

# 2023 WATER QUALITY STUDY PLAN

STEVENS CREEK HYDROELECTRIC PROJECT

FERC No. 2535

Prepared for:

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## 1.0 INTRODUCTION

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Dominion Energy South Carolina, Inc. (DESC) is the licensee of the Stevens Creek Hydroelectric Project (Project) (Federal Energy Regulatory Commission [FERC] No. 2535). The Project, which has an installed capacity of 17.28 megawatts, is located in Edgefield and McCormick counties, South Carolina and Columbia County, Georgia, at the confluence of Stevens Creek and the Savannah River. The Project's dam is located approximately 1 mile upstream of the Augusta Diversion Dam (project works for the Augusta Canal Project [FERC No. 11810]), and approximately 13 miles downstream of the United States Army Corps of Engineers (USACE) J. Strom Thurmond Dam (Thurmond Dam). The Stevens Creek Reservoir is approximately 25 miles long, extending upstream to the Thurmond Dam and 12 miles up Stevens Creek. The surface area of the reservoir is 2,400 acres at the normal full pond elevation 187.5 feet. The Project drainage area is approximately 7,173 square miles.

DESC operates the Project to generate clean, renewable energy and re-regulate highly variable river flows discharged by the USACE from the Thurmond Dam. DESC's operational protocols include providing an hourly discharge of +/- 15 percent of the scheduled daily average discharge from Thurmond Dam, if the actual discharge from Thurmond Dam is within 500 cubic feet per second of the scheduled discharge.

On November 22, 1995, FERC issued a 30-year license which is scheduled to expire on October 31, 2025. DESC intends to file an application for a new license with FERC on or before October 31, 2023. The Project is currently involved in a relicensing process which involves cooperation and collaboration between DESC, as licensee, and a variety of stakeholders including state and federal resource agencies, state and local government, non-governmental organizations, and interested individuals. DESC established a Water Quality, Fish, and Wildlife Resource Conservation Group (RCG) with interested stakeholders to address Project issues related to aquatic and terrestrial resources. DESC, in consultation with the RCG, developed a Water Quality Study Plan and performed the study from January 2021 through February 2022.

In comments on the Water Quality Study Report, which was distributed on June 30, 2022, the South Carolina Department of Natural Resources (SCDNR), Georgia Department of Natural Resources (GADNR), and National Marine Fisheries Service (NMFS) recommended that the water quality study be extended another year. Specifically, the agencies recommended a more focused study on the Stevens Creek arm of the reservoir to help

