

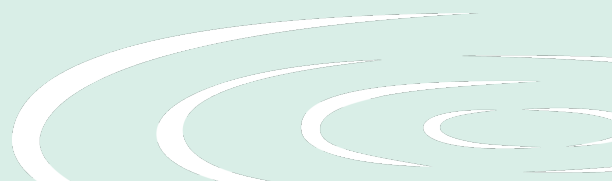
WATER QUALITY MANAGEMENT PLAN • MARCH 2023

Water Quality Management Plan for the General National Pollutant Discharge Elimination System (NPDES) Permit for the Discharge of Lanthanum-modified Clay to Surface Waters of the United States in the San Diego Region

Water Quality Order # R9-2021-0056
NPDES NO. # CAG999003

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1 INTRODUCTION

Located in northern San Diego County, California, Lake Henshaw is a 52,000-acre foot (AF) surface water impoundment of the upper San Luis Rey River, north and east of the city of San Diego (Figure 1). The Vista Irrigation District (District) operates Lake Henshaw and groundwater wells within the 43,000-acre Warner Ranch surrounding the lake to provide municipal, domestic, agricultural, and recreational water supply for use by the District, the City of Escondido (Escondido), and the La Jolla, Rincon, San Pasqual, Pauma, and Pala Bands of Indians (the Bands). The lake also stores local runoff from several intermittent tributaries including the west fork and mainstem of the San Luis Rey River, the Agua Caliente, San Ysidro, Buena Vista, Matagual, and Carrista creeks, and several unnamed creeks (Figure 1). Other designated beneficial uses for Lake Henshaw water include industrial process and service supply; freshwater replenishment; rare, threatened, or endangered species habitat; hydropower generation; warm freshwater habitat; contact and noncontact recreation; and wildlife habitat (San Diego Regional Water Quality Control Board 2021).

The District was alerted to the possibility of Harmful Algal Blooms (HABs) in Lake Henshaw by remote sensing data made available through the California HABs portal (<https://fhab.sfei.org/>) (San Francisco Estuary Institute 2022). In lakes and reservoirs, excessive seasonal cyanobacteria can result in low dissolved oxygen (DO), high pH, high un-ionized ammonia, and problematic levels of one or more cyanotoxins, including microcystin, cylindrospermopsin, anatoxin-a, and saxitoxin. At elevated concentrations, cyanotoxins can cause public health concerns and bioaccumulate in the tissue of aquatic biota, such as shellfish, fish, and marine mammals, potentially harming these organisms as well as the humans that consume them. Cyanobacteria blooms containing toxins are often referred to as HABs. In March 2020, the District began monitoring for the presence of cyanobacteria and cyanotoxins in Lake Henshaw. Since then, routine monitoring and laboratory analysis have confirmed the seasonal presence of elevated levels of the cyanotoxins microcystin and anatoxin-a at multiple sites in the lake.

Additionally, the District launched a project to manage HABs and cyanotoxins in Lake Henshaw and Lake Wohlford. Phase I objectives of this project included developing short-term solutions (defined as occurring prior to 2024) for mitigating or treating HABs; screening potential long-term alternatives (defined as occurring in the year 2024 or later) for preventing or minimizing HABs; developing a HABs Mitigation and Monitoring Plan that includes a Water Quality Monitoring Plan; and gathering relevant data to inform future phases of the project. The findings of Phase I were documented in the Lake Henshaw and Lake Wohlford Harmful Algal Blooms Management and Mitigation Plan (HABs Management and Mitigation Plan; Stillwater Sciences 2022a). The HABs Management and Mitigation Plan serves as the *Technical Report* for the District's application for the San Diego Regional Water Quality Control Board (RWQCB) General Permit for the Discharge of Lanthanum Modified Clay for the Mitigation of Phosphorus in Surface Waters of the United States Water Quality Order #R9-2021-0056 (herein referred to as the General Permit).

