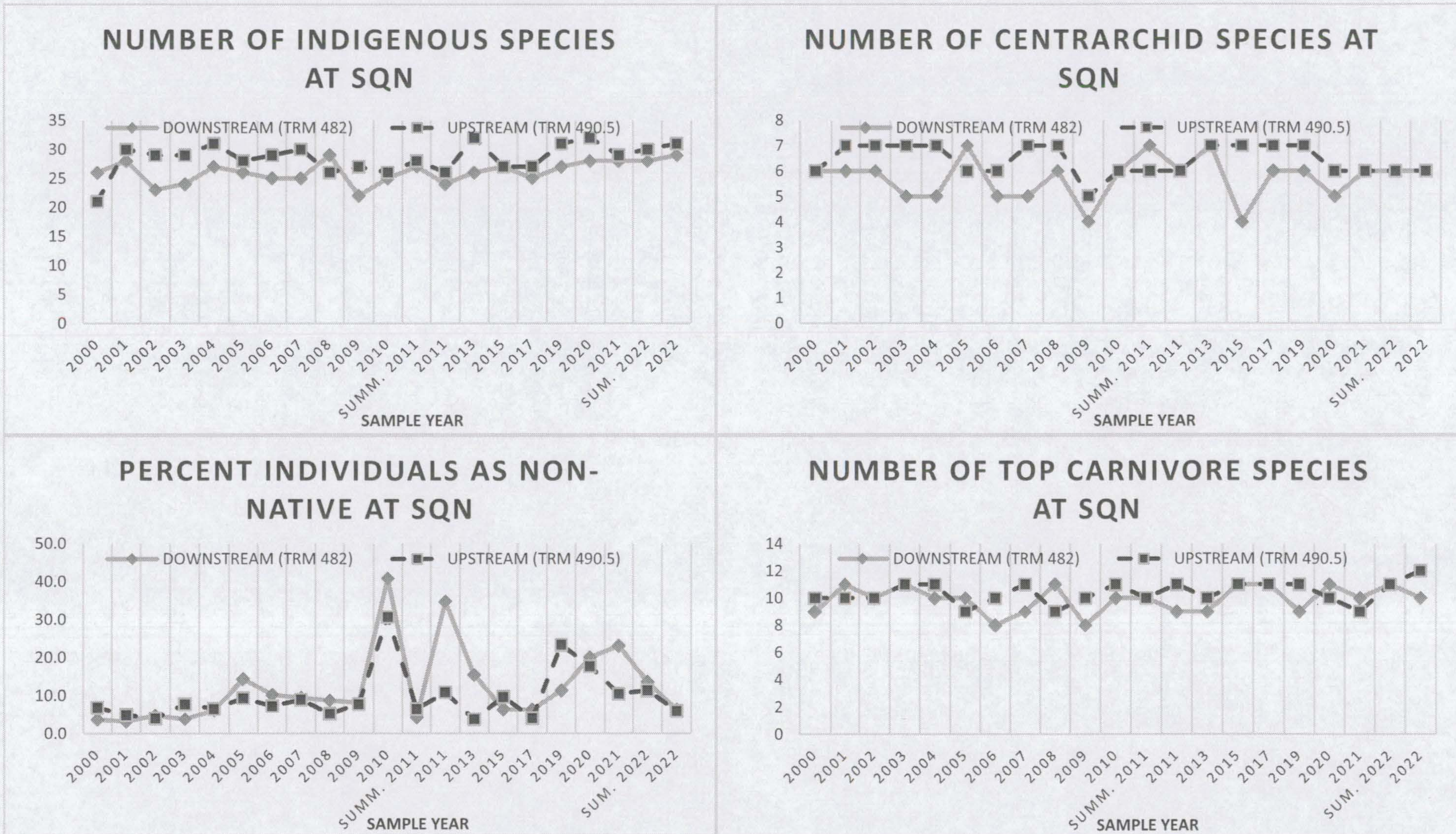


Table 5-2:.. Spffie-s ide-utme-d hy I\forli.mark Station .as be-iug representatirre of tJbe fish community irn Hookse-U **Pool**

1.	Alewife	(Alosa pseudoha.rengus)
2.	American shad	(Alosa sapidissima)
3.	Adan.tic saJbnon	*(Salmo salar)*
4.	FaUfish	(Semotifus corpOfafa)
5.	Largemouth bass	*(l\1tcropterns salmoides)*
6.	Pumpkmseed	*(Lepomis gibbosus)*
7.	SmaUmouth bass	*(lv.ltcropterns dolomie:u)*
8.	White sucker	(atostmm1.s commersoni)
9.	Yellow perch	*(Perea flavescens)*

EPA agrees that the species]iste.d ,vere pa.rt ofthe hafanoed,mdigenous fish community in]967. Merrimack:Station s data and anaJ.yses of these species are an important component of EPA s assessment ofthenna.]l irmipact.s. However, while it is appropriate ts0 identify and focus on representative irmiportant species fop redicti, e" § 316(a) demonstrations, non-predicti, e *(i., e..* retrospective, or <Typer) demons.trntions which are designed to assess prior apprecia.hle ha.rm, should not he restricted to assessing the status of representcati, e important species. In fact, EPA's Draft]977 316(a) Technical Gnid.1.t1ce recommends that referenoes to Reipresentative Importa.o.t Species be dimina.ted from Type I demonstrations (EPA]977a).. Merrimack:Stations § 316(a) demonstration is large]yretrospecti e (Type I). Therefore, EPA':sassessment of the balanced indigenous fish comnmnity of Hooksett Pool encompassed aH species present in 1967. This does not mean tha.t every species of fish present in 1967 requires an in-deptihre, iew, hut ,vhen assessing community-wide iimpacts, there is no reason to exclude a.hy resident species that ,vas present prior to the increase in discharges of heated effluent to Hooksett Pool.

5.3.. Ot!he1·Aquaitir Commuuities

Assessing changes in the resident fish community of a water body often pro, ides the most oonsp.icuous e, idence of impacts to the overall aqru.atic community, but a comp]ete §316(a) variance demonstration is not li!mirted to fish. P]:mktonic organis.ms *(e.g..* phyts0plankton, zooplankton, me.roplankton.), macroinvertebrates *(e.g.,* shellfish), habitat formers *(e.g.,* subaquatic, egetcation), and wifotlife are an supposed to be assessed at the level of detail appropriate to the facilirty s potentiaJl to iimpact tihese communities. EPA provides specific guidanoe for f.aci]ities devdoping demonstrations in its Draft]977 3]6(a) Tecl.imcal Gnid.mce.

Merrimack: Station does not assess i:m.pact.s tc aquatic comnmnities other th.an fish. in the Fisheries Aru!Jlysis Report.. However, iit does srate that the Station's past and current operations have resulted in no appreciable harm to the babnoed, indigenous populations of fish a.nd other aquatic organismsm the :segment of the Merrirmack River receiving the Station's th.enual discharge. Merrimack: Station bases this conclusion on an reports, pasti and present, preipared by

Appendix D. Pages 25 and 36 from EPA Region 1. 2011. Draft NPDES Permit for the PSNH Merrimack Station; Clean Water Act NPDES Permitting Determinations for the Thermal Discharge and Cooling Water Intake Structures at Merrimack Station in Bow, New Hampshire NPDES Permit No. NH 0001465

> *[t]he Congress intended that there be a very limited waiver for those major sources of thermal effluents which could establish beyond any question the lack of relationship between federally established effluent limitations and that water quality which assures the protection of public water supplies and the protection and propagation of a balanced, indigenous population of fish, shellfish, and wildlife, and allows recreational activities, in and on the water.*

Congressional Research Service, "A Legislative History of the Water Pollution Control Act Amendments of 1977," Vol. IV, 95th Cong., 2nd Session, (cited hereinafter as the "1977 Legislative History"), at 642 (Senate Report); *see also id.* at 457.

EPA has not, however, interpreted § 316(a) to require absolute certainty before a variance could be granted. *Seabrook*, 1977 EPA App. LEXIS 16, at *32. In reality, achieving absolute certainty about a § 316(a) determination is likely to be impossible. *See id.* EPA has stated, however, that "[t]he greater the risk, the greater the degree of certainty that should be required." *Id. See also* 44 Fed. Reg. at 32,894.

The above material suggests that EPA should take a conservative approach to assessing variance applications in order to ensure that the standard of assuring the protection and propagation of the BIP is satisfied. Such an approach is also appropriate in light of the fact that the applicant for a § 316(a) variance is asking to be excused from the otherwise applicable limitations, and given the CWA's overarching goal of restoring and maintaining the "biological integrity of the Nation's waters," 33 U.S.C. § 1251(a), and attaining "water quality which provides for the protection and propagation of fish, shellfish and wildlife." 33 U.S.C. § 1251(a)(2).

While the variance applicant's burden is a stringent one, EPA's NPDES permit decisions are subject to the "arbitrary and capricious" standard of review under the Administrative Procedures Act. 5 U.S.C. §§ 701–706. Thus, EPA decisions regarding whether a permit applicant has carried its burden in seeking a § 316(a) variance, and in setting the thermal discharge limits included in the permit, must have a rational basis and be consistent with applicable law.

With respect to the question of how much evidence is needed to support a § 316(a) variance, EPA has explained that, "no hard and fast rule can be made as to the amount of data that must be furnished . . . and much depends on the circumstances of the particular discharge and receiving waters." *Seabrook*, 1977 EPA App. LEXIS 16, at *31. At the same time, information requirements are likely to increase to the extent that there is greater reason for concern over the protection and propagation of the BIP. As EPA stated in the preamble to its current § 316(a)-related regulations in 40 C.F.R. Part 125, Subpart H:

> *Section 125.72 accordingly gives the Director the flexibility to require substantially less information in the case of renewal requests. This does not mean, however, that the Director may not require a full demonstration for a*

25

The Division of Water Pollution Control anticipates that the collection of physical data on the Allen fossil plant discharge and near field Mississippi River characteristics should suffice to show that the discharge is not likely to have an adverse impact in the river below the discharge point.

The Division would like to see annual data ;;collected in the Cumberland River system for the next three years. After that period, the Divi ion would expect that the RFAI data be collected once every two years. The Tennessee Rive system may be sampled with a frequency of once every two years. The Division considers the long history of reservoir operation and the history of plant operations indicate that annual frequency is not necessary except where there are significant changes to either reservoir operations or to discharges made to the reservoirs.