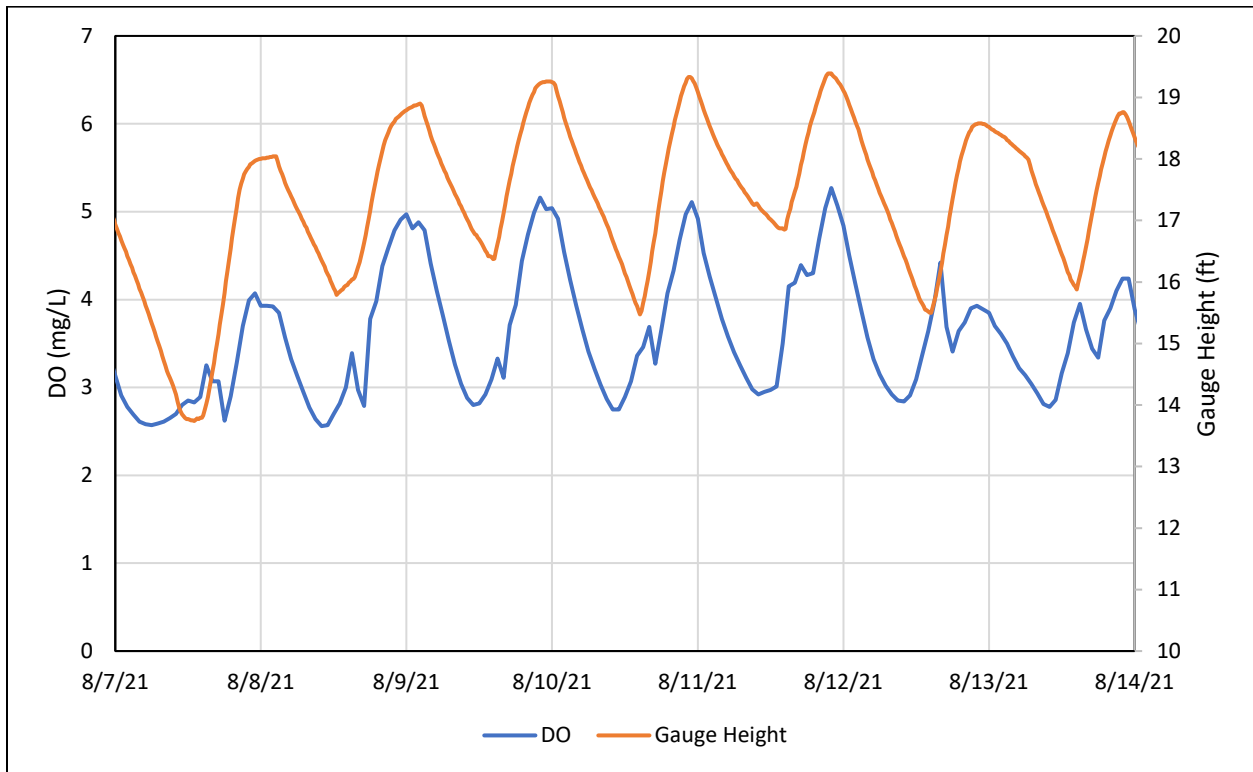
determine the factors causing low dissolved oxygen (DO) levels in that reach. This study plan lays out the methodology and schedule for performing a targeted study of Stevens Creek.

## **1.1 Background Information**

The study conducted by DESC from January 2021 to February 2022 provided valuable additional insight into water quality at the Project. Though improvements to DO levels in Thurmond Dam releases have been made, low DO levels are still intermittently experienced in the Stevens Creek Reservoir and forebay during the summer months. However, releases from the Stevens Creek Powerhouse have been shown to be consistently at or above minimum DO criteria for the states of Georgia and South Carolina. Additionally, consistent with the previous two decades of monitoring, low summer DO levels in the Stevens Creek arm of the reservoir continue to persist.

Data from the 2021-2022 study indicate the lowest DO levels at the Stevens Creek monitoring location occurred during the daytime, while the highest DO levels occurred at night. This is opposite of what is typically seen in natural systems where diurnal fluctuations in DO due to photosynthesis and respiration yield the highest DO levels during the afternoon and the lowest DO levels in the early morning hours prior to sunrise. Upon closer examination, it was determined that the highest (nighttime) and lowest summer DO levels corresponded with highest and lowest daily water surface elevations in Stevens Creek (Figure 1.1).

On December 13, 2022, DESC held a meeting with a subset of the RCG, the Water Quality Technical Working Committee (TWC), to discuss additional study needs for the 2023 monitoring season. During the meeting, the group discussed the need to better understand the extent and duration of low DO events in Stevens Creek. A reconnaissance trip of the study area was completed on February 22, 2023. A follow-up meeting was held with the TWC on April 17, 2023. This draft study plan includes recommendations from resource agencies and stakeholders identified during the two meetings.



**Figure 1.1 Example of Dissolved Oxygen<sup>1</sup> and Water Level Fluctuations<sup>2</sup> in Stevens Creek**

<sup>1</sup> As measured 4.5 RMs upstream of the confluence of Stevens Creek with the Savannah River at the Project dam.

<sup>2</sup> As measured at United States Geological Survey Gage Number 02196000, located approximately 8 RMs upstream of the uppermost point of the Project boundary line.