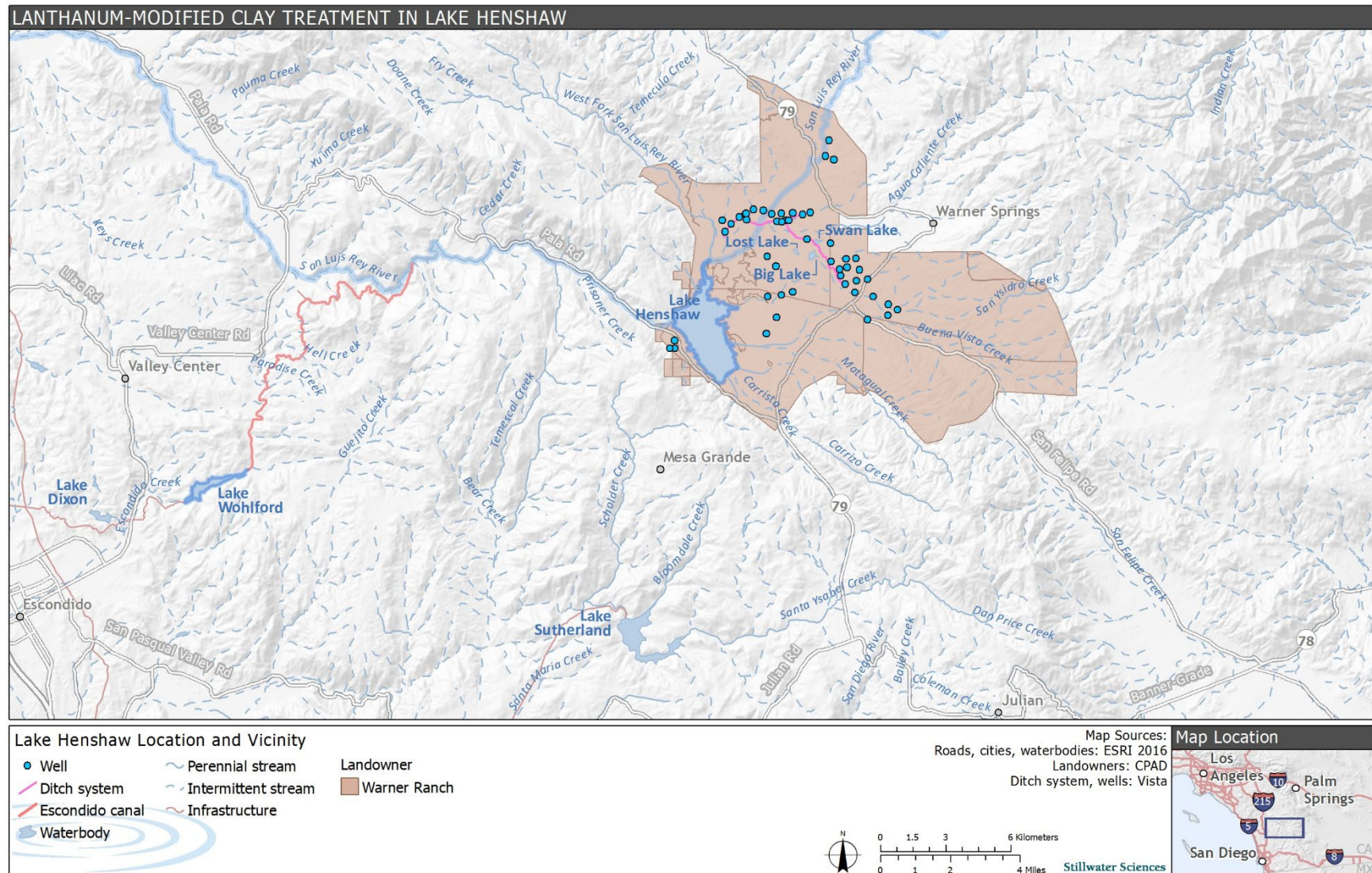


Figure 1. Project vicinity and location map.

Based on consideration of numerous potential in- and out-of-lake management methods to control HABs, phosphorus inactivation/chemical sediment sealing through the use of lanthanum-modified clay was selected as one in a set of suitable methods for short- and long-term water quality improvements in Lake Henshaw. The goal of the lanthanum-modified clay application in Lake Henshaw is to remove bioavailable phosphorus (i.e., orthophosphate) from the water column and minimize or eliminate orthophosphate release from Lake Henshaw sediments during hypoxic ($\text{DO} < 2$ milligrams per liter [mg/L]) or anoxic ($\text{DO} = 0$ mg/L) conditions. The magnitude of orthophosphate release measured in Lake Henshaw sediment chambers was the largest ever measured in similar studies of California reservoirs (for additional details see *Technical Report* Section 2.2.2.3). Minimizing or eliminating such a high flux would reduce internal loading of phosphorus and the potential for this nutrient to support HABs (for additional details see *Technical Report* Figure 2-55). A fundamental assumption of phosphorus inactivation as a lake management technique is that phosphorus is the limiting nutrient and its control will, in turn, control nuisance algae growth. Existing information characterizing Lake Henshaw indicates the lake has shifted from a nitrogen-limited system to one that is phosphorus-limited on a total nutrient basis and on a bioavailable nutrient basis (i.e., orthophosphate, ammonia, nitrate) both nitrogen and phosphorus are present at high levels throughout the year (for additional details see *Technical Report* Section 2.2.2.4).

2 GENERAL PERMIT BACKGROUND

The Code of Federal Regulations Section 122.48 requires that all NPDES permits specify monitoring and reporting requirements. Water Code Sections 13267 and 13383 also authorize the San Diego Regional Water Quality Control Board to require technical and monitoring reports. This Water Quality Monitoring Plan (WQMP) adheres to monitoring and reporting requirements described in item no. 7 of the General Permit Attachment F – Fact Sheet, which implements the federal and State of California (State) regulations.

The WQMP describes the tasks and time schedules that answer the following questions:

1. Does the discharge of lanthanum-modified clay cause or contribute to an exceedance of receiving water limitations?
2. Does the discharge of lanthanum-modified clay cause or contribute to an exceedance of the “no toxics in toxic amounts” narrative toxicity objective?

Additionally, General Permit Attachment E – Monitoring and Reporting Program (MRP) establishes monitoring, reporting, and recordkeeping requirements that implement federal and State laws and/or regulations.

3 DESCRIPTION OF TREATMENT AREA

Lake Henshaw is fed by surface runoff as well as pumped inflow from the District’s Warner Ranch Wellfield. Water pumped from the wellfield flows by gravity into an approximately 1,800-foot unlined channel¹ before entering the intermittent San Luis Rey River upstream of Lake Henshaw, then flows for approximately one mile before entering the lake. During winter months, following significant precipitation events, natural, intermittent inflows to Lake Henshaw occur from the San Luis Rey River, West Fork San Luis Rey River, Matagual Creek, Carrizo Creek, Carrista Creek, Buena Vista Creek, and Agua Caliente Creek (Figure 1). During April through October in most years, water in the San Luis Rey River between Henshaw Dam and the Escondido Canal Diversion Dam is predominantly supplied by releases from the dam (Section 2.3 in the *Technical Report*).

The 52,000-AF Lake Henshaw produces an average annual yield of 13,500 AF of water for entitlements held by the District, Escondido, and the Rincon Band of Indians. The La Jolla Band of Indians also benefits from the passive recreational use of water released from Lake Henshaw to the San Luis Rey River as it flows through a campground operated on their reservation lands. The Diversion Dam and the start of the Escondido Canal also are located within the La Jolla Reservation, and the canal supplies water to the 6,500-AF Lake Wohlford.

Groundwater pumping at the Warner Ranch Wellfield began in 1951 at the start of wellfield operations, with regular sampling conducted by the District for field water quality indicators, major and minor ions, nutrients, and trace elements. The United States Geological Survey Groundwater Ambient Monitoring and Assessment program (USGS GAMA) also sampled the Warner Ranch groundwater and analyzed samples for general parameters, major ions, trace elements, nutrients, dissolved organic carbon (DOC), microbiology, volatile organic compounds (VOCs), wastewater compounds, and contaminants of emerging concern (CECs). Refer to Section 2.1.3 in the *Technical Report* for a complete summary of the historical monitoring data, analysis, and discussion.