If you have questions, please contact **Mr.** Larry Bunting at (615) 532-0665 or by E-mail at *lbunting@mail.state.tn.us.*

Sincerely,

nfu:l

Manager, Permit Section
Division of Water Pollution Control

SAQ/LCBu
TVA316a_2001.doc

cc: Division of Water Pollution Control, Permit Section, Vojin Janjic
Division of Water Pollution Control, Environmental Assistance Centers-Memphis, Knoxville, Nashville, Johnson City
Permit files

Appendix C. Letter from TDEC to TVA dated September 17, 2001, approving use of RFAI as methodology in determining BIP status of aquatic community at TVA power plants

A60 020125 004

LKP
xc: L. F. Campbell, KFP 1A-KST
F.E. Dominioni, ASP 1A-MET
L.C.Diamond, BR 4X-C
R.D. Harned,JOF 1A-NJT
W.L. Hunt, GFP 1A-GLT
C.S. McCarty, CUF 1A-CC
T.E. Miller, JSF 1A-RGT
J.W. Shipp, Jr., MR 2T-C
B. B. Walton, ET 10A-K
EDMS, EB 5G-C, Env. Doc.
[illegible] NPDES [illegible]
dence

STATE OF TENNESSEE
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
401 CHURCH STREET
L & C ANNEX 6TH FLOOR
NASHVILLE TN 37243-1534

September 17, 2001

Ms. Janet K. Watts
Department Manager
1101 Market Street, LP 5D
Chattanooga, TN 37402

Subject: **TVA Studies Planned for Clean Water Act Section 316 purposes Cumberland River system – Cumberland (TN0005789), Gallatin (TN0005428) fossil plants; and Tennessee River system - Kingston (TN0005452), Bull Run (TN0005410), Johnsonville (TN0005444) fossil plants, and Mississippi River - Allen (TN0005355) fossil plant**

Dear Ms. Watts:

The Division of Water Pollution Control (the Division) has received the letter proposing studies for Section 316(a) thermal variances for the fossil plants in Tennessee. The Division agrees with evaluation of the reservoirs in the area of the discharges in the Cumberland and Tennessee River systems using TVA's Reservoir Fish Assemblage Index (RFAI). Sampling both upstream and downstream of the discharges that can be compared to the data from the Reservoir Vital Signs program will indicate whether adverse instream effects are seen in the outfall discharge areas. Tennessee agrees that any adverse impacts should be promptly investigated. Determination of any conclusion of adverse impact should be validated and the potential causes identified as quickly as possible.

The Division has some reservations concerning the Cumberland River system where there appears to be less data and where the TVA Vital Signs program has not been doing baseline sampling. However, the Division recognizes that over time, more data can be added for these reservoirs.

Tennessee agrees that monitoring of the fish assemblage for the three zonal areas (inflow, transition and forebay) and major embayments that have been identified will reflect the ecological health of the reservoir. In addition to the fish sampling, the Division would like to see the benthos be included in assessment of reservoir health. However, the Division recognizes that an acceptable methodology suitable for the reservoir systems is not available at this time. Perhaps the benthos can be evaluated under the Vital Signs program and a methodology developed for the aquatic sub-environments of the major reservoir systems. The Division believes using three zonal areas and major embayments for the evaluation of the reservoir system is a better approach than simply viewing the reservoirs as either "stream" or "lacustrine" environments.

For the John Sevier fossil plant, the Division agrees that no further biological study is called for at this time. However, it is anticipated that some sampling will be required prior to the permit expiration in 2004.

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Table B-1 Continued.

Year	Date	Intake Temperature, °F	Discharge Temperature, °F	CCW flow	Total Generation	Flow past SQN
	12/31/2020	52.1	52.7	2714	2396	46182
	AVG	**66**	**67.4**	**2683**	**2251**	**54314**
2021	1/31/2021	47.3	47.8	2662	2396	40288
	2/28/2021	46.2	46.3	2666	2395	56414
	3/31/2021	54.3	54.7	2681	2394	65935
	4/30/2021	60.9	62.7	1940	1493	48316
	5/31/2021	66.8	73.2	2504	1709	18734
	6/30/2021	74.9	79.9	2712	2357	20785
	7/31/2021	80.8	84.7	2697	2337	21167
	8/31/2021	82.1	84.4	2694	2173	32002
	9/30/2021	78.3	79.8	2702	2178	38331
	10/31/2021	73.1	73.5	1535	1203	42163
	11/30/2021	60.2	61.7	2625	2037	33186
	12/31/2021	54	56.9	2697	2393	23653
	AVG	**64.9**	**67.1**	**2510**	**2089**	**36748**
2022	1/31/2022	48.9	49.3	2651	2395	52677
	2/28/2022	48.4	47.7	2624	2395	55515
	3/31/2022	55.5	55.2	2636	2393	63758
	4/30/2022	61.5	65.9	2706	2386	12672
	5/31/2022	68.7	76.1	2668	2370	18772
	6/30/2022	78.2	82.8	2676	2043	20984
	7/31/2022	82.6	86.3	2649	2320	22106
	8/31/2022	82.2	84.1	2743	2327	27040
	9/30/2022	78.8	81	2755	2347	30950
	10/31/2022	67.9	70	2470	1867	24485
	11/30/2022	60.9	62.4	1967	1432	26426
	12/31/2022	52.2	53.3	2692	2396	46815
	AVG	**65.5**	**67.8**	**2603**	**2223**	**33517**

Table B-1. Intake and discharge water temperatures (°F), megawatts generated, and flow* (cfs) of the condenser circulating water (CCW) system at Sequoyah Nuclear Plant and flow past the plant, 2018-2022

Year	Date	Intake Temperature, °F	Discharge Temperature, °F	CCW flow	Total Generation	Flow past SQN
2018	1/31/2018	42.7	43.7	2465	2390	20557
	2/28/2018	48.7	48.9	2281	2315	73191
	3/31/2018	53.4	54	2328	2387	53524
	4/30/2018	59.4	61	1984	1375	25716
	5/31/2018	69.5	74.6	2802	2103	30508
	6/30/2018	76.4	79.4	2791	2353	42886
	7/31/2018	81.1	85.7	2685	2318	25398
	8/31/2018	81.7	83.8	2693	2324	28745
	9/30/2018	81.4	82.6	2688	2314	42427
	10/31/2018	73.1	74.4	2757	2156	36620
	11/30/2018	58.2	57.9	1694	1232	62411
	12/31/2018	50.5	50.2	2635	1847	82122
	AVG	**64.7**	**66.4**	**2484**	**2093**	**43675**
2019	1/31/2019	49.2	49.5	2644	2386	93129
	2/28/2019	49.4	51.8	2657	2387	103951
	3/31/2019	53.4	56.1	2651	2392	112942
	4/30/2019	62.7	63.8	2624	2241	33372
	5/31/2019	72	75.6	2669	2366	38756
	6/30/2019	77.2	79.9	2750	2349	34375
	7/31/2019	81.4	85.9	2675	2329	28338
	8/31/2019	83.1	85.6	2683	2193	28439
	9/30/2019	82.3	84.4	2923	2012	23185
	10/31/2019	74.6	76.5	2067	1392	19863
	11/30/2019	59.4	59.1	2509	1325	35929
	12/31/2019	52.7	52.6	2710	2255	64533
	AVG	**66.5**	**68.4**	**2630**	**2136**	**51401**
2020	1/31/2020	50.7	50.6	2688	2257	71529
	2/29/2020	50.7	50.9	2715	2391	114774
	3/31/2020	54.6	54.4	2697	2356	87796
	4/30/2020	61.7	61.4	2045	1531	73007
	5/31/2020	66.6	69.4	2740	2008	49246
	6/30/2020	76	79.6	2715	2360	28418
	7/31/2020	81.2	85.8	2703	2310	23495
	8/31/2020	83.6	84.9	2854	2299	27220
	9/30/2020	80.3	82.3	2828	2342	29709
	10/31/2020	71.3	71.5	2748	2377	44528
	11/30/2020	62.9	64.9	2747	2390	55864

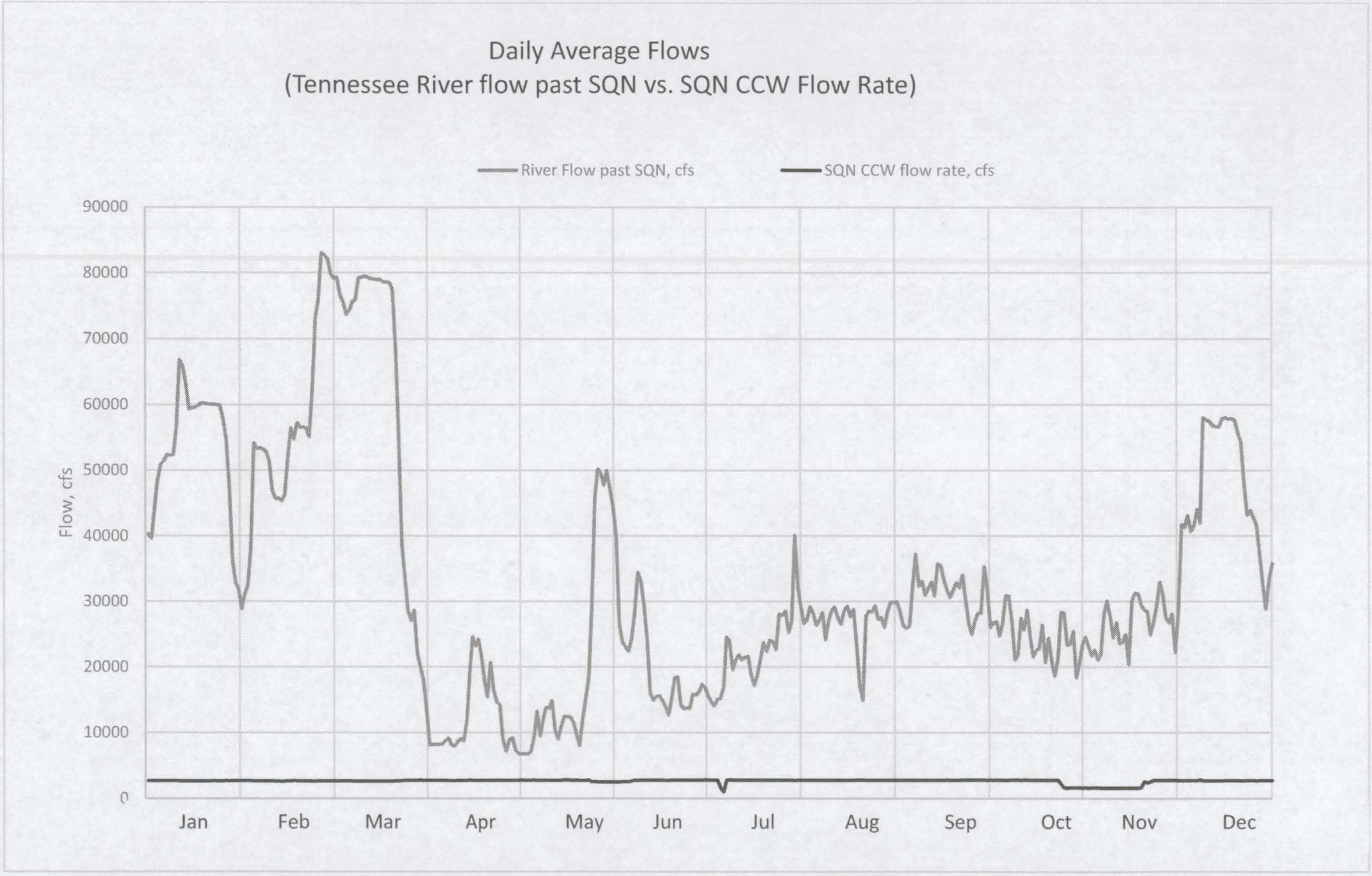


Figure B-3. Comparison of Tennessee River flows (cfs) past Sequoyah Nuclear (SQN) plant to SQN plant condenser cooling water withdrawals (cfs) during 2022