## 2.0 OBJECTIVE

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The overall objective of this study is to assess the DO dynamics in the Stevens Creek arm of the Project impoundment, as well as the temporal and longitudinal extent of low DO levels. The objective of this study will be reached via three distinct efforts within the Stevens Creek arm of the Project impoundment:

1. Continuous monitoring will be used to enable comparisons to monitoring results from 2022, and to track changes in DO as they occur through the system.
2. Longitudinal surveys will be used to determine the upstream extent of hypoxic conditions and to track changes in DO as they occur through the system.
3. Off-channel surveys will be used to pinpoint suspected sources of hypoxic water being flushed into the system.

### 3.0 GEOGRAPHIC AND TEMPORAL SCOPE

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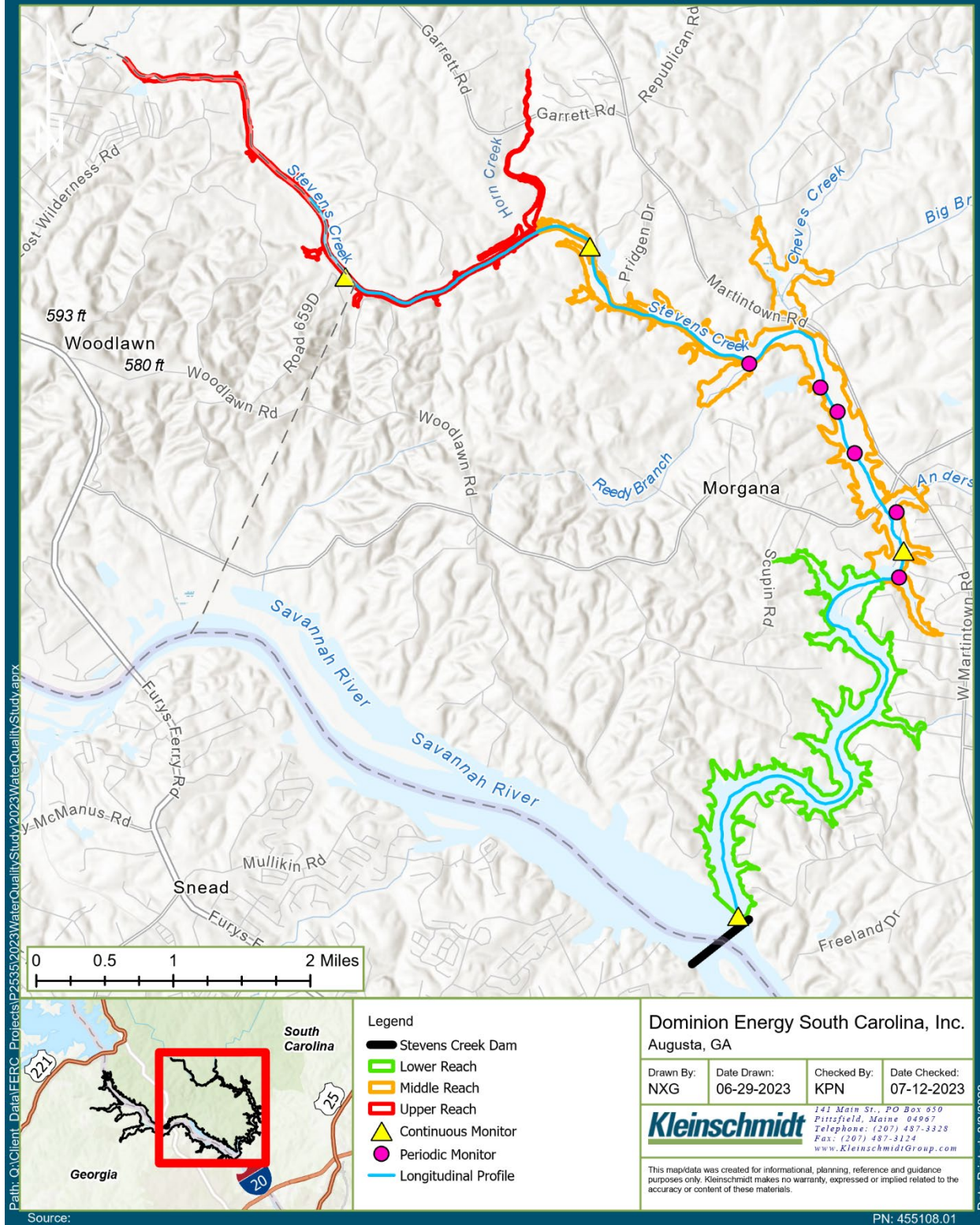
For the purposes of conceptualizing DO conditions, the Stevens Creek arm of the reservoir has been divided into three reaches (Lower, Middle, and Upper), each approximately 4 river miles (RMs) in length. Water quality will be monitored continuously in each reach: at the mouth of Stevens Creek upstream of Stevens Creek Dam (Lower Reach; Study Site 4); within Stevens Creek, approximately 4.5 RMs upstream of its confluence with the Savannah River at Stevens Creek Dam (Middle Reach; Study Site 5); and approximately 8.5 RMs upstream of the mouth of Stevens Creek directly below the confluence of Horn Creek with Stevens Creek (Upper Reach; Study Site 7) (Figure 3.1). An additional continuous monitor will be located at RM 10.5 to collect data at the uppermost portion of the Stevens Creek Project boundary that is accessible by motorboat (Study Site 8). Other locations in Stevens Creek will be monitored periodically to provide additional information on the mechanisms affecting DO concentrations in Stevens Creek. The monitoring will be conducted from May 1 to October 31, 2023.