In 2022, the District began monitoring the two inputs from the wellfield into Lake Henshaw, the wellfield terminus, and an outflow point associated with the 70s Wells. These data (Table 1) indicate that total phosphorus in Warner Ranch Wellfield terminus is predominantly bioavailable orthophosphate and concentrations are fairly steady at both locations. For the recent (2022) data, average concentrations at the wellfield terminus are roughly twice those at the 70s Wells and roughly 40% higher than the historical average (2000–2019, n=8).

¹ The HABs Management and Mitigation Plan (Stillwater Sciences 2022a) incorrectly refers to this feature as an unnamed stream. The channel is not indicated as a “blue line stream” on USGS topographic maps and is an artificially maintained conveyance between the Warner Wellfield terminus and the San Luis Rey River.

Table 1. Phosphorus concentrations in Warner Ranch Wellfield pumped groundwater during 2022.

Sample Date	Wellfield Terminus		70s Wells	
	Total Phosphorus (mg/L)	Orthophosphate (mg/L)	Total Phosphorus (mg/L)	Orthophosphate (mg/L)
1/3/2022	0.08	0.08	0.03	0.03
1/10/2022	0.08	0.03	0.08	0.03
1/18/2022	0.08	0.08	0.03	0.03
1/24/2022	0.04	0.03	0.09	0.08
1/31/2022	0.07	0.07	0.04	0.04
2/7/2022	0.07	0.07	0.03	0.03
2/14/2022	0.09	0.07	0.04	0.04
2/22/2022	0.08	0.07	0.03	0.03
2/28/2022	0.08	0.08	0.03	0.03
3/7/2022	0.08	0.07	0.03	0.03
3/14/2022	0.06	0.06	0.02	0.03
4/4/2022	0.06	0.06	0.02	0.03
5/31/2022	0.07	0.06	0.02	0.02
8/1/2022	0.08	0.07	0.04	0.04
9/6/2022	0.08	0.07	0.04	0.03
10/3/2022	0.07	0.07	0.03	0.03
11/7/2022	0.08	0.05	0.04	0.02
12/5/2022	0.06	0.07	0.02	0.02
Average	0.07	0.06	0.04	0.03

Sampling of water quality within Lake Henshaw began in 1978 as part of the USEPA National Eutrophication Study. Water quality parameters (i.e., DO, conductivity, pH, alkalinity, nutrients, chlorophyll-a) were collected as integrated depth samples at two sites (one site near the dam and one site in the shallow southern portion of the lake) and composited across sites for analysis. Secchi depth was collected at both sites. Since 1984, lake water quality samples have been collected by the District approximately semi-annually (e.g., June and December) for numerous minerals (i.e., magnesium, potassium, sodium), metals/metalloids (i.e., aluminum, antimony, arsenic, barium, beryllium, boron, cadmium, calcium, chromium, copper, iron, lead, manganese, mercury, nickel, selenium, silver, thallium, zinc), nutrients (nitrate), and other constituents (alkalinity, bicarbonate, carbonate, hardness, chloride, conductance, fluoride, hydroxide, pH, sulfate, surfactants, total dissolved solids, turbidity). Beginning in 2020, the District has collected additional water quality data at three sites within Lake Henshaw and one site immediately downstream of the dam. Beginning in March 2020, cyanotoxin (microcystin, anatoxin-a) samples were collected from at least two of these four sites. Nutrient (total phosphorus [TP], total nitrogen [TN]) samples were collected at two sites beginning in August 2020. The District eventually included both a surface and bottom water sample at one site, and the frequency of monitoring for both cyanotoxins, TN, and TP increased from approximately biweekly to weekly. Beginning in January 2021, nutrient analyses were expanded beyond TN and TP to include orthophosphate (PO_4^{3-}), nitrate (NO_3^-), and ammonia (NH_4^+). Refer to Section 2.2.2 in the *Technical Report* for a complete summary of this data, analysis, and discussion.

At full pool (spillway elevation 2,690.59 feet above sea level), Lake Henshaw has a surface area of 2,256 acres, a volume of 51,832.2 AF, and a maximum depth of 49 feet. The reservoir is broad and shallow, sloping gently from its northern, eastern, and southern edges towards a narrow, deeper channel near the dam. The surface area of Lake Henshaw varies seasonally. The typical average depth is roughly 8–20 feet, as the reservoir is rarely at maximum capacity.

4 LANTHANUM-MODIFIED CLAY - PHOSPHORUS INACTIVATION

Lanthanum-modified clay rapidly inactivates free reactive (i.e., orthophosphate or soluble) phosphorus as it moves down through the water column of a water body following application. Inactivation occurs when the lanthanum cation forms a chemical bond with the orthophosphate anion (PO_4^{3-}) to form an insoluble and biologically inert mineral called rhabdophane ($\text{La}(\text{PO}_4) \cdot \text{H}_2\text{O}$). Rhabdophane settles on and integrates with the bottom sediments of the water body, forming a thin (<2 mm) and permeable clay layer. Lanthanum-modified clay also binds orthophosphate in sediment pore waters, thereby inactivating bioavailable phosphorus released from the sediments.

5 LANTHANUM-MODIFIED CLAY APPLICATION METHODOLOGY

During the proposed 2023 lanthanum-modified clay application, the District expects that the reservoir will be at 5%–40% capacity, which corresponds to 600–1,500 surface acres, respectively. All areas within Lake Henshaw, including various coves, are subject to treatment with lanthanum-modified clay. The lanthanum-modified clay treatment surface area will be a function of the lake's capacity at the time of treatment, as well as a function of cost and labor feasibility.

Approximately 28,630 pounds of bioavailable phosphorous (i.e., orthophosphate) will be targeted for inactivation in Lake Henshaw. The mass-based stoichiometry for the lanthanum-modified clay product that will be used is 50 pounds of lanthanum-modified clay for every 1 pound of bioavailable phosphorus. Given this stoichiometry, approximately 1,432,000 pounds of lanthanum-modified clay would be needed to inactivate all of the bioavailable phosphorus. As this amount of lanthanum-modified clay is greater than what is reasonable or affordable to apply in a single treatment, the District proposes to apply within the range of 24,000 – 716,000 pounds of lanthanum-modified clay per treatment, with no more than 716,000 pounds total applied in a given year. This translates to 0.9–26.7 milligrams per liter (mg/L) or parts per million (ppm) lanthanum-modified clay per treatment, with the most likely application range being substantially lower at 0.9–2.7 mg/L due to cost constraints. The above dosing amounts were calculated following analysis of water and sediment samples collected from ten locations in Lake Henshaw in February 2023. The calculations assume a lake surface area of approximately 1,200 acres.