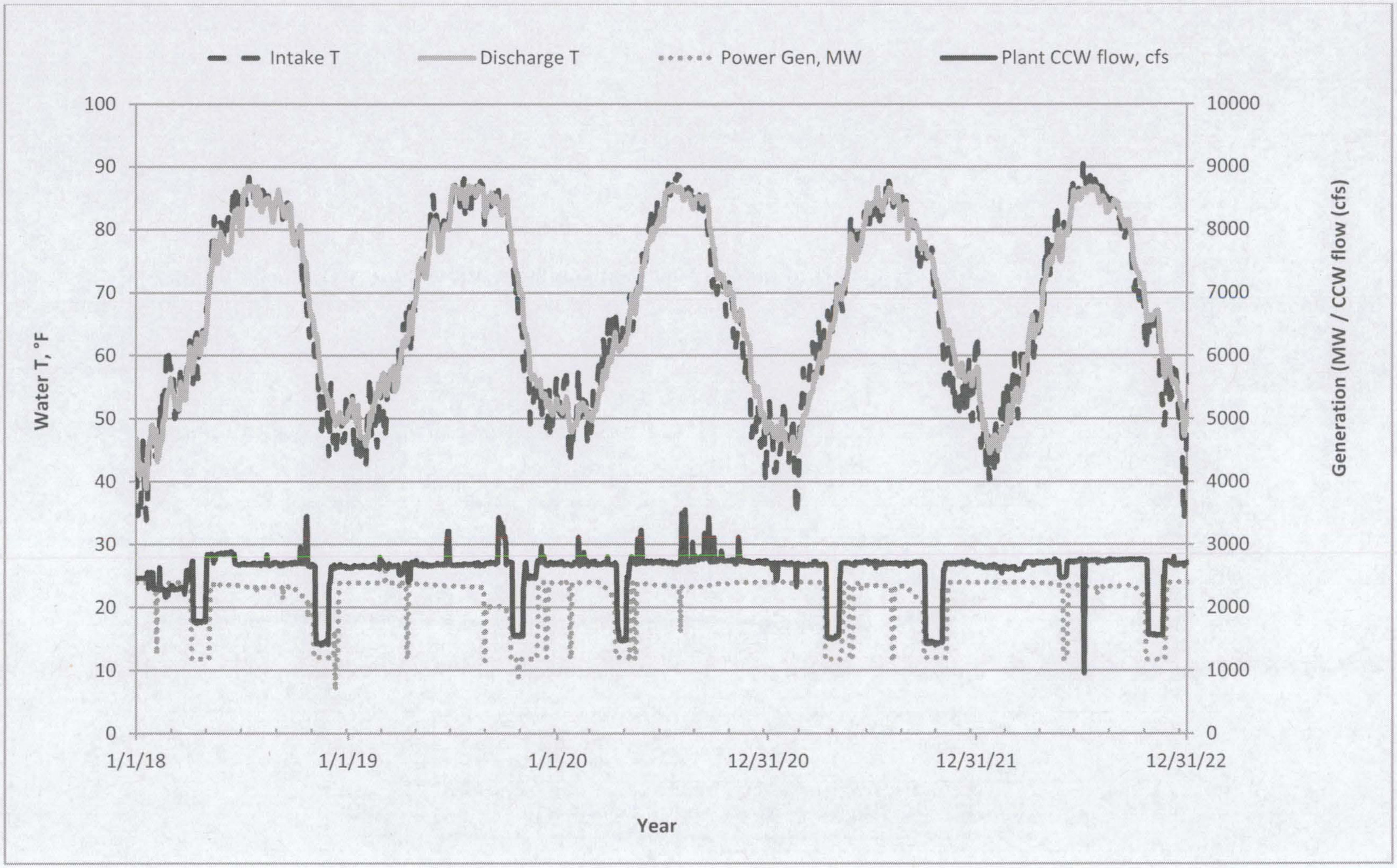
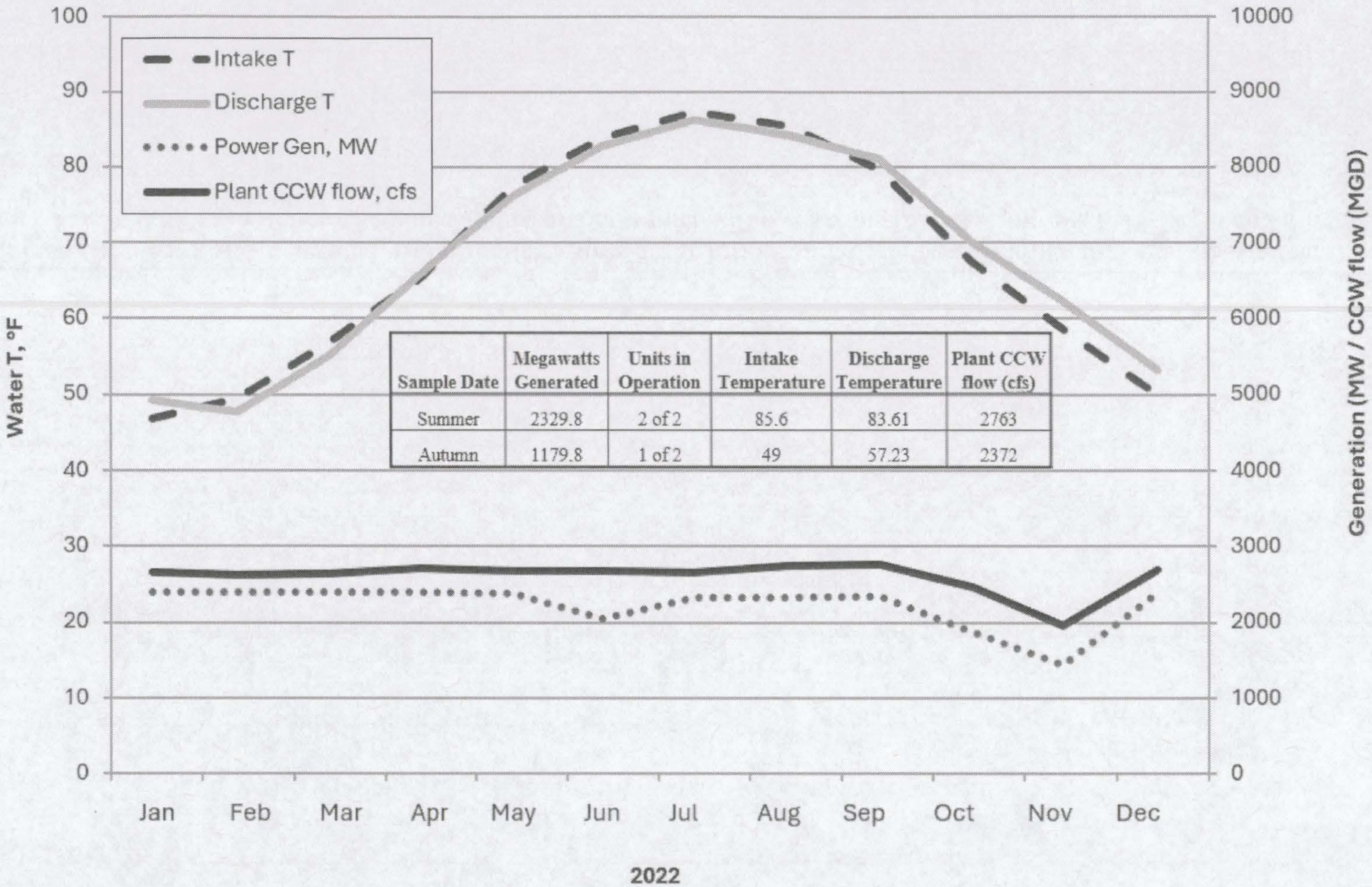


Figure B-2. Megawatts generated, water temperatures of the intake and discharge, and flow through the condenser circulating water (CCW) system at Sequoyah Nuclear Plant during the years prior to the survey (2018-2021) and during survey (2022)



Sample Date	Megawatts Generated	Units in Operation	Intake Temperature	Discharge Temperature	Plant CCW flow (cfs)
Summer	2329.8	2 of 2	85.6	83.61	2763
Autumn	1179.8	1 of 2	49	57.23	2372

Figure B-1. Monthly Average Megawatts generated, water temperatures of the intake and discharge, and flow through the condenser circulating water (CCW) system at Sequoyah Nuclear Plant during 2022

Appendix B. Evaluation of Sequoyah Nuclear Plant operating conditions during 2018-2022

Evaluation of Plant Operating Conditions

Relevant plant operational data—mean daily temperatures at the CCW intake and discharge, mean daily flow through the CCW system, and mean daily power generation by the three nuclear units at SQN—were compiled from 2018 through 2022.

Biological monitoring was conducted upstream and downstream of SQN on August 21 and 22, and November 21 and 22, 2022. Daily mean generation for both days in August was 2,330 MW, while the mean generation for sampling days in November was 1180.1 respectively, with the summer sample occurring during slightly above the historical average. Daily mean intake temperatures for these dates were 85.5 ˚F for summer and 49.2 for autumn. Daily mean discharge temperature on the date sampling occurred in the affected downstream reach was 85.6 ˚F in the summer sample and 49 ˚F during the autumn sample. Daily flow rates were 2,763 and 2,765 cfs for both summer sample dates and 2372 and 2502 cfs for the autumn sample dates, both of which are higher than the observed historical average of 1,806 cfs (Table B-1, Figure B-1).

During 2022, daily mean generation ranged from 1,432 to 2,396 MW, with an annual daily average of 2,223 MW. Mean daily CCW flow during 2022 ranged from 1,967 to 2,755 cfs and averaged 2,603 cfs (Figure B-3). Daily mean intake temperatures ranged from 48.4 to 82.6 ˚F, with an annual average of 65.5 ˚F. Daily mean discharge temperatures ranged from 47.7 to 86.3 ˚F, with an annual average of 67.8 ˚F. Daily averages of CCW flow and generation during 2022 were generally higher when compared to 2018- 2021 daily averages while river flow was generally lower.(Table B-1, Figure B-2).

Table A-4. Scoring criteria for laboratory-processed benthic macroinvertebrate community samples from inflow, transition, and forebay zones of mainstem Tennessee River reservoirs

Benthic Community	Forebay			Transition			Inflow		
Metrics	1	3	5	1	3	5	1	3	5
Average number of taxa	< 2.8	2.8-5.5	> 5.5	< 3.3	3.3-6.6	> 6.6	< 4.2	4.2-8.3	> 8.3
Proportion of samples with long-lived organisms	< 0.6	0.6-0.8	> 0.8	< 0.6	0.6-0.9	> 0.9	< 0.6	0.6-0.8	> 0.8
Average number of EPT (Ephemeroptera, Plecoptera, Trichoptera)	< 0.6	0.6-0.9	> 0.9	< 0.6	0.6-1.4	> 1.4	< 0.9	0.9-1.9	> 1.9
Average proportion of oligochaete individuals	> 41.9	41.9-21.0	< 21.0	> 21.9	21.9-11.0	< 11.0	> 23.9	23.9-12.0	< 12.0
Average proportion of total abundance comprised by the two most abundant taxa	> 90.3	90.3-81.7	< 81.7	> 87.9	87.9-77.8	< 77.8	> 86.2	86.2-73.1	< 73.1
Average density excluding chironomids and oligochaetes	< 125.0	125.0-249.9	> 249.9	< 305.0	305.0-609.9	> 609.9	< 400.0	400.0-799.9	> 799.9
Zero-samples - proportion of samples containing no organisms	> 0	---	0	> 0	---	0	> 0	---	0

*Transition criteria were used to score sites upstream of SQN (*TRM 488.0 *and* TRM 490.5*); Forebay criteria were used to score sites downstream of SQN (*TRM 481.3 *and* TRM 483.4*)*

Table A-3. RFAI scoring criteria for inflow, transition, and forebay sections of upper mainstem reservoirs* in the Tennessee River system.