Longitudinal surveys will generally be planned around discharges from the Thurmond Dam. In order to track changes in DO as they occur throughout the creek system, the longitudinal survey will consist of an upstream tow that will be conducted in the morning and a downstream tow in the afternoon.

Off-channel DO monitoring will occur at the mouths of several shallow ponds to help determine if they are a source of hypoxic waters entering the creek system. Off-channel monitoring will be coordinated with the longitudinal surveys so that monitoring stations are established and recorded while the longitudinal tows are being conducted.

Inflow into the Project boundary will be estimated for each longitudinal survey and off-channel monitoring effort.

# 2023 Water Quality Study Sites



**Figure 3.1 2023 Water Quality Study Sites**



## 4.0 DATA COLLECTION METHODS AND ANALYSIS

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For all monitoring studies within the Lower Reach, the monthly average, maximum, and minimum DO, as well as temperature, conductivity, pH, and turbidity will be assessed. For all monitoring studies at the Middle and Upper reaches, only DO and temperature will be assessed.

The parameters being assessed in this study (monthly maximum and minimum DO and temperature, conductivity, pH, and turbidity) will be discussed individually in the study report. For each parameter, a summary of findings will be reported for each effort (continuous monitoring, longitudinal surveys, and off-channel surveys). For each effort, data will be interpreted among each survey site within each reach (Upper, Middle, and Lower).

Post-data collection calculations will include the calculation of the average monthly DO, temperature, conductivity, pH, and turbidity. A data analysis will be conducted to calculate the duration of events when DO falls below 4.0 milligrams per liter. Trends in the data will be visualized using line plot graphs. On these graphs, the x-axis will represent time and the y-axis will represent parameter values (DO, temperature, etc.). Tables will be created that illustrate these results. Maps will be created for the longitudinal surveys for each survey effort. These maps will depict the upstream and downstream routes of the surveys and include a color gradient which depicts the average DO level in a given area. These maps will assist with the visualization of trends of longitudinal surveys and DO concentration throughout the survey area.

### 4.1 Continuous Monitoring

Water quality will be monitored at Study Sites 4, 5, 7, and 8 for temperature and DO, conductivity, turbidity, and pH using a YSI EXO3 continuous water quality monitor (Yellow Springs Instruments [YSI]). Water temperature and DO at Study Sites 7 and 8 will be monitored using a HOBO DO Logger (Onset). The instruments will be calibrated according to the manufacturer's specifications and set to record measurements at hourly intervals. The continuous monitors will be deployed from May 1, 2023, through October 31, 2023.