All personnel working on the application team will be certified and properly trained for the application of lanthanum-modified clay. The application team will follow the product label, material safety data sheet (MSDS), and all other applicable state and federal laws associated with implementation of this project. Lanthanum-modified clay granules will be staged at a designated area onshore and loaded into application boats. The lanthanum-modified clay granules will be mixed into water slurry in a collection tank on each boat, and the slurry will be broadcast evenly across the lake water surface at a specific volume per acre. Each boat will be equipped with a

Global Positioning System (GPS) guidance system in order to regulate application rate and ensure even dosing across the lake. Each application event is projected to be completed in 2–4 days, with the first application tentatively planned to occur in April/May 2023. Figure 2 depicts the form that will be used to document application activity.

I. GENERAL

Date _____ Location _____ Start Time _____ Stop Time _____
 Agency _____ Personnel _____
 Weather _____
 Total Area Treated (AC or linear ft) _____ Target Weed(s) _____

II. : LANTHANUM – MODIFIED CLAY (LMB) INFORMATION

Amount of LMB Used: _____ Rate or Target Concentration: _____
 Method of Application: _____

III. TREATED WATERBODY INFORMATION

Waterbody type (Circle One: reservoir, lake, pond) Other: _____
 Water flow (cubic ft/sec) _____ Water Depth (ft): _____ Water temperature (F): _____
 Color: (circle one) none brown green other: _____ Clarity (circle one) poor fair good
 Other Information: _____

IV. GATES, WEIRS, CHECKS OR OTHER CONTROL STRUCTURES (ONLY FILL OUT IF APPLICABLE)

A. Are there any gates or control structures in the treatment area that may allow discharge of treated water outside of the treatment area?? Yes No
 (If the answer to question A is Yes, then answer question B below, otherwise leave blank)

Before Application

B. Have flow control structures been closed to prevent unintended discharge from the treatment area? Yes No
 C. Have flow control structures intentionally remained open to meet pre-project flow requirements? Yes No

During Application

D. Were flow control structures inspected for discharge? Yes No
 E. If discharge occurred; provide detail in the table below

Gate Location/Description	Time Closed	Time Opened	Approximate Flow (cubic ft/sec)

VI. CERTIFICATION

I _____ (print name) certify that the WQMP has been followed (sign here): X _____

Figure 2. Lanthanum-modified clay application log.

6 TRANSPORT, FATE AND FACTORS INFLUENCING LANTHANUM-MODIFIED CLAY USE

Laboratory analysis of samples collected from the lake approximately weekly from January 2021 through present indicate that total phosphorus (TP) is highest during summer months, ranging 0.3 to 0.8 mg/L, when TP is suspended within the water column inside of phytoplankton cells. Orthophosphate concentrations tend to peak during late/summer fall, following the onset of hypoxic ($\text{DO} < 2 \text{ mg/L}$) or anoxic ($\text{DO} = 0 \text{ mg/L}$) conditions in lake bottom waters and/or sediments, which can release orthophosphate into the overlying water column (for additional detail see *Technical Report* Section 2.2.2.3). TP content of Lake Henshaw sediments based on samples collected at four sites in 2021 ranges approximately 1,200 to 4,000 milligram per kilogram (mg/kg), which is relatively high (Beutel 2021). These elevated levels of phosphorus due in large part to internal loading is a substantial factor driving poor water quality in the lake.

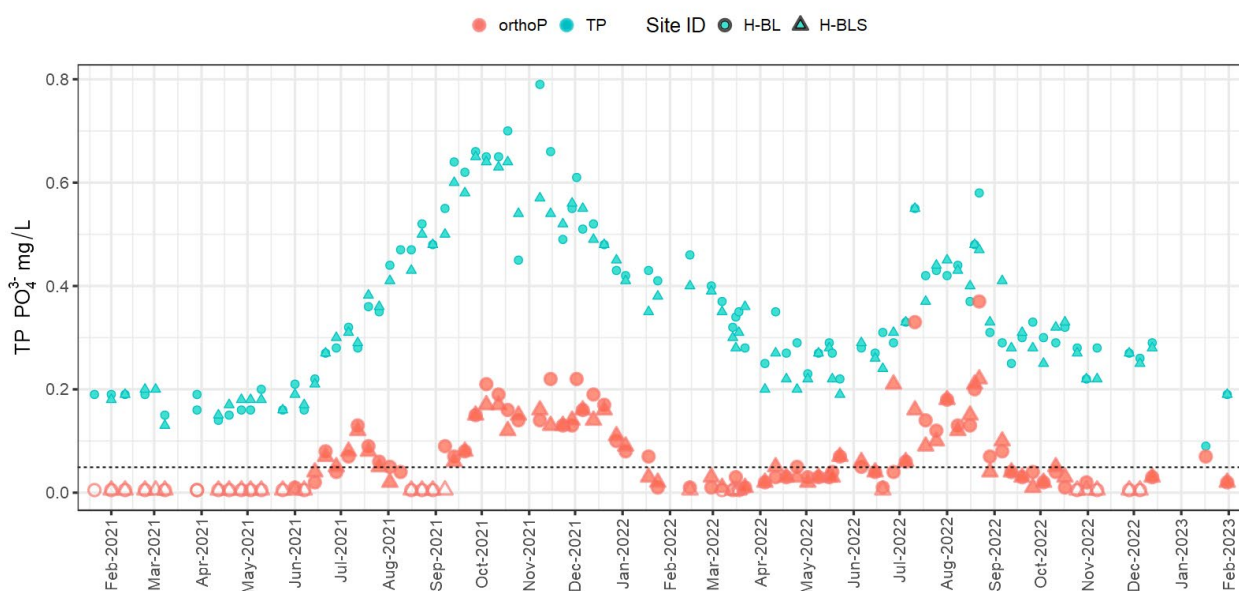


Figure 3. Total phosphorus (TP; pink) and orthophosphate (PO_4^{3-} ; blue) at buoy line surface (H-BLS; triangle) and buoy line bottom (H-BL; circle) sites in Lake Henshaw, January 2021 through early February 2023. Analytical laboratory quantification limits (QLs) are shown as dashed line. All results below the quantification limits are considered estimated values. Results reported as non-detects by the analytical laboratory are shown as 0.5 x instrument sensitivity limit (0.01 mg/L) and represented by open circles and triangles. No method detection limit (MDL) was reported by the analytical laboratory.