		Scoring Criteria								
		Forebay			Transition			Inflow		
Metric	Gear	1	3	5	1	3	5	1	3	5
1. Total species	Combined	<14	14-27	>27	<15	15-29	>29	<14	14-27	>27
2. Total Centrarchid species	Combined	<2	2-4	>4	<2	2-4	>4	<3	3-4	>4
3. Total benthic invertivores	Combined	<4	4-7	>7	<4	4-7	>7	<3	3-6	>6
4. Total intolerant species	Combined	<2	2-4	>4	<2	2-4	>4	<2	2-4	>4
5. Percent tolerant individuals	Electrofishing	>62%	31-62%	<31%	>62%	31-62%	<31%	>58%	29-58%	<29%
	Gill netting	>28%	14-28%	<14%	>32%	16-32%	<16%			
6. Percent dominance by 1 species	Electrofishing	>50%	25-50%	<25%	>40%	20-40%	<20%	>46%	23-46%	<23%
	Gill netting	>29%	15-29%	<15%	>28%	14-28%	<14%			
7. Percent non-indigenous species	Electrofishing	>4%	2-4%	<2%	>6%	3-6%	<3%	>17%	8-17%	<8%
	Gill netting	>16%	8-16%	<8%	>9%	5-9%	<5%			
8. Total top carnivore species	Combined	<4	4-7	>7	<4	4-7	>7	<3	3-6	>6
9. Percent top carnivores	Electrofishing	<5%	5-10%	>10%	<6%	6-11%	>11%	<11%	11-22%	>22%
	Gill netting	<25%	25-50%	>50%	<26%	26-52%	>52%			
10. Percent omnivores	Electrofishing	>49%	24-49%	<24%	>44%	22-44%	<22%	>55%	27-55%	<27%
	Gill netting	>34%	17-34%	<17%	>46%	23-46%	<23%			
11. Average number per run	Electrofishing	<121	121-241	>241	<105	105-210	>210	<51	51-102	>102
	Gill netting	<12	12-24	>24	<12	12-24	>24			
12. Percent anomalies	Electrofishing	>5%	2-5%	<2%	>5%	2-5%	<2%	>5%	2-5%	<2%
	Gill netting	>5%	2-5%	<2%	>5%	2-5%	<2%			

* *Upper mainstem Tennessee River reservoirs include Chickamauga, Fort Loudon, Melton Hill, Nickajack, Tellico, and Watts Bar.*

Table A-2. Expected trophic guild proportions* and expected numbers of all species* (including non-indigenous) in upper mainstem Tennessee River reservoir transition and forebay zones, compared to values observed during 2020 monitoring at Sequoyah Nuclear Plant.

		Proportion (%)				Number of species				Observed Upstream (TRM 490.5)		Observed Downstream (TRM 482.0)	
		Trisected range [a]				Trisected range [a]							
Trophic Guild	Zone	-	Expected	+	Average [b]	-	Expected	+	Average [b]	Proportion	Number of Species	Proportion	Number of Species
Benthic Invertivore	Transition	< 2.5	2.5 to 5.0	> 5.0	2.8 ± 0.1	< 2	2 to 4	> 4	3.9 ± 0.2	2.4	3		
	Forebay	< 4.5	4.5 to 9.0	> 9.0	2.5 ± 0.1	< 2	2 to 4	> 4	3.3 ± 0.3			1.5	2
Insectivore	Transition	< 24.2	24.2 to 48.4	> 48.4	42.9 ± 2.1	< 4	4 to 8	> 8	7.8 ± 0.4	58.1	8		
	Forebay	< 28.5	28.5 to 57.1	> 57.1	54.3 ± 2.7	< 4	4 to 8	> 8	8.7 ± 0.5			70.0	7
Top Carnivore	Transition	< 12.0	12.0 to 23.9	> 23.9	14.2 ± 0.7	< 4	4 to 8	> 8	7.8 ± 0.4	13.5	11		
	Forebay	< 16.1	16.1 to 32.1	> 32.1	17.1 ± 0.9	< 4	4 to 8	> 8	9.9 ± 0.3			11.4	11
Omnivore	Transition	> 29.9	29.9 to 59.7	< 59.7	27.8 ± 1.4	> 5	3 to 5	< 3	5.8 ± 0.3	25.6	7		
	Forebay	> 20.8	20.8 to 41.6	< 41.6	20.7 ± 1.0	> 6	3 to 6	< 3	6.1 ± 0.3			16.6	7
Planktivore	Transition	> 25.6	25.6 to 51.2	< 51.2	12.5 ± 0.6	0	1	> 1	1.1 ± 0.1	0.4	1		
	Forebay	> 5.8	5.8 to 11.5	< 11.5	2.4 ± 0.1	0	1	> 1	1.0 ± 0.1			0.6	1
Parasitic	Transition	< 0.4	0.4 to 0.7	> 0.7	0.3 ± 0.01	0	1	> 1	1.0 ± 0.1	---	---		
	Forebay	< 0.3	0.3 to 0.7	> 0.7	0.2 ± 0.01	0	1	> 1	0.1 ± 0.08			---	---
Herbivore	Transition	< 0.2	0.2 to 0.4	> 0.4	0.1 ± 0.01	0	1	> 1	1.0 ± 0.1	---	---		
	Forebay	---	---	---	---	---	---	---	---			---	---

** Expected values were calculated using data collected from 1993 to 2020 in upper mainstem Tennessee River reservoirs. Over this period, 915 electrofishing runs and 610 overnight gill net sets were conducted in transition areas; 1,275 electrofishing runs and 850 overnight gill net sets were conducted in forebay areas.*

[a] Trisected ranges are intended to show below expected (-), expected, and above expected (+) values for trophic level proportions and species occurring within the transition zones in upper mainstem Tennessee River reservoirs.

[b] Average expected values are bound by 95% confidence intervals.

Table A-1. Shoreline Aquatic Habitat Index (SAHI) metrics and scoring criteria

Metric	Scoring Criteria	Score
Cover	Stable cover (boulders, rootwads, brush, logs, aquatic vegetation, artificial structures) in 25 to 75% of the drawdown zone	5
	Stable cover in 10 to 25% or > 75% of the drawdown zone	3
	Stable Cover in < 10% of the drawdown zone	1
Substrate	Percent of drawdown zone with gravel substrate > 40	5
	Percent of drawdown zone with gravel substrate between 10 and 40	3
	Percent substrate gravel < 10	1
Erosion	Little or no evidence of erosion or bank failure. Most bank surfaces stabilized by woody vegetation.	5
	Areas of erosion small and infrequent. Potential for increased erosion due to less desirable vegetation cover (grasses) on > 25% of bank surfaces.	3
	Areas of erosion extensive, exposed or collapsing banks occur along > 30% of shoreline.	1
Canopy Cover	Tree or shrub canopy > 60% along adjacent bank	5
	Tree or shrub canopy 30 to 60% along adjacent bank	3
	Tree or shrub canopy < 30% along adjacent bank	1
Riparian Zone	Width buffered > 18 meters	5
	Width buffered between 6 and 18 meters	3
	Width buffered < 6 meters	1
Habitat	Habitat diversity optimum. All major habitats (logs, brush, native vegetation, boulders, gravel) present in proportions characteristic of high quality, sufficient to support all life history aspects of target species. Ready access to deeper sanctuary areas present.	5
	Habitat diversity less than optimum. Most major habitats present, but proportion of one is less than desirable, reducing species diversity. No ready access to deeper sanctuary areas.	3
	Habitat diversity is nearly lacking. One habitat dominates, leading to lower species diversity. No ready access to deeper sanctuary areas.	1
Gradient	Drawdown zone gradient abrupt (> 1 meter per 10 meters). Less than 10% of shoreline with abrupt gradient due to dredging.	5
	Drawdown zone gradient abrupt. (> 1 meter per 10 meters) in 10 to 40% of the shoreline resulting from dredging. Rip-rap used to stabilize bank along > 10% of the shoreline.	3
	Drawdown zone gradient abrupt in > 40 % of the shoreline resulting from dredging. Seawalls used to stabilize bank along > 10 % of the shoreline.	1

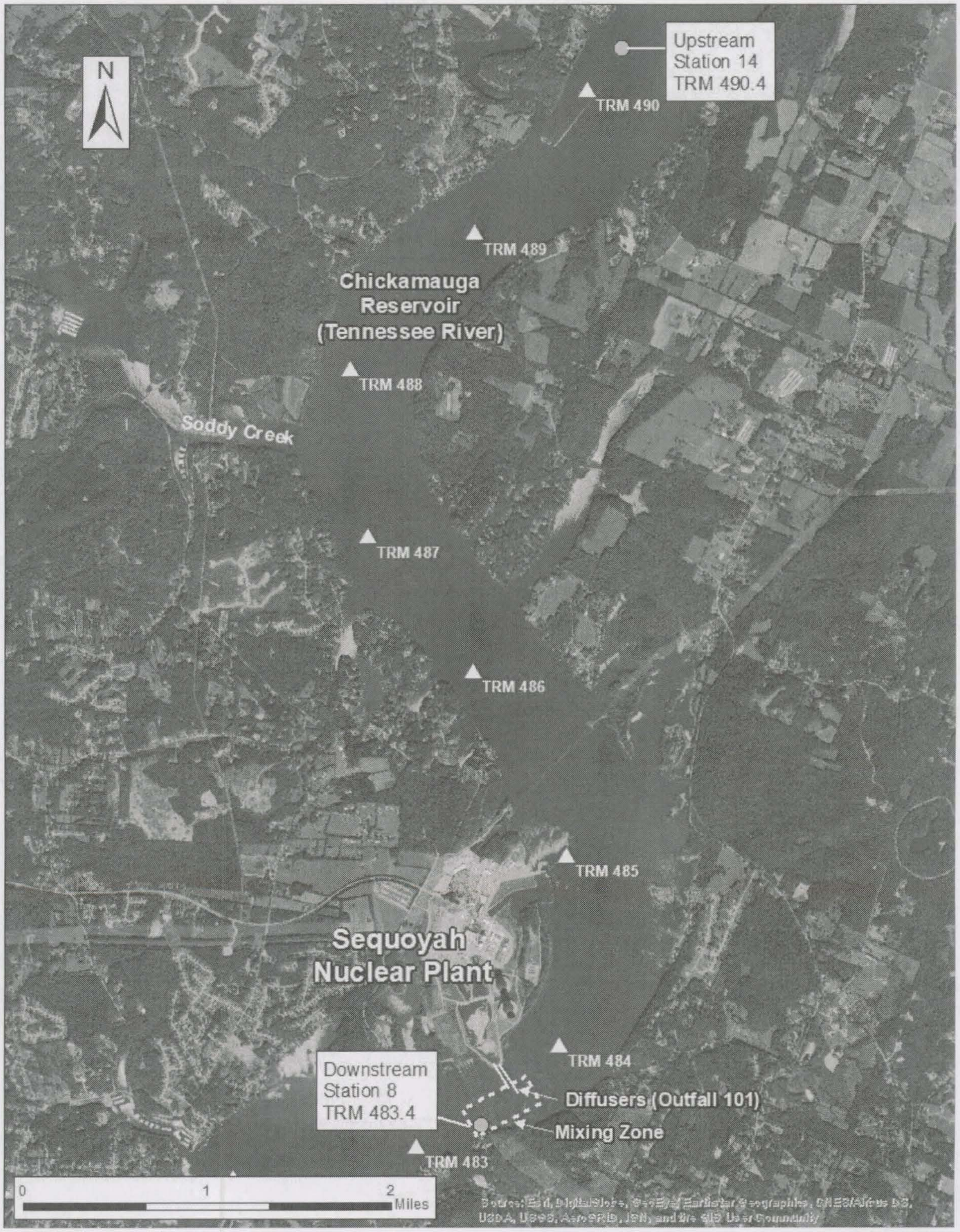


Figure A-1. Locations of water temperature monitoring stations used to compare water temperatures upstream of Sequoyah Nuclear Plant (SQN) intake (ambient) and downstream of SQN discharge electrofishing sample reaches upstream and downstream of SQN, transects were established across the river at the most upstream boundary, at mid-reach, and at the most downstream boundary. Along each transect, samples were collected at the RDB, in mid-channel, and at the LDB by recording readings at one- to two-meter intervals along a vertical gradient from just above the bottom of the river to approximately 0.3 meters from the surface.