The instruments will be cleaned, checked for accuracy, and downloaded monthly, at a minimum. A separate, calibrated meter will be used to record DO, water temperature, pH, conductivity, and turbidity readings during each maintenance visit to the sites. These data will be compared to deployed instrument data as a check on accuracy and for use in post-processing and correction of any fouling or calibration drift. All monitors will be placed approximately three feet below the surface of the stream. The depth of Stevens Creek at the various monitoring locations varies throughout the reaches. The stream channel areas which contain the two continuous monitors within the Upper Reach are approximately five feet deep. The stream channel area where the Middle Reach monitor is located is approximately six feet deep. The stream channel area where the Lower Reach monitor is recording is approximately ten feet deep. The water elevation range varies between 183 feet and 187.5 feet.

The hourly measurements will be compared with the longitudinal survey at corresponding dates, times, and locations. Similarly, these hourly measurements will be used to track discharges from Thurmond Dam as they push into the Stevens Creek arm of the reservoir. Correlations among continuous and longitudinal survey data will be shown in graphs, tables, and figures.

All continuous data will be compiled at the end of the monitoring season. The data will be analyzed by computing daily and monthly minimum, maximum, and average values for DO and water temperature and comparing them to applicable water quality criteria. The data for pH, conductivity, and turbidity will also be compared to applicable water quality criteria.

## **4.2 Longitudinal Surveys**

Roaming surveys will be performed to document the extent of low DO occurrences in Stevens Creek. Between May 1 and October 31, 2023, roaming surveys will be performed monthly between the mouth of Stevens Creek and up to ten RMs upstream of the mouth. Surveys will be performed by towing a YSI EXO 3 which will be submerged approximately one foot underwater. The logger will be towed upstream recording water quality measurements, latitude, and longitude every 30 seconds (approximately 1 measurement every 175 feet). The upstream terminus of each survey will be determined when measured DO readings are consistently stable over a five-minute period (i.e., upstream of the extent of low DO conditions). The boat will travel at a speed of approximately four miles per hour

while towing the instrument and recording data. There will not be a standard time of month or day of the week when surveys will be completed; however, surveys will be standardized in that they will be completed at least two weeks apart, at approximately the same time of day for each survey, and at consistent depths.

Longitudinal surveys will generally be planned around discharges from the Thurmond Dam. The upstream longitudinal survey will be conducted in the morning when DO within Stevens Creek is often at its lowest levels and/or when water levels are falling, and in the afternoon when Thurmond Dam is actively discharging.

The data recorded from the longitudinal surveys will be analyzed using Geographic Information System to determine the spatial extent of low DO concentrations.

### **4.3 Off-Channel Surveys**

DO and water temperature measurements will be collected during four separate events to occur monthly from July through October 2023. Monitoring will be conducted at 6 locations (Figure 3-1) during 24 to 48-hour periods. By monitoring the off-channel locations for a period ranging between 24 and 48 hours, the full effects of the releases from Thurmond Dam can be monitored. The locations were selected to include points where shallow, off-channel areas become inundated as releases from Thurmond Dam raise water levels in Stevens Creek. Optical HOB0 U26 DO loggers (Onset) will be placed at the mouths of off-channel areas to record DO levels as these areas fill and drain over a complete water level cycle.

There will not be a standard time of month or day of the week when surveys will be completed; however, surveys will be standardized in that they will be completed at least two weeks apart, at approximately the same time of day for each survey, and at consistent depths. In an effort to synthesize the data collected from the off-channel surveys with the other concurrent survey efforts, the results of the off-channel, longitudinal, and continuous surveys will be compared and contrasted to determine if off-channel areas are contributing to low DO conditions on the main stem of Stevens Creek.

### **4.4 Inflow Estimation**

The inflow of water into the uppermost portion of the Project boundary on Stevens Creek will be estimated for each longitudinal survey and off-channel monitoring effort by prorating the data from the United States Geological Survey (USGS) gage number

02196000 "Stevens Creek Near Modoc, SC", which is located approximately 8 RMs upstream of the top of the Stevens Creek Project boundary line and 20 RMs from the Project dam. The drainage area at the USGS gage is 545 square miles compared to 588 square miles at the Project boundary line on Stevens Creek. Due to the location of the gauge, it does not account for additional inflow into the creek (i.e., rain and creek input). Therefore, inflow will be grouped into one of three categories: normal; high; and low. Estimated inflow will be reported in tables and/or graphs for each survey event.