As part of the District's consideration of numerous potential in- and out-of-lake management methods to control HABs, a variety of source control measures have been completed or are currently being investigated to prevent future external loading of phosphorus to Lake Henshaw:

- In February 2021, the District discontinued the use of sodium hexametaphosphate, an anti-scalant, in the Warner Ranch Wellfield, where the wellfield is a major source of water for Lake Henshaw. The District used the orthophosphate-containing anti-scalant from February 2015–January 2021.

- The District is currently investigating options for treating Warner Ranch Wellfield input to Lake Henshaw to bind orthophosphate in flowing water coming from the wellfield before it enters the lake. There are two inputs from the wellfield into Lake Henshaw; the wellfield terminus and an outflow point associated with the 70s Wells. The District is currently monitoring both locations for total phosphorus (TP) and orthophosphate (OP) concentrations. Analysis of 18 samples taken throughout 2022 at the wellfield terminus and an outflow point associated with the 70s Wells showed an average of 0.07 mg/L TP and 0.04 mg/L TP and an average of 0.06 mg/L OP and 0.03mg/L OP, respectively.
- Lastly, most of the Warner Ranch continues to be available for grazing under grazing licenses issued by the District, and typical head counts vary between 1,500 and 2,500 cattle. Since the 1990s, fencing has prevented cattle from having direct access to Lake Henshaw, and the District has recently installed fencing to prevent cattle from having direct access to ditches conveying pumped well water in the Warner Ranch Wellfield. Exclusion fencing and off-channel watering ponds within Warner Ranch reduces the potential for cattle to mobilize sediment and associated phosphorus that can then be transported into to Lake Henshaw.

Beyond measures to control the input of phosphorus to Lake Henshaw, the District has undertaken algaecide treatments to mitigate effects of HABs within the lake. In June 2021, the District obtained a Statewide Aquatic Weed Control Permit for application of copper sulfate, chelated copper, and sodium carbonate peroxyhydrate (peroxide) to control HABs in Lake Henshaw. Algaecide peroxide treatments in Lake Henshaw occurred on March 14 and 15, 2022 and May 16–19, 2022, but appeared to have a minor effect on HABs with variable and modest changes in chlorophyll-*a*, the ratio of pheophytin-*a* to chlorophyll-*a*, total cyanobacteria cell densities, and nutrient concentrations following treatment. A third algaecide treatment was undertaken by the District using SeClear, a non-chelated copper sulfate treatment, on August 17 and 18, 2022. The August copper-based treatment appears to have been more effective at controlling HABs than the application of peroxide-based algaecides in Lake Henshaw in March and May of that same year (Stillwater Sciences 2022b). This conclusion is supported by:

- Significantly greater reduction in cyanobacterial cell counts after treatment with copper as compared to treatment with peroxide;
- The significant reduction in the concentration of anatoxin-*a* from a range of 1.09–7.15 micrograms per liter (µg/L) prior to treatment to non-detect (<0.15 µg/L) within 4 days of treatment with copper;
- The absence of a rebound in microcystin concentrations 2 weeks following treatment with copper, as observed in March and May when treated with peroxide; and
- Greater percentage reduction in chlorophyll-*a* after treatment with copper compared with treatment with peroxide.

The District will continue to gain experience with algaecide treatments in order to improve their effectiveness and reduce their impacts. However, algaecide treatments in combination with currently implemented source control measures have not adequately controlled the phosphorus levels and HABs in Lake Henshaw. Thus, beginning in spring 2023, the use of lanthanum-modified clay is being proposed in combination with algaecides covered under the Statewide Aquatic Weed Control Permit, to better control HABs and support designated beneficial uses (see also Section 7).

Lanthanum-modified clay application rates and application techniques for this project are based on the assessment of the lake conditions and data from water and sediment samples collected from the lake over the past two years.

To prevent the lanthanum-modified clay applied to Lake Henshaw from discharging to downstream waterbodies, the controllable valves at the Henshaw Dam intake tower will be closed during a lanthanum-modified clay application to control the extent, if any, that the receiving waters of the San Luis Rey River would be affected by residual lanthanum-modified clay. Applications will not occur during a time when heavy precipitation would be likely to result in reservoir spill events. The reservoir has not been close to capacity in 20 years (since the early to mid-1990s). Currently, the application of lanthanum-modified clay is planned for when Lake Henshaw is between 5%–40% capacity, such that the potential for unplanned reservoir discharge due to storm activity is extremely small. Lanthanum-modified clay applications will target late spring, summer, and fall periods when orthophosphate is in the water column and/or likely to be released from bottom sediments.

In the event of an exceedance of receiving water limitations caused by the application of lanthanum-modified clay, the District will cease the discharging water downstream, notify the San Diego Water Board, and remediate the exceedance in a timely manner. The District will take all reasonable steps to minimize or correct any adverse impact on the environment, including accelerated or additional monitoring, as may be necessary to determine the nature and effect of the non-complying discharge.

7 DESIGNATED BENEFICIAL USES

Lake Henshaw is a surface water impoundment of the upper San Luis Rey River. According to the San Diego Regional Water Quality Control Board Water Quality Control Plan for the San Diego Basin (Basin Plan; 2021) dated September 8, 1994 and amended September 1, 2021, Table 2-4, the following beneficial uses exist for Lake Henshaw:

- Municipal and Domestic Supply
- Agricultural Supply
- Industrial Service Supply
- Industrial Process Supply
- Freshwater Replenishment
- Contact Water Recreation
- Non-contact Water Recreation
- Warm Freshwater Habitat
- Wildlife Habitat
- Rare, Threatened, or Endangered Species
- Hydropower Generation

Definitions for these beneficial uses are as follows:

Municipal and Domestic Supply (MUN) – Includes uses of water for community, military, or individual water supply systems including, but not limited to, drinking water supply.