Thermal Plume Characterization

Physical measurements to characterize and map the SQN thermal plume were collected concurrent with biological field sampling. The plume was characterized under representative thermal maxima and seasonally expected low flow conditions. Measurements were collected during periods of normal operation of SQN, as reasonably practicable, to capture the thermal plume under existing river flow/reservoir elevation conditions. This effort evaluated potential impacts on recreation and water supply uses and allowed general delineation of the "Primary Study Area" – per the EPA (1977) draft guidance defined as the "*entire geographic area bounded annually by the locus of the 2°C above ambient surface isotherms as these isotherms are distributed throughout an annual period*" – ensuring placement of the biological sampling locations within thermally influenced areas.

However, it is important to emphasize that the ≥2°C isopleth boundary is not a bright line; it is dynamic, changing geometrically in response to changes in ambient river flows and temperatures and SQN operations. As such, samples collected outside of, but generally proximate to the Primary Study Area boundary cannot be considered free of thermal influence and thus should not be discounted. Every effort was made to collect biological samples in thermally affected areas as guided by the Primary Study Area definition.

Depth profiles of temperature from the river surface to the bottom were collected at points along transects crossing the plume. One transect was located proximate to the thermal discharge point; subsequent downstream transects were concentrated in the near field area of the plume where the change in plume temperature was expected to be most rapid. The distance between transects in the remainder of the Primary Study Area increased with distance downstream (or away from the discharge point). The farthest downstream transect was just outside of the Primary Study Area. A transect upstream of the discharge, in an area not affected by the thermal plume, was included for determining ambient temperature conditions. The total number of transects needed to fully characterize and delineate the plume was determined in the field.

Collection of temperature profiles along a given transect began at or near the shoreline from which the discharge originated and continued until the far shore was reached. Measurements across a transect were typically conducted at points 10%, 30%, 50%, 70%, and 90% from the originating shoreline, though the number of measurement points along transects was sometimes decreased or increased in proportion to the magnitude of the temperature change across a given transect. The distances between transects, and between points of measurement along each transect, depended on the size of the discharge plume.

Temperature data were compiled and analyzed to present the horizontal and vertical dimensions of the SQN thermal plume using spatial analysis techniques to yield plume cross-sections, which can be used to demonstrate the existence of a zone of passage for fish and other aquatic species under or around the plume.

Water Quality Parameters at Fish Sampling Sites during RFAI Samples

Water quality conditions were measured using a Hydrolab® that provided readings for water temperature (°C), conductivity (μS/cm), dissolved oxygen (mg/L), and pH. Within each of the simply due to method variation (25% of the QA paired sample sets exceeded that value). Any difference in scores of four points or greater between communities is examined on a metric-by-metric basis to determine what caused the difference in scores and the potential for the difference to be thermally related.

Visual Encounter Survey (Wildlife Observations)

Permanent survey sites were established on both the right and left descending banks at one location upstream of the SQN thermal discharge, centered at TRM 490.5 (Figure 4), and at a second location downstream of the discharge, centered at TRM 482.0 (Figure 5). Each survey site spanned a distance of 2,100 m along the shoreline, and the beginning and ending points were marked using global positioning system (GPS) for relocation.

Surveys were conducted by steadily traversing the site by boat, at approximately 30 m offshore and parallel to the shoreline, and simultaneously recording observations of wildlife. The sampling frame of each survey generally followed the strip or belt transect concept: from the center-line of each transect landward to an area that included the shoreline and riparian zone (i.e., belt width generally averages 60 m where vision is not obscured), all individuals observed were enumerated. Wildlife observed visually or detected audibly was identified to the lowest taxonomic trophic level, and a direct count of individuals observed per trophic level was recorded. If a flock of a species or a mixed flock of a group of species was observed, numbers of individuals present of each species were estimated. Time was recorded at the start and end points of each survey to provide a general measure of effort expended. Variation of observation times among surveys was primarily due to the difficulty of approaching some wildlife species without inadvertently flushing them from basking or perching sites.

The principal objective of the surveys was to provide a preliminary set of observations to verify that trophic levels of birds, mammals and reptiles were not affected by thermal effects from the SQN discharge. If expected trophic levels were not represented, further investigation will be used to target particular species or species groups (guilds) in an attempt to determine the cause.

Chickamauga Reservoir Flow and SQN Temperature

Total daily average discharge from Watts Bar and Chickamauga dams was used to describe the amount of water flowing past SQN and was obtained from TVA's River Operations database. Given the location of the SQN plant on Chickamauga Reservoir (Figure 1), flow past SQN was estimated as 23 percent of releases from Watts Bar Dam and 77 percent of releases from Chickamauga Dam.

Water temperature data were also obtained from TVA's River Operations database. Locations of water temperature monitoring stations used to compare water temperatures upstream of SQN intake and downstream of SQN discharge are depicted in Figure 9. Station 14 (TRM 490.4) was used to measure the ambient temperature upstream of the SQN intake. Station 8 (TRM 483.4) was used to measure temperatures downstream of the SQN discharge. Water temperatures at both stations were computed as the average of temperatures measured at depths of 3, 5, and 7 ft.

then applied to scores (Table A-4). The individual metrics are described below:

(1) Average number of taxa — Calculated by averaging the total number of taxa present in each sample at a site. Greater taxa richness indicates better conditions than lower taxa richness

(2) Proportion of samples with long-lived organisms — A presence/absence metric that is evaluated based on the proportion of samples with at least one long-lived organism (*Corbicula, Hexagenia*, mussels, or snails) present. The presence of long-lived taxa is indicative of conditions that allow long-term survival.

(3) Average number of EPT taxa — Calculated by averaging the number of *Ephemeroptera* (mayfly), *Plecoptera* (stonefly), and *Trichoptera* (caddisfly) taxa present in each sample at a site. Higher diversity of these taxa indicates good water quality and better habitat conditions.

(4) Percentage of oligochaetes — Calculated by averaging the percentage of oligochaetes in each sample at a site. Oligochaetes are considered tolerant organisms, so a higher proportion indicates poorer water quality.

(5) Percentage as dominant taxa — Used as an evenness indicator, this metric is calculated by selecting the two most abundant taxa in a sample, summing the number of individuals in those two taxa, dividing that sum by the total number of animals in the sample, and converting to a percentage for that sample. The percentages are then averaged for the 10 samples at each site. Because the most abundant taxa often differ among the 10 samples at a site, this approach allows more discretion to identify imbalances at a site than developing an average for a single dominant taxon for all samples at a site. Dominance of one or two taxa indicates poor conditions.

(6) Average density excluding chironomids and oligochaetes — Calculated by first summing the number of organisms – excluding chironomids and oligochaetes – present in each sample and then averaging these densities for the 10 samples at a site. This metric examines the community, excluding taxa which often dominate under adverse conditions. Higher abundance of taxa other than chironomids and oligochaetes indicates good water quality conditions.

(7) Zero-samples: Proportion of samples containing no organisms — For each site, the proportion of samples in which no organisms are present. "Zero-samples" indicate living conditions unsuitable to support aquatic life (i.e. toxicity, unsuitable substrate, etc.). A site with no zero samples was assigned a score of five. Any site with one or more zero samples was assigned a score of one.

A similar or higher benthic index score at the downstream sites compared to the upstream site was used as the basis for determining absence of impact on the benthic macroinvertebrate community related to SQN's thermal discharge. The QA component of REH monitoring compared benthic index scores from 49 paired sample sets collected over seven years. Differences between these paired sets ranged from 0 to 14 points; the 75th percentile was four points, the 90th percentile was six points. The mean difference between these 49 paired scores was 3.1 points with 95% confidence limits of 2.2 and 4.1. Based on these results, a difference of four points or less was the value selected for defining "similar" scores between upstream and downstream benthic communities. That is, if benthic scores at the downstream sites are within four points of the upstream score, the communities are considered similar. However, differences greater than four points can be expected

N = total number of individuals
n_i = total number of individuals in the i^{th} species.

An independent two-sample *t*-test was used to test for differences in CPUE, species richness, and diversity values upstream and downstream of SQN ($\alpha = 0.05$). Before statistical tests were performed using this method, data were analyzed for normality using the Shapiro-Wilk test (Shapiro and Wilk, 1965) and homogeneity of variance using Levene's test (Levene 1960). Non-normal data or data with unequal variances were transformed using either square root conversion or the ln(x+1) transformation. Transformed data were reanalyzed for normal distribution and equal variances. If transformation normalized the data or resulted in homogeneous variances, transformed data were tested using an independent two-sample *t*-test. If transformed data were not normally distributed or had unequal variances, statistical analysis was conducted using the Wilcoxon-Mann-Whitney test (Mann and Whitney, 1947; Wilcoxon, 1945).

Benthic Macroinvertebrate Community Sampling Methods and Data Analysis for Sites Upstream and Downstream of SQN

To assess the benthic macroinvertebrate community in the vicinity of SQN from 2000 to 2020, along transects established across the full width of Chickamauga reservoir upstream of SQN in the transition/mid-reservoir zone at TRM 490.5 (Figure 4) and downstream in the forebay area at TRMs 483.4 and 481.3 (Figure 5). Prior to this time, a sampling site in the forebay zone of Chickamauga Reservoir at TRM 482.0 was used as the downstream comparison site. Benthic scores and community composition from this site were used through 2010 (field-processed) for downstream comparisons to the upstream benthic site at TRM 490.5.

Beginning in 2011, samples were collected in the reservoir's forebay and transition zones along transects established across the full width of the reservoir at three sites. One site upstream of the plant intake was maintained at TRM 490.5 (Figure 4). To more accurately assess any possible effects of the SQN discharge on the benthic communities downstream, two sites were selected: just downstream of the mixing zone (TRM 483.4) and at a site further downstream (TRM 481.3) (Figure 5).

During autumn 2020, benthic macroinvertebrate data were collected along these three transects. The upstream transect was used as a control site for comparison to the downstream benthic communities potentially affected by the SQN thermal effluent. A Ponar dredge (area per sample 0.06 m^2) was used to collect benthic samples at ten points equally spaced along each transect. When heavier substrate was encountered, a Peterson dredge (area per sample 0.11 m^2) was used. Sediments from each sample were washed on a 533μ screen, and organisms were picked from the screen and from any remaining substrate. Samples were fixed in formalin and sent to an independent consultant who identified each organism collected to the lowest possible taxonomic level.