## 5.0 REPORTING

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A draft report summarizing study findings will be issued within four months of the end of the sampling period. The report will include tabular and graphical summaries of the water quality data, as well as summaries of pertinent hydrologic and meteorological data, and data collected by the United States Geological Survey as part of the existing Project license requirement.

Summary-level statistical analyses will be conducted for all three survey efforts. These analyses will include monthly average, minimum, and maximum values of each measured parameter and will be reported in tables and graphs for each survey effort. In addition, correlations among continuous, longitudinal, and off-channel survey data will also be shown in graphs, tables, and figures.

**APPENDIX A**  
**STAKEHOLDER CONSULTATION MATRIX**

Commentor	Comment Code	Comment	Applicant Response
NMFS	SCWQ NMFS GC01	To better conceptualize the extent of hypoxic conditions in Stevens Creek, and describe the DO dynamics within the reservoir, we propose dividing the Stevens Creek branch of the reservoir into 3 reaches (Upper, Middle, and Lower), each approximately 4 river miles in length (Figure 1). The lower reach begins at the confluence with the Savannah River and extends a little over 4 miles upstream, terminating downstream of the proposed continuous monitoring site. The middle reach extends from the lower reach 4.6 river miles upstream, terminating just downstream of the confluence with Horn Creek. The middle reach would contain all of the proposed off-channel survey sites. The Upper reach extends from the middle reach another 4.16 miles, terminating at the project boundary.	The study plan has been revised to include this recommendation.
NMFS	SCWQ NMFS GC02	We recommend modifying the proposed Plan to include a continuous monitoring station at the lower bound of each reach. The two stations proposed in the Plan would serve the lower and middle reaches. An additional continuous monitoring station will need to be established in the upper reach. The agencies propose placing it just downstream of the confluence with Horn Creek. We propose deploying all three continuous monitoring stations year round, recording WQ data every hour. Those data will be used as the lowest-resolution method of tracking hypoxic conditions as they move through the system.	An additional continuous monitoring station was established directly downstream of the confluence with Horn Creek as recommended. All three continuous monitors will be deployed from May 1 through October 31, 2023. Vast water quality data has been collected within the Project boundary, including in Stevens Creek. The objective of this study was to determine the extent and duration of low dissolved oxygen levels within Stevens Creek, which data indicate occurs between May and October. Dominion feels that existing data is adequate to characterize water quality during shoulder seasons and additional data collection outside of the proposed time frame is unnecessary for the purposes of understanding potential project effects to water quality.

Commentor	Comment Code	Comment	Applicant Response
NMFS	SCWQ NMFS GC03	<p>The longitudinal surveys represent the highest-resolution method of tracking hypoxic conditions and will be key in determining their upstream extent. We recommend modifying the proposed Plan to conduct a longitudinal survey once per month for the period from May through November. Additionally, we recommend conducting two surveys during months when hypoxic conditions typically do not occur (December - April) in order to enable comparisons to "healthy" river conditions. Surveys should begin at the confluence of Stevens Creek and the Savannah River and sample the entire 12.77 river miles of Stevens Creek within the project boundary.</p>	<p>The study plan has been revised to reflect that longitudinal studies will be conducted at least once per month from May through October. Surveys will begin at the mouth and sample up to 10 river miles of Stevens Creek, which is as far as the motorboat can travel. Longitudinal surveys are not planned to occur between November and April as the objective of the study was to determine the extent and duration of low dissolved oxygen levels within Stevens Creek, which data indicate occurs between May and October. Dominion feels that existing data is adequate to characterize water quality during shoulder seasons and additional data collection outside of the proposed time frame is unnecessary for the purposes of understanding potential project effects to water quality.</p>