Agricultural Supply (AGR) – Includes uses of water for farming, horticulture, or ranching including, but not limited to, irrigation, stock watering, or support of vegetation for range grazing.

Industrial Process Supply (PROC) – Includes uses of water for industrial activities that depend primarily on water quality.

Industrial Service Supply (IND) – Includes uses of water for industrial activities that do not depend primarily on water quality including, but not limited to, mining, cooling water supply, hydraulic conveyance, gravel washing, fire protection, or oil well repressurization.

Freshwater Replenishment (FRSH) – Includes uses of water for natural or artificial maintenance of surface water quantity or quality (e.g., salinity).

Contact Water Recreation (REC-1) – Includes uses of water for recreational activities involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, swimming, wading, water-skiing, skin and SCUBA diving, surfing, white water activities, fishing, or use of natural hot springs. Note that fishing is the only listed activity currently permitted on Lake Henshaw.

Non-contact Water Recreation (REC-2) – Includes the uses of water for recreational activities involving proximity to water, but not normally involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tidepool and marine life study, hunting, sightseeing, or aesthetic enjoyment in conjunction with the above activities.

Warm Freshwater Habitat (WARM) – Includes uses of water that support warm water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish or wildlife, including invertebrates.

Wildlife Habitat (WILD) – Includes uses of water that support terrestrial ecosystems including, but not limited to, preservation and enhancement of terrestrial habitats, vegetation, wildlife (e.g., mammals, birds, reptiles, amphibians, invertebrates), or wildlife water and food sources.

Rare, Threatened, or Endangered Species (RARE) – Includes uses of water that support habitats necessary, at least in part, for the survival and successful maintenance of plant or animal species established under state or federal law as rare, threatened, or endangered.

Hydropower Generation (POW) – Includes uses of water for hydropower generation.

8 CUMULATIVE AND INDIRECT EFFECTS

No adverse cumulative and indirect effects are anticipated. The expected direct effect of use applying lanthanum-modified clay to Lake Henshaw is a reduction in the amount of orthophosphate in the water, which is subsequently anticipated to reduce the incidence of HABs in Lake Henshaw and improve water quality.

9 POTENTIAL DESIGNATED USE IMPACTS

No long-term adverse designated use impacts are anticipated. The lake water column is likely to experience a short-term increase in turbidity immediately after lanthanum-modified clay is applied to the water. This short-term increase is expected to last between 24–48 hours, at which time turbidity is anticipated to return to pre-treatment levels.

10 KNOWN AND POTENTIAL IMPACTS TO WATER QUALITY

No adverse impacts to water quality are anticipated. As previously stated, the expected effect of use applying lanthanum-modified clay to Lake Henshaw is a reduction in the amount of orthophosphate in the water, which is subsequently anticipated to reduce the incidence of HABs in Lake Henshaw and improve water quality.

11 SAMPLE LOCATION AND TIMING

Surface water monitoring will be conducted according to USEPA test procedures approved under 40 CFR Section 136, “Guidelines Establishing Test Procedures for the Analysis of Pollutants Under the Clean Water Act,” as amended.

11.1 Sample Locations

Approximate sample locations are shown in Figure 4 and described in Table 2, Table 5, and Table 6.

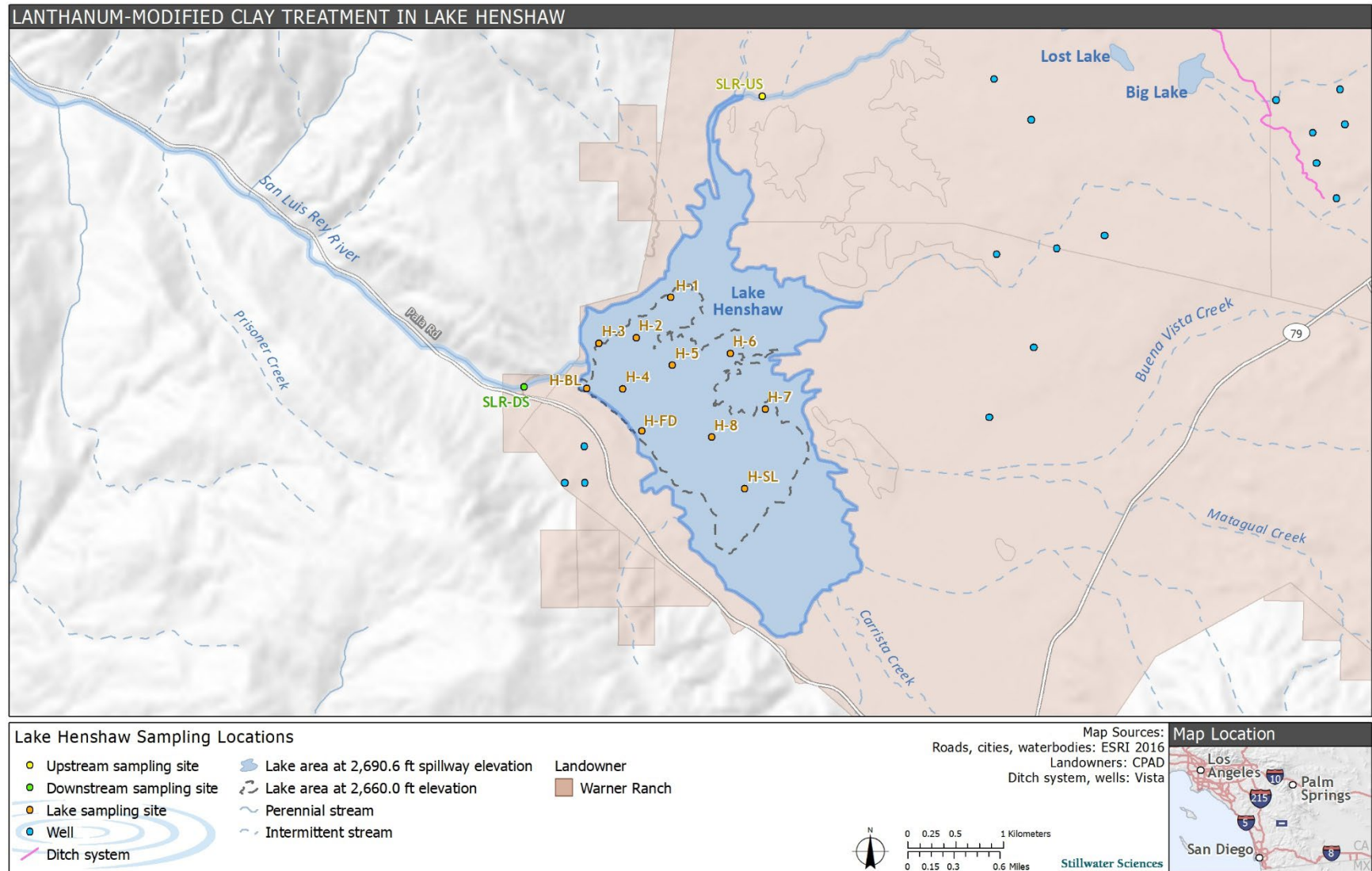


Figure 4. Lake Henshaw sampling locations.