Benthic samples were evaluated using seven metrics that represent characteristics of the benthic community. Results for each metric were assigned a rating of 1, 3, or 5, based on comparison to reference conditions developed for REH reservoir transition sample sites (Table 4). For each sample site, the ratings for the seven metrics were then summed to produce an RBI score. Potential RBI scores ranged from 7 to 35. Ecological health ratings derived from the range of potential values (7-12 "Very Poor", 13-18 "Poor", 19-23 "Fair", 24-29 "Good", or 30-35 "Excellent") were impacted fish community. The threshold is used to serve as a conservative screening level; i.e., any fish community that meets these criteria is obviously not adversely impacted. RFAI scores below this level require a more in-depth look to determine if BIP exists. An inspection of individual RFAI metric results and species of fish used in each metric are an initial step to help identify if operation of SQN is a contributing factor. This approach is appropriate because a validated multi-metric index is being used and scoring criteria applicable to the zone of study are available.

A comparison of RFAI scores from the area downstream of SQN to those from the upstream (control) area is one basis for determining if operation of the plant has had any impacts on the resident fish community. The definition of "similar" is integral to accepting the validity of these interpretations. The Quality Assurance (QA) component of the VS monitoring program deals with how well the RFAI scores can be repeated and is accomplished by collecting a second set of samples at 15%-20% of the areas each year. Comparison of paired-sample QA data collected over seven years shows that the difference in RFAI index scores ranges from 0 to 18 points. The mean difference between these 54 paired scores is 4.6 points with 95% confidence limits of 3.4 and 5.8. The 75th percentile of the sample differences is 6, and the 90th percentile is 12. Based on these results, a difference of 6 points or less in the overall RFAI scores is the value selected for defining "similar" scores between upstream and downstream fish communities. That is, if the downstream RFAI score is within 6 points of the upstream score and if there are no major differences in overall fish community composition, then the two locations are considered similar. It is important to bear in mind that differences greater than 6 points can be expected simply due to method variation (25% of the QA paired sample sets exceeded that value). An examination of the 12 metrics (with emphases on fish species used for each metric) is conducted to analyze any difference in scores and the potential for the difference to be thermally related.

Statistical Analyses

In addition to RFAI analyses, data were analyzed using traditional statistical methods. Data from the survey were used to calculate catch per unit effort (CPUE), expressed as number of fish per electrofishing run or fish per net night. CPUE values were calculated by pollution tolerance, trophic guilds (e.g., benthic invertivores, top carnivores, etc.), thermal sensitivity (Yoder et al. 2006), and indigenousness. CPUE, species richness, and diversity values were computed for each electrofishing effort (to maximize sample size; n = 30) and compared upstream and downstream to assess potential effects of power plant discharges.

Diversity was quantified using two commonly used diversity indices: Shannon diversity index (Shannon 1948) diversity index. This index accounts for the number of species present, as well as the relative abundance of each species.

Shannon diversity index values were computed using the formula:

$$H' = -\sum_{i=1}^{S} \left(\frac{n_i}{N}\right) \ln\left(\frac{n_i}{N}\right)$$

Where:

S = total number of species

upper mainstem Tennessee River reservoirs absent from point source effects (i.e. power plant discharges). Data from 1,275 electrofishing runs (a total of 382,500 meters of shoreline sampled) and from 850 overnight experimental gill net sets were included in this analysis for forebay areas in upper mainstem Tennessee River reservoirs. For upper mainstem Tennessee River transition zones, data from 915 electrofishing runs and 610 overnight experimental gill net sets were included. From these data, the range of proportional values for each trophic level and the range of the number of species included in each trophic level were trisected. These trisections were intended to show less than expected, expected and above expected values for trophic level proportions and species occurring within each reservoir zone in upper mainstem Tennessee River reservoirs. The data were also averaged and bound by confidence intervals (95%) to further evaluate expectations for proportions of each trophic level and the number of species representing each trophic level by reservoir zone (Table A-2).

(4) **A lack of domination by pollution-tolerant species**: Domination by pollution-tolerant species is determined by metrics 3 ("Number of benthic invertivore species"), 4 ("Number of intolerant species"), 5 ("Percent tolerant individuals"), 6 ("Percent dominance by one species"), and 10 ("Percent omnivores").

Scoring categories are based on "expected" fish community characteristics in the absence of human-induced impacts other than impoundment of the reservoir. These categories were developed from historical REH fish assemblage data representative of forebay and transition zones from upper mainstem Tennessee River reservoirs (Hickman and McDonough, 1996). Attained values for each of the 12 metrics were compared to the scoring criteria and assigned scores to represent relative degrees of degradation: least degraded (5); intermediately degraded (3); and most degraded (1). Scoring criteria for upper mainstem Tennessee River reservoirs are shown in Table A-3.

If a metric was calculated as a percentage (e.g., "Percent tolerant individuals"), the data from electrofishing and gill netting were scored separately and allotted half the total score for that individual metric. Individual metric scores for a sampling area (i.e., upstream or downstream) were summed to obtain the RFAI score for the area.

TVA uses RFAI results to determine maintenance of BIP using two approaches. One is "absolute" in that it compares the RFAI scores and individual metrics to predetermined values. The other is "relative" in that it compares RFAI scores attained downstream to scores at the upstream control site. The "absolute" approach is based on Jennings et al. (1995) who suggested that favorable comparisons of the RFAI score attained from the potential impact zone to a predetermined criterion can be used to identify the presence of normal community structure and function, and hence existence of BIP. For multi-metric indices, TVA uses two criteria to ensure a conservative screening of BIP. First, if an RFAI score reaches 70% of the highest attainable score of 60 (adjusted upward to include sample variability as described below), and second, if fewer than half of RFAI metrics receive a low (1) or moderate (3) score, then community structure and function are considered normal, indicating that BIP had been maintained and no further evaluation would be needed.

RFAI scores range from 12 to 60. Ecological health ratings (12-21 "Very Poor", 22-31 "Poor", 32-40 "Fair", 41-50 "Good", or 51-60 "Excellent") are then applied to scores. As discussed in detail below, the average variation for RFAI scores in TVA reservoirs is 6 (± 3). Therefore, any location that attains a RFAI score of 45 (75% of the highest score) or higher would be considered to have BIP. It must be stressed that scores below this threshold do not necessarily reflect an adversely

Fish Health

(12) Percent anomalies – Incidence of diseases, lesions, tumors, external parasites, deformities, blindness, and natural hybridization is noted for all fish collected, with higher incidence indicating less favorable environmental conditions.

RFAI methodology addresses all four attributes or characteristics of a "balanced indigenous population" (BIP), defined by the CWA as described below:

(1) A biotic community characterized by diversity appropriate to the ecoregion: Diversity is addressed by the metrics in the Species Richness and Composition category, especially metric 1 – "Number of species." Determination of reference conditions based on the forebay and transition zones of upper mainstem Tennessee River reservoirs (as described below) ensures appropriate species expectations for the ecoregion.

(2) The capacity for the community to sustain itself through cyclic seasonal change: TVA uses an autumn data collection period for biological indicators, both REH and upstream/downstream monitoring. Autumn monitoring is used to document community condition or health after being subjected to the wide variety of stressors throughout the year.

One of the main benefits of using biological indicators is their ability to integrate stressors through time. Examining the condition or health of a community at the end of the "biological year" (i.e., autumn) provides insights into how well the community has dealt with the stresses through an annual seasonal cycle. Likewise, evaluation of the condition of individuals in the community (in this case, individual fish as reflected in Metric 12) provides insights into how well the community can be expected to withstand stressors through winter. Further, multiple sampling years during the permit renewal cycle add to the evidence of whether the autumn monitoring approach has correctly demonstrated the ability of the community to sustain itself through repeated seasonal changes.

(3) The presence of necessary food chain species: Integrity of the food chain is measured by the Trophic Composition metrics, with support from the Abundance metric and Species Richness and Composition metrics. A healthy fish community is comprised of species that utilize complex feeding mechanisms extending into multiple levels of the aquatic food web. Three dominant fish trophic levels exist within Tennessee River reservoirs: insectivores, omnivores, and top carnivores. To determine the presence of necessary food chain species, these three groups should be well represented within the overall fish community. Other fish trophic levels include benthic invertivores, planktivores, herbivores, and parasitic species. Insectivores include most sunfish, minnows, and silversides. Omnivores include gizzard shad, common carp, carpsuckers, buffalo, and channel and blue catfish. Top carnivores include bass, gar, skipjack herring, crappie, flathead catfish, sauger, and walleye. Benthic invertivores include freshwater drum, suckers, and darters. Planktivores include alewife, threadfin shad, and paddlefish. Herbivores include largescale stonerollers. Lampreys in the genus *Ichthyomyzon* are the only parasitic species occurring in Tennessee River reservoirs.

To establish expected proportions of each trophic guild and the expected number of species included in each guild occurring in transition zones in upper mainstem Tennessee River reservoirs (Nickajack, Chickamauga, Watts Bar, and Fort Loudon reservoirs), data collected from 1993 to 2022 were analyzed for each reservoir zone (inflow, transition, forebay). Samples collected in the downstream vicinity of thermal discharges were not included in this analysis so that accurate expectations could be calculated with the assumption that these data represent what should occur in

Species Richness and Composition

(1) **Total number of species** – Greater numbers of species are considered representative of healthier aquatic ecosystems. As conditions degrade, numbers of species at an area decline.

(2) **Number of centrarchid species** – Sunfish species (excluding black basses) are invertivores and a high diversity of this group is indicative of reduced siltation and suitable sediment quality in littoral areas.

(3) **Number of benthic invertivore species** – Due to the special dietary requirements of this species group and the limitations of their food source in degraded environments, numbers of benthic invertivore species increase with better environmental quality.

(4) **Number of intolerant species** – A category of species that are particularly intolerant of physical, chemical, and thermal habitat degradation. Higher numbers of intolerant species suggest the presence of fewer environmental stressors.

(5) **Percentage of tolerant individuals** (excluding young-of-year) – An increased proportion of individuals tolerant of degraded conditions signifies poorer water quality.

(6) **Percent dominance by one species** – Ecological quality is considered reduced if one species inordinately dominates the resident fish community.

(7) **Percentage of non-indigenous species** – Based on the assumption that non-indigenous species reduce the quality of resident fish communities.

(8) **Number of top carnivore species** – Higher diversity of piscivores is indicative of the availability of diverse and plentiful forage species and the presence of suitable habitat.

Trophic Composition

(9) **Percent top carnivores** – A measure of the functional aspect of top carnivores which feed on major planktivore populations.

(10) **Percent omnivores** – Omnivores are less sensitive to environmental stresses due to their ability to vary their diets. As trophic links are disrupted due to degraded conditions, specialist species such as insectivores decline while opportunistic omnivorous species increase in relative abundance.

Abundance

(11) **Average number per run** (number of individuals) – Based on the assumption that high quality fish assemblages support large numbers of individuals.

River Bottom Habitat

Along each transect described above, a benthic grab sample was collected with a Ponar dredge at each of ten points equally spaced from the LDB to the RDB. Substrate material collected with the Ponar was emptied into a screen, and percent composition of each substrate was estimated to determine existing benthic habitat across the width of the river. Water depths (feet) at each sample location were recorded. If no substrate was collected after multiple Ponar drops, it was assumed that the substrate was bedrock. For example, when the Ponar was pulled shut, collectors could feel substrate consistency. If it shut easily and was not embedded in the substrate on numerous drops within the same location, the substrate was recorded as bedrock.