Commentor	Comment Code	Comment	Applicant Response
NMFS	SCWQ NMFS GC04	<p>Surveys should be planned around discharges from Thurmond and standardized throughout the study period. One of the goals of the longitudinal surveys is to capture the maximum extent of hypoxic water. Therefore, the upstream survey should be conducted during the morning as DO is at its lowest around 11am. The other goal is to track changes in DO as they occur through the system. Therefore, it would be necessary to survey the area while Thurmond is actively discharging and water begins to push up into Stevens Creek, which occurs in the afternoon, around 2 pm. We propose modifying the proposed Plan to conduct a tow in both directions (up and downstream) during each survey. The upstream tow should be conducted in the morning, and the downstream tow in the afternoon. Surveys should also be coordinated with the off-channel monitoring so that monitors are in position and recording while the longitudinal surveys are being conducted. This will allow additional synthesis of data between the two efforts.</p>	<p>Longitudinal surveys are planned around discharges from Thurmond Dam, with an upstream tow in the morning and a downstream tow in the afternoon as recommended. The longitudinal surveys are also being coordinated with the off-channel monitoring.</p>

Commentor	Comment Code	Comment	Applicant Response
NMFS	SCWQ NMFS GC05	<p>Another key goal of the project is identifying the source of hypoxic waters that persist in the Stevens Creek arm of the reservoir. The current hypothesis is that discharges from Thurmond Dam are impounded by the Stevens Creek Dam and redirected up the Stevens Creek arm of the reservoir. Those waters then flush a series of shallow ponds that are situated off the mainstem of the middle reach of Stevens Creek. The stagnant water in those ponds is believed to be lowering the DO concentration in the reservoir. Previous work indicates that DO concentrations in the Stevens Creek arm of the reservoir improve as discharges from Thurmond enter the system, between afternoon and midnight. As water level declines from midnight to noon the next day, so does DO. Monitoring DO at the mouths of those shallow ponds will help determine if they are the source of hypoxic waters entering the system. Off-channel monitoring should be coordinated with the longitudinal surveys so that monitoring stations are established and recorded while the longitudinal tows are being conducted.</p>	<p>The off-channel monitoring is being coordinated with the longitudinal surveys as recommended.</p>
NMFS	SCWQ NMFS SC01	<p>In section 1.1, the discussion of how DO changes with temperature throughout the day is highly relevant to understanding the water quality dynamics at this project. We suggest including those analyses in revisions to the 2022 water quality report. As it stands, section 1.1 of this report is the first time these data are presented to the record.</p>	<p>The referenced discussion will be added to the 2022 water quality report as suggested.</p>

Commentor	Comment Code	Comment	Applicant Response
NMFS	SCWQ NMFS SC02	Section 2.0 presents the overall objective of the study. Because the study consists of three distinct efforts, the objective of each effort should be stated: a) The continuous monitoring is being conducted to enable comparisons to 2022, and can be used to track changes in DO as they occur through the system. b) The longitudinal survey is being conducted to determine the upstream extent of hypoxic conditions and can also be used to track changes in DO as they occur through the system. c) The off-channel surveys are being conducted to pinpoint a suspected source of hypoxic water being flushed into the system	Section 2.0 was revised to describe the effort objectives as recommended.
NMFS	SCWQ NMFS SC03	Section 3.0 should be revised to address all three efforts distinctly and completely.	Section 3.0 was revised to address the three efforts. Additional information was provided in Section 4.0.
NMFS	SCWQ NMFS SC04	Section 4.0, in general, requires more detail. In describing the data collection methods, provide the specific data that will be produced by each effort. Describe how those data will be summarized. What calculations will be done? What tables will be included? Describe how trends in the data will be visualized. What figures will be produced? What will the axes present? How will those figures address the effort's objectives? Describe what statistical analyses, if any, will be performed.	Section 4.0 was revised to include the requested information.