Table 2. Lake Henshaw sampling location descriptions.

Site ID	Description	Latitude	Longitude
H-1	Open water	33.248063	-116.752269
H-2	Open water	33.24427	-116.75616
H-3	Open water	33.24377	-116.76035
H-4	Open water	33.23944	-116.75768
H-5	Open water	33.24167	-116.75209
H-6	Open water	33.24277	-116.74557
H-7	Open water	33.23751	-116.74166
H-8	Open water	33.23486	-116.74772
H-BL(S)	Buoy line at dam in bottom waters (H-BL) and in surface waters (H-BLS)	33.239479	-116.761714
H-FD	Southwestern shoreline at the in-water end of the fishing dock in surface waters	33.235453	-116.75556
H-SL	Southern portion of lake in surface waters	33.23	-116.744

The sample locations described are sufficient to represent: (a) the quality of surface water prior to application; (b) the quality of surface water within the treatment area; and (c) the quality of surface water outside the treatment area that potentially could be affected by the application. With respect to (a) and (b), while the locations within the lake shown in Figure 4 and Table 2 account for less than one sample per 10 surface acres, data collected in March, May, and August 2022 as part of algaecide application events demonstrate that the Lake Henshaw water column is generally well-mixed, with water temperature, pH, and turbidity measurements remaining generally stable with depth across shallow and deeper sites (Appendix A). While water temperature and pH can be elevated in surface waters during summer months, when solar heating is greatest and rates of photosynthesis are high, the relatively high wind fetch² of Lake Henshaw (approximately 1 to 2 miles) and overall shallow water column depths mean that wind mixing of the water column occurs regularly and throughout the lake. Given the high degree of mixing, lake sample locations shown in Figure 4 and Table 2 are expected to be representative of water quality conditions in Lake Henshaw prior to lanthanum-modified clay application and within the treatment area, where the latter would include either a portion of the lake or the entire lake, depending on the lanthanum-modified clay dose.

The lanthanum-modified clay treatment amount (i.e., dose) will be scaled to the lake's volume and surface area at the time of treatment; lanthanum-modified clay may be applied to all open water or a smaller area based on cost and lake conditions. "Within treatment area" lake samples will only be collected from locations in Figure 4 and Table 2 that fall within the actual treatment area. With respect to (c), if lanthanum-modified clay treatment includes the entire surface area of the lake, then all lake sampling locations will be considered "within treatment area" and the site immediately downstream of Lake Henshaw Dam on the San Luis Rey River (SLR-DS) will be designated as surface water outside the treatment area that potentially could be affected by the application. If lanthanum-modified clay treatment does not include the entire surface area of the lake, then lake sampling locations outside the treatment area will still be collected, but they will be designated as surface water outside the treatment area that potentially could be affected by the application, along with location SLR-DS. Samples will be collected according to Section 11.2.

² The unobstructed distance along the lake water surface for wave development from wind.

Additionally, during event monitoring, one field duplicate (FD) and one field blank (FB) will be collected and submitted for analysis for each grab sample analyte.

11.2 Sample Collection Schedule

1. Pre-Application Monitoring. Background monitoring samples shall be collected prior to the time of the application event and at the specified monitoring locations, no sooner than 24 hours before the application event.
2. Event Monitoring. Event monitoring samples shall be collected during application within the treatment area.
3. Post-Event Monitoring. Post-event monitoring samples shall be collected within the application area in static water and outside the treatment area in flowing water within one week after application.

11.3 Visual, Physical, and Chemical (VPC) Monitoring Requirements

Samples will be analyzed as required in Table 3.

Table 3. Visual, physical, and chemical (VPC) monitoring requirements.

Sample Type	Constituent/Parameter	Units	Sample Method
Visual	Monitoring area description and location Appearance of water ¹ Weather conditions (fog, rain, wind, etc.)	Not applicable	Visual Observation
Physical	1. Water temperature ^{2,3}	°F or °C	<i>In situ</i> vertical profile ^{2,3}
	2. Dissolved oxygen (DO) ^{2,3}	mg/L	
	3. pH ^{2,3}	standard units	
	4. Turbidity ^{2,3}	NTU	
Chemical	1. Free lanthanum – water ⁴	µg/L	Grab ⁴
	2. Total lanthanum – sediment ⁵	ug/kg	
	3. Alkalinity ⁴	mg/L CaCO ₃	
	4. Total suspended solids (TSS) ⁴	mg/L	
	5. Orthophosphate – water ⁴	mg/L	
	6. Total phosphorus (TP) – water ⁴	mg/L	
	7. Total phosphorus (TP) – sediment ⁵	mg/kg	

¹ Appearance of water shall include details on floating or suspended matter, color, sheen, clarity, bottom deposits, aquatic life, algae, objectionable growth, and nuisance conditions.

² *In situ* vertical profiles in the water column at 1-foot depth intervals.

³ *In situ* field testing instrumentation will be calibrated, operated, and maintained according to manufacturer's recommendations.

⁴ Water grab samples shall be collected at the surface of the lake for all sites except at Site H-BL, which will be collected in bottom waters in the deepest part of the lake.

⁵ Sediment grab samples will be collected at two locations, one at Site H-BL and one at a shallow site within the treatment area.