Fish Community Sampling Methods and Data Analysis for Sites Upstream and Downstream of SQN

Thermal discharge from SQN enters Chickamauga Reservoir in the Tennessee River at TRM 483.6 (Figure 2). To evaluate the fish community in the vicinity of SQN, two sample sites were selected. One site was centered in the transition zone of Chickamauga Reservoir at TRM 490.5, upstream of the plant's intake (Figure 3), and served as a reference site unaffected by the thermal discharge. The second site was centered in the transition zone at TRM 482.0, downstream of the cooling water discharge (Figure 4), and served as the site affected by thermal effluent. TVA's Reservoir Ecological Health (REH) program monitors three additional sample areas on Chickamauga Reservoir: Forebay, TRM 472.3; Inflow, TRM 529.0; and Hiwassee River Embayment, HiRM 8.5.

Fish sampling methods utilized include boat electrofishing and gill netting (Hubert 1996; Reynolds 1996). Electrofishing methodology consisted of fifteen boat electrofishing runs near the shoreline, each 300 meters long and of approximately 10 minutes duration. The total near-shore area sampled was approximately 4,500 meters (15,000 feet).

Experimental gill nets (so called because of their use for research as opposed to commercial fishing) were used as an additional gear type to collect fish from deeper habitats not effectively sampled by electrofishing. Each experimental gill net consists of five 6.1-meter panels for a total length of 30.5 meters (100.1 feet). The distinguishing characteristic of experimental gill nets is mesh size that varies between panels. For this application, each net has panels with mesh sizes of 2.5, 5.1, 7.6, 10.2, and 12.7 cm. Experimental gill nets are typically set perpendicular to river flow, extending from near shore to the main channel of the reservoir. Ten experimental gill nets were set overnight in each sample reach.

Fish collected were identified by species, counted, and examined for anomalies (such as disease, deformations, parasites or hybridization). The resulting data were analyzed using RFAI methodology.

The RFAI uses 12 fish community metrics from four general categories: Species Richness and Composition; Trophic Composition; Abundance; and Fish Health. Individual species can be utilized for more than one metric, though hybrid species and non-indigenous species are excluded from metrics counting numbers of individual species. Together, these 12 metrics provide a balanced evaluation of fish community integrity. The individual metrics are shown below, grouped by category:

Appendix A. Field study design, sampling methods, and Reservoir Fish Assemblage Index methodology used by TVA to monitor biological communities in the vicinity of Sequoyah Nuclear Plant during the period 2000-2011, 2013, 2015, 2017, 2019-2022.

Evaluation of Plant Operating Conditions

Data describing the operation of SQN during the course of biological monitoring—specifically daily averages of power generation, water temperatures at the CCW system intake and discharge, and the flow rate of water through the CCW system—were collected, compiled, analyzed and compared to available historical operations data to assist in the interpretation of thermal plume characteristics and biological community information.

Aquatic Habitat in the Vicinity of SQN

Shoreline and river bottom habitat data presented in this report were collected during autumn 2020. TVA assumes habitat data to be valid for five years, barring any major changes to the river/reservoir (e.g. major flood event). No significant changes have occurred in the river system from the initial characterization, but in the event of such a change, habitat will be re-evaluated during the following sample period.

Shoreline Aquatic Habitat Assessment

An integrative multi-metric index (Shoreline Aquatic Habitat Index or SAHI), including several habitat parameters important to resident fish species, was used to measure existing fish habitat quality in the vicinity of SQN. Using the general format developed by Plafkin et al. (1989), seven metrics were established to characterize selected physical habitat attributes important to reservoir resident fish populations which rely heavily on the littoral (shoreline) zone for reproductive success, juvenile development, and adult feeding (Table A-1). Habitat Suitability Indices (U.S. Fish and Wildlife Service), along with other sources of information on biology and habitat requirements (Etnier and Starnes 1993), were consulted to develop "reference" criteria or "expected" conditions from a high quality environment for each parameter. Some generalizations were necessary in setting up scoring criteria to cover the various requirements of all species into a single index.

When possible, the quality of shoreline aquatic habitat was assessed while traveling parallel to the shoreline in a boat and evaluating the habitat within 10 vertical feet of full pool. Transects were established across the width of Chickamauga Reservoir within the fish community sampling reaches upstream and downstream of SQN (Figure 11). At each transect, near-shore aquatic habitat was assessed along sections of shoreline corresponding to the left descending bank (LDB) and right descending bank (RDB). For each shoreline section (16 upstream and 16 downstream of SQN), percentages of aquatic macrophytes in the littoral areas were estimated, then each section was scored by comparing the observed conditions associated with each individual metric to the "reference" conditions and assigning the observations a corresponding value: "Good" – 5; "Fair" – 3; or "Poor" – 1 (Table A-1). The scores for each of the seven metrics were summed to obtain the SAHI value for the shoreline section, and this value was assigned a habitat quality descriptor based on trisecting the range of potential SAHI values ("Poor", 7-16; "Fair", 17-26; and "Good", 27-35).

APPENDICES

Table 19. (Continued)

November, 2022	–		LDB						Mid-channel						RDB			
TRM 490.5	**Depth**	**°C**	**°F**	**pH**	**Cond**	**DO**	**Depth**	**°C**	**°F**	**pH**	**Cond**	**DO**	**Depth**	**°C**	**°F**	**pH**	**Cond**	**DO**
Upstream Boundary	0.30	11.65	52.97	7.83	197.20	9.70	0.30	12.80	55.04	7.76	198.30	9.14	0.30	12.55	54.59	7.66	198.20	9.23
	1.50	11.22	52.20	7.81	197.40	9.70	1.50	12.77	54.99	7.75	199.70	9.13	1.50	12.45	54.41	7.61	198.60	9.27
	2.50	10.88	51.58	7.80	197.50	9.84	3.00	12.77	54.99	7.73	198.50	9.14	2.40	12.41	54.34	7.60	198.60	9.47
							4.00	12.76	54.97	7.71	198.00	9.12						
							6.00	12.74	54.93	7.71	198.10	9.14						
							8.00	12.74	54.93	7.71	198.00	9.10						
							8.50	12.72	54.90	7.70	198.10	9.19						
Mid-reach	0.30	11.94	53.49	7.74	199.20	9.33	0.30	12.69	54.84	7.78	197.30	9.17	0.30	12.65	54.77	7.81	198.80	9.27
	1.50	11.90	53.42	7.68	199.70	9.32	1.50	12.64	54.75	7.75	197.40	9.17	1.50	12.63	54.73	7.81	198.50	9.28
	2.60	11.85	53.33	7.69	199.50	9.43	3.00	12.61	54.70	7.73	197.20	9.18	3.00	12.63	54.73	7.78	198.40	9.29
							5.00	12.58	54.64	7.73	197.30	9.16	3.60	12.61	54.70	7.79	198.50	9.41
							7.00	12.54	54.57	7.72	197.90	9.15						
							9.00	12.53	54.55	7.70	198.10	9.16						
							10.00	12.55	54.59	7.68	197.90	9.20						
Downstream Boundary	0.30	12.58	54.64	7.79	198.00	9.22	1.50	12.76	54.97	7.79	199.00	9.24	0.30	11.96	53.53	7.79	201.20	9.36
	1.50	12.50	54.50	7.78	198.10	9.23	3.00	12.69	54.84	7.78	197.90	9.23	1.50	11.91	53.44	7.81	201.00	9.39
	3.00	12.43	54.37	7.77	198.20	9.26	4.00	12.63	54.73	7.77	197.90	9.25	3.00	11.91	53.44	7.79	201.00	9.43
	4.20	12.35	54.23	7.77	198.30	9.31	5.00	12.56	54.61	7.77	198.00	9.29	4.00	11.90	53.42	7.79	201.00	9.49
							6.00	12.47	54.45	7.77	198.10	9.33						
							7.00	12.31	54.16	7.77	198.10	9.33						
							8.00	12.25	54.05	7.77	198.20	9.35						
							9.00	12.20	53.96	7.77	198.20	9.36						
							10.00	12.18	53.92	7.76	198.30	9.38						
							11.20	12.17	53.91	7.76	198.30	9.35						

Table 19. (Continued)

November, 2022 –	LDB						Mid-channel						RDB					
TRM 482	Depth	°C	°F	pH	Cond	DO	Depth	°C	°F	pH	Cond	DO	Depth	°C	°F	pH	Cond	DO
Upstream	0.3	11.61	52.90	7.95	199.20	9.55	0.30	13.22	55.80	7.97	198.10	9.26	0.30	12.33	54.19	7.91	197.90	9.26
Boundary	1.5	11.57	52.83	7.95	200.10	9.55	1.50	13.19	55.74	7.96	198.20	9.27	1.50	12.29	54.12	7.90	197.70	9.31
	3	11.55	52.79	7.94	200.10	9.64	3.00	13.12	55.62	7.95	198.00	9.28	2.30	12.34	54.21	7.87	197.60	9.60
	3.4	11.55	52.79	7.93	200.20	9.91	4.00	13.09	55.56	7.94	198.00	9.28						
							5.00	13.18	55.72	7.93	198.00	9.27						
							6.00	13.05	55.49	7.94	198.00	9.26						
							7.00	13.17	55.71	7.93	197.70	9.25						
							8.00	12.92	55.26	7.92	198.30	9.27						
							8.90	12.87	55.17	7.92	197.80	9.29						
							9.90	12.74	54.93	7.93	197.90	9.30						
							11.00	12.86	55.15	7.91	198.10	9.27						
							12.00	12.68	54.82	7.91	197.90	9.26						
							13.10	12.63	54.73	7.90	197.90	9.24						
							14.10	12.59	54.66	7.89	197.70	9.26						
							15.10	12.72	54.90	7.88	197.60	9.27						
Mid-reach	0.3	13.14	55.65	7.93	198.60	9.33	0.30	13.05	55.49	7.94	198.20	9.30	0.30	12.96	55.33	7.91	199.30	9.22
	1.4	13.13	55.63	7.92	198.60	9.31	1.50	13.06	55.51	7.94	198.10	9.29	1.50	12.49	54.48	7.88	198.60	9.23
	2.8	12.97	55.35	7.92	199.30	9.34	3.00	12.98	55.36	7.93	198.30	9.27	3.00	12.46	54.43	7.86	198.50	9.30
							4.00	12.79	55.02	7.93	198.10	9.28	3.50	12.48	54.46	7.85	198.30	9.75
							5.00	12.61	54.70	7.92	198.20	9.30						
							5.90	12.53	54.55	7.93	198.30	9.31						
							8.00	12.45	54.41	7.92	198.20	9.31						
							10.00	12.44	54.39	7.90	198.00	9.30						
							12.10	12.43	54.37	7.89	198.00	9.35						
							14.10	12.42	54.36	7.88	198.00	9.59						
Downstream Boundary	0.3	13.09	55.56	7.96	198.80	9.37	0.30	13.13	55.63	7.95	198.40	9.30	2.50	13.18	55.72	7.85	199.20	9.81
	1.5	13.07	55.53	7.96	198.70	9.34	1.50	13.06	55.51	7.94	198.40	9.29	0.30	13.17	55.71	7.88	199.20	9.36
	2.4	13.08	55.54	7.98	199.00	9.19	3.00	13.04	55.47	7.95	198.40	9.28	1.50	13.17	55.71	7.87	199.20	9.43
							4.00	13.09	55.56	7.93	198.40	9.30						
							5.00	13.06	55.51	7.94	198.50	9.29						
							6.00	13.04	55.47	7.93	198.40	9.32						
							7.00	13.00	55.40	7.93	198.40	9.31						
							8.00	13.00	55.40	7.92	198.40	9.32						
							9.00	12.97	55.35	7.92	198.50	9.29						
							10.00	12.95	55.31	7.92	198.40	9.27						
							11.00	12.94	55.29	7.92	198.50	9.27						
							12.00	12.95	55.31	7.92	198.50	9.26						
							13.00	12.94	55.29	7.90	198.50	9.31						
							15.00	12.94	55.29	7.90	198.50	9.29						
							17.10	12.94	55.29	7.88	198.60	9.28						