Commentor	Comment Code	Comment	Applicant Response
NMFS	SCWQ NMFS SC05	<p>In addition to the above, Section 4.1 should be revised to contain the following information: a) How long continuous monitors will be deployed throughout the year. b) Approximate depth of the stream channel of each monitor's location, the sonde placement depth, and the typical minimum and maximum range of the water level. c) How the data collected will be synthesized with the other efforts of the study. For example, the hourly measurements should be compared with the longitudinal survey at the appropriate dates, times, and locations. Similarly, hourly measurements could be used to track discharges from JST as they push into the Stevens Creek arm of the reservoir. d) State the statistical analyses that will be performed. For example, correlating DO, temperature, and gauge height at each monitoring station.</p>	<p>Section 4.1 was revised to include the requested information.</p>

Commentor	Comment Code	Comment	Applicant Response
NMFS	SCWQ NMFS SC06	<p>In addition to #4 above, section 4.2 should be revised to contain the following information: a) What the approximate speed of the boat towing the YSI will be. How many points will be collected along the survey. b) The approximate depth of the YSI as it is towed through each data logging point. c) How longitudinal surveys will be scheduled throughout the study period. Is the intent to coordinate with releases from Thurmond? d) How longitudinal surveys will be standardized throughout the study period. Will they be conducted at the same time of day? Same time of the month? e) How the data collected will be synthesized with the other efforts of the study. For example, the measurements taken during the longitudinal study should be compared with those at the continuous monitoring station as the survey passes those locations. Additionally, longitudinal surveys should be scheduled to occur at the same time as the off-channel monitoring effort.</p>	<p>Section 4.2 was revised to include the requested information.</p>

Commentor	Comment Code	Comment	Applicant Response
NMFS	SCWQ NMFS SC07	<p>In addition to #4 above, section 4.3 should be revised to contain the following information: a) How off-channel surveys will be scheduled throughout the study period. Is the intent to coordinate with releases from Thurmond? b) How off-channel surveys will be standardized throughout the study period. Will monitors be placed at the same time of day? Same time of the month? c) How the data collected will be synthesized with the other efforts of the study. For example, the off-channel monitors should be deployed at the same time as the longitudinal surveys so the two efforts can be directly compared. Similarly, hourly DO measurements at the off-channel monitoring sites should be compared to the hourly measurements at the continuous monitoring sites.</p>	<p>Section 4.3 was revised to include the requested information.</p>
NMFS	SCWQ NMFS SC08	<p>Section 5.0, in general, requires more detail. A number of the recommendations in #4 above are pertinent to this section of the study Plan. For each of the three efforts, provide the specific data that will be produced by each effort. Describe how those data will be summarized. What tables will be included? What figures will be produced? Describe what statistical analyses, if any, will be performed.</p>	<p>Section 5.0 was revised to include the requested information.</p>

Commentor	Comment Code	Comment	Applicant Response
NMFS	SCWQ NMFS SM01	For continuous monitoring a) Establish an additional continuous monitoring station just below the confluence of Stevens Creek and Horn Creek. b) Deploy continuous monitoring stations year-round.	A continuous monitor was established just below the confluence of Stevens Creek and Horn Creek as recommended. The monitors will be deployed from May 1 through October 31, 2023. The objective of the study was to determine the extent and duration of low dissolved oxygen levels within Stevens Creek, which data indicate occurs between May and October. Dominion feels that existing data is adequate to characterize water quality during shoulder seasons and additional data collection outside of the proposed time frame is unnecessary for the purposes of understanding potential project effects to water quality.
NMFS	SCWQ NMFS SM02	For Longitudinal Surveys Each survey should consist of an up- and downstream tow, beginning at the confluence of Stevens Creek and the Savannah River and sampling the entire 12.77 river miles of Stevens Creek within the project boundary (or vice versa). b) Conduct one survey each month from May through November, and conduct an additional two surveys between December and April for a total of 9.	The longitudinal surveys will be conducted at least monthly from May through October and cover from the mouth of Stevens Creek to approximately 10 river miles upstream, which is the furthest the motorboat can travel. Longitudinal surveys are not planned to occur between November and April as the objective of the study was to determine the extent and duration of low dissolved oxygen levels within Stevens Creek, which data indicate occurs between May and October. Dominion feels that existing data is adequate to characterize water quality during shoulder seasons and additional data collection outside of the proposed time frame is unnecessary for the purposes of understanding potential project effects to water quality.