Table 19. (Continued)

Summer 2022 – TRM 490.5	LDB						Mid-channel						RDB					
	Depth	°C	°F	pH	Cond	DO	Depth	°C	°F	pH	Cond	DO	Depth	°C	°F	pH	Cond	DO
Upstream Boundary	0.3	26.96	80.52	8.18	176.5	8.19	0.3	26.37	79.46	7.62	176.5	6.16	0.3	26.3	79.34	7.44	177.9	5.37
	1.5	26.88	80.38	7.81	177	6.13	1.5	26.28	79.30	7.53	176.7	5.42	1.5	26.29	79.32	7.41	177.8	5.24
	3	26.44	79.59	7.48	177.9	4.83	3	26.21	79.17	7.48	177.5	5.08	3	26.23	79.21	7.31	178.2	5.2
	4.3	26.36	79.44	7.46	178.1	4.59	4	26.2	79.16	7.47	178.1	4.99	4	26.21	79.17	7.24	178.1	5.16
							6	26.19	79.14	7.45	178.8	4.76	5.2	26.17	79.10	7.09	178.3	5.45
							8	26.12	79.01	7.43	179	4.55						
							10.1	26.05	78.89	7.44	179.4	4.68						
Mid-reach	0.3	26.62	79.91	7.7	178.3	6.21	0.3	26.49	79.68	7.73	178.1	6.71	0.3	26.42	79.55	7.62	176.5	6.07
	1.5	26.55	79.79	7.52	179.5	5.01	1.5	26.4	79.52	7.63	178.3	6.15	1.5	26.39	79.50	7.63	176.5	6.12
	3	26.39	79.50	7.48	177.3	4.96	3	26.29	79.32	7.51	179.3	5.24	2.7	26.36	79.44	7.62	175.6	6.15
	3.2	26.39	79.50	7.49	177.7	4.88	5	26.18	79.12	7.46	179.6	4.79						
							7	26.12	79.01	7.43	179.3	4.68						
							9	26.12	79.01	7.43	178.7	4.65						
							11	26.11	78.99	7.41	178.4	4.56						
							11.3	26.11	78.99	7.44	178.4	4.66						
Downstream Boundary	0.3	26.6	79.88	7.86	177.6	7.39	0.3	26.52	79.73	7.66	177.9		0.3	26.68	80.02	7.71	179.4	6.59
	1.5	26.58	79.84	7.78	177.6	6.8	1.5	26.42	79.55	7.59	176.8	5.65	1.5	26.62	79.91	7.68	179.3	6.51
	2.7	26.22	79.19	7.5	176.8	4.91	3	26.28	79.30	7.5	176.7	5.21	3	26.59	79.86	7.64	179.3	6.24
							5	26.25	79.25	7.48	176.8	5.16	4	26.55	79.79	7.57	179.2	5.96
							6	26.24	79.23	7.47	176.6	5.13	4.6	26.44	79.59	7.49	178.2	5.38
							8	26.22	79.19	7.46	176.2	5.07						
							10	26.21	79.17	7.45	176.4	5.04						
							12	26.2	79.16	7.45	176	5.02						
							12.8	26.2	79.16	7.46	176.4	5.12						
							16	26.81	80.25	7.45	179.2	5.24						
							18	26.77	80.18	7.43	180.7	5.04						
							18.6	26.77	80.18	7.42	180.7	5.02						

Table 19. Water quality parameters collected during summer and autumn 2022 along vertical depth profiles at three transects within biological sample reaches sited upstream (TRM 490.5) and downstream (TRM 482.0) of Sequoyah Nuclear Plant

Summer 2022 - TRM 482	LDB						Mid-channel						RDB					
	Depth	°C	°F	pH	Cond	DO	Depth	°C	°F	pH	Cond	DO	Depth	°C	°F	pH	Cond	DO
Upstream Boundary	0.3	28.96	84.13	7.55	180.00	5.88	0.30	28.95	84.11	7.53	180.00	5.79	0.30	28.31	82.96	7.59	180.20	6.11
	1.5	28.95	84.11	7.56	180.20	5.85	1.50	29.01	84.22	7.54	180.20	5.80	1.50	27.10	80.78	7.61	179.30	6.27
	3	28.92	84.06	7.53	180.10	5.75	3.00	28.99	84.18	7.53	179.90	5.79	3.00	26.84	80.31	7.59	178.70	6.03
	4	28.52	83.34	7.51	180.50	5.66	4.00	28.95	84.11	7.52	180.20	5.79	4.00	26.60	79.88	7.58	178.80	6.46
	4.8	27.77	81.99	7.50	180.10	5.71	5.00	28.96	84.13	7.52	179.90	5.79						
							7.00	28.74	83.73	7.52	180.10	5.79						
							9.00	28.25	82.85	7.52	179.80	5.76						
							11.00	27.79	82.02	7.52	179.60	5.78						
							13.00	27.39	81.30	7.51	179.40	5.69						
							15.00	26.86	80.35	7.50	179.70	5.64						
							17.00	26.72	80.10	7.49	179.60	5.56						
							17.60	26.69	80.04	7.48	179.30	5.54						
Mid-reach	0.3	28.40	83.12	7.57	179.80	5.90	0.30	28.96	84.13	7.56	180.20	5.86	0.30	28.23	82.81	7.58	179.40	6.31
	1.5	28.39	83.10	7.55	179.90	5.84	1.50	28.68	83.62	7.55	179.70	5.85	1.50	28.13	82.63	7.65	178.90	6.42
	3	28.28	82.90	7.51	179.50	5.42	3.00	28.59	83.46	7.55	179.70	5.79	3.00	28.06	82.51	7.57	179.50	5.97
	4	28.18	82.72	7.48	178.30	5.40	4.00	28.53	83.35	7.53	179.60	5.76	4.00	28.04	82.47	7.55	179.50	5.84
							5.00	28.16	82.69	7.53	179.40	5.78	5.00	28.02	82.44	7.56	179.60	6.02
							7.00	27.94	82.29	7.52	179.60	5.77						
							9.00	27.79	82.02	7.52	179.40	5.78						
							11.00	27.55	81.59	7.51	179.20	5.77						
							13.00	26.93	80.47	7.50	178.60	5.78						
							15.00	26.76	80.17	7.40	176.80	5.34						
							15.30	26.75	80.15	7.39	176.70	5.10						
Downstream Boundary	0.3	27.95	82.31	7.55	179.30	5.99	0.30	28.45	83.21	7.56	179.70	5.90	0.30	28.21	82.78	7.55	179.80	5.77
	1.5	27.85	82.13	7.55	179.00	5.74	1.50	28.40	83.12	7.55	179.90	5.93	1.50	28.15	82.67	7.54	180.10	5.76
	3	27.74	81.93	7.52	178.60	5.65	3.00	28.37	83.07	7.53	179.60	5.88	3.00	28.15	82.67	7.55	179.60	5.84
	4	27.74	81.93	7.50	178.80	5.68	4.00	28.19	82.74	7.52	179.60	5.72						
							6.00	27.90	82.22	7.52	179.70	5.77						
							8.00	27.34	81.21	7.52	179.00	5.76						
							10.00	26.96	80.53	7.49	179.20	5.66						
							12.00	26.87	80.37	7.48	179.00	5.62						
							14.00	26.86	80.35	7.48	178.90	5.52						
							16.00	26.81	80.26	7.45	179.20	5.24						
							18.00	26.77	80.19	7.43	180.70	5.04						
							18.60	26.77	80.19	7.42	180.70	5.02						

Table 18. (Continued)

Transect and Profile Location (% from right descending bank)

Depth (m)	Ambient - TRM 485.4	SQN Discharge-TRM 483.7			TRM 483.1			TRM 482.7			TRM 482.0			TRM 481.2		
	Thalweg - 30%	10%	50%	90%	10%	50%	90%	10%	50%	90%	10%	50%	90%	10%	50%	90%
Summer 2022																
0.3	79.84	82.96	84.11	84.13	83.59	84.52	83.52	82.81	84.13	83.12	83.26	83.64	83.26	82.78	83.21	82.31
1.5	79.72	80.78	84.22	84.11	83.53	84.16	83.53	82.63	83.62	83.10	83.23	83.55	83.26	82.67	83.12	82.13
3	79.61	80.31	84.18	84.06	83.52	83.70	83.43	82.51	83.46	82.90	83.01	83.41	83.03	82.67	83.07	81.93
4		79.88	84.11	83.34		83.10	83.37	82.47	83.35	82.72	82.89	83.17	82.87		82.74	81.93
5	79.57		84.13	81.99				82.44	82.69							
6						82.33						82.99			82.22	
7	79.52		83.73						82.29							
8						81.93						82.90			81.21	
9	79.54		82.85						82.02							
10						81.18						82.53			80.53	
11	79.52		82.02						81.59							
12						80.60						81.73			80.37	
13	79.48		81.30						80.47							
14						80.46						80.42			80.35	
15			80.35						80.17							
16						80.28						80.20			80.26	
17			80.10													
18												80.20			80.19	

*Shaded numbers represent temperatures 3.6°F (2°C) or greater above ambient temperature (i.e., thermal plume).

Table 18.Depth profiles of water temperature (°F) collected to determine the extent of the thermal plume* discharged from TVA's SequoyahNuclear Plant during autumn and summer 2022

	Transect and Profile Location (% from right descending bank)																			
	Ambient-TRM 485.4					SQN Discharge-TRM 483.7					TRM 482.8					TRM 481.6				
Depth (m)	10%	30%	50%	70%	90%	10%	30%	50%	70%	90%	10%	30%	50%	70%	90%	10%	30%	50%	70%	90%
Autumn 2022																				
0.3	54.19	54.41	54.39	53.71	52.84	54.19	54.28	55.80	54.21	52.90	55.33	55.15	55.49	55.71	55.65	55.71	55.09	55.63	55.71	55.56
1.5	54.23	54.46	54.39	53.69	52.81	54.12	54.30	55.74	54.25	52.83	54.48	55.04	55.51	55.71	55.63	55.71	55.02	55.51	55.71	55.53
3		54.46	54.37	53.73	52.65		54.25	55.62	54.21	52.79	54.43	55.06	55.36	55.42	55.35			55.47	55.69	
4		54.45	54.37		52.52		54.27	55.56	54.14			55.04	55.02	55.26				55.56	55.69	
5		54.46	54.36				54.27	55.72	54.14				54.70	55.35				55.51		
6		54.46	54.36				54.23	55.49	54.16				54.55	55.29				55.47	55.69	
7		54.48	54.28				54.25	55.71	53.98				54.41	55.04				55.40		
8		54.46	54.36					55.26	53.80				54.39	54.93				55.40	55.49	
9		54.46	54.37					55.17	53.92				54.37	54.72				55.35		
10		54.48	54.28					54.93	53.82				54.36	54.68				55.31	55.27	
11		54.48						55.15	53.83					54.68				55.29		
12		54.46						54.82	53.83									55.31	55.33	
13								54.73												
14								54.66										55.29	55.26	
15								54.90										55.29		
17																		55.29	55.31	

*Shaded numbers represent temperatures 3.6˚F (2°C) or greater above ambient temperature (i.e., thermal plume).