All laboratory analyses shall be conducted at a laboratory certified for such analyses by the California State Water Resources Control Board Division of Drinking Water (DDW). The laboratory will be accredited under the DDW Environmental Laboratory Accreditation Program (ELAP) to ensure the quality of analytical data used for regulatory purposes to meet the requirements of Order-R9-2021-0056.

Data collected as part of the physical and chemical monitoring parameters in surface water (water temperature, DO, pH, turbidity, TP, orthophosphate) will be used to address question 1 in Section 2, “Does the discharge of lanthanum-modified clay cause or contribute to an exceedance of receiving water limitations?” An exceedance will be determined according to numeric (various) or narrative (biostimulatory) objectives set for each of the aforementioned parameters/constituents in the Basin Plan, as applicable (San Diego Regional Water Quality Control Board 2021). Additional chemical monitoring parameters (free lanthanum, total lanthanum) will be used to address question 2 in Section 2, “Does the discharge of lanthanum-modified clay cause or contribute to an exceedance of the “no toxics in toxic amounts” narrative toxicity objective?”. The toxicity objective in the Basin Plan states “all waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in human, plant, animal, or aquatic life” (San Diego Regional Water Quality Control Board 2021). Physical and chemical water quality data will be used in combination with benthic macroinvertebrate (Section 11.4) and periphyton monitoring (Section 11.5) to determine whether the discharge of lanthanum-modified clay caused an exceedance of the Basin Plan narrative toxicity objective.

The District will measure *in situ* water quality parameters (water temperature, DO, pH, turbidity) using a pre-calibrated multi-probe sonde with designated sensors (Table 4). For *in situ* water quality, the sonde will be calibrated at the start of each sampling day and checked at the end of the day. Calibration data will be recorded on a calibration log that includes measurement quality objective criteria for real-time comparison. Additionally, all monitoring instruments and devices will be properly maintained. Appropriate QA/QC methods and documentation will be followed. All sample bottles will be rinsed with water from the water body to be collected from. QA/QC in the field will be assured by accurate and thoroughly completed sample labels, field sheets, and chain of custody and sample log forms. Sample labels will include sample identification code, date, time, site name, sampling location, collector’s name, sample type, and preservative, if applicable.

Table 4. *In situ* water quality methods for monitoring in Lake Henshaw.

Parameter	Method	Units	MDL
Water Temperature	EPA 170.1	Degrees Celsius (°C)	0.1
Dissolved Oxygen (DO)	SM4500-O(G)	Milligrams per liter (mg/L)	0.1
pH	SM4500-H	Standard unit of pH (s.u.)	0.1
Turbidity (Nephelometric)	EPA 180.1; ISO 7027-1; SM 2130-B	Nephelometric Turbidity Unit (NTU)/Formazin Nephelometric Unit (FNU)	0.1

11.4 Benthic Macroinvertebrate Bioassessment Monitoring

One (1) pre-treatment and one (1) post-treatment benthic macroinvertebrate sample will be collected in representative wadeable stream habitats upstream and downstream of the treatment area, as shown in Table 5, if the stream meets sampleability criteria. A reach is considered

“sampleable” in the *Standard Operating Procedures (SOP) for the Collection of Field Data for Bioassessments of California Wadeable Streams: Benthic Macroinvertebrates, Algae, and Physical Habitat* (Ode et al. 2016) if at least half of the reach has a wetted width of at least 0.3 meter (m) and no more than three transects are completely dry within the monitoring reach at the time of sampling. If more than three transects in the representative upstream and/or downstream habitat are dry at pre-treatment sampling time, and the reach(es) cannot be shifted slightly upstream or downstream to reduce the number of dry transects, then the reach(es) will not be sampled for benthic macroinvertebrates.

If sampleable reaches are present, benthic macroinvertebrate sampling will be conducted within seven days prior to commencement of the lanthanum-modified clay application in Lake Henshaw and within 30 days of post-application. Post-application benthic invertebrate monitoring is not required if no discharge from the treated waterbody occurs during application or within 30 days after the completion of the application. Data collected as part of the benthic macroinvertebrate monitoring will be used to address question 2 in Section 2, “Does the discharge of lanthanum-modified clay cause or contribute to an exceedance of the “no toxics in toxic amounts” narrative toxicity objective?”. The toxicity objective in the Basin Plan states “all waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in human, plant, animal, or aquatic life” (San Diego Regional Water Quality Control Board 2021). Physical and chemical water quality data (Section 11.3) will be used in combination with benthic macroinvertebrate and periphyton monitoring (Section 11.5) to determine whether the discharge of lanthanum-modified clay caused an exceedance of the Basin Plan narrative toxicity objective.

Table 5. Benthic macroinvertebrate sampling location descriptions.

Site ID	Location	Description
SLR-US*	Upstream	Upstream of Lake Henshaw on San Luis Rey River
SLR-DS*	Downstream	Downstream of Lake Henshaw Dam on the San Luis Rey River between the dam and the Rey River Ranch (approximately 4.5 miles downstream of the dam)

* Latitude and longitude will be determined following reconnaissance surveys to determine representative stream lengths for upstream and downstream comparison.

Benthic macroinvertebrate samples will be collected using *SOP for the Collection of Field Data for Bioassessments of California Wadeable Streams: Benthic Macroinvertebrates, Algae, and Physical Habitat* (Ode et al. 2016). Laboratory analysis of benthic macroinvertebrates for taxonomic identifications shall be conducted at a Southwest Association of Freshwater Invertebrate Taxonomists (SAFIT) level of II or IIa level (midges to subfamily) in accordance with the most recent State SOPs for Laboratory Processing and Identification of Benthic Macroinvertebrates in California (Woodward et al. 2012). Benthic macroinvertebrate data collected and identified shall be used for calculating California Stream Condition Index scores on a per sample basis (one reach, one sampling event). Scores are calculated using the most recent version of Instructions for Calculating Bioassessment Indices and other Tools for Evaluating Wadeable Streams in California: The California Stream Condition Index (CSCI), Algal Stream Condition Index (ASCI) and Index of Physical Integrity (IPI) (Boyle et al. 2020). Data shall be reported in the SWAMP format and uploaded into the California Environmental Data Exchange Network (CEDEN).

11.5 Periphyton Bioassessment Monitoring

One (1) pre-treatment and one (1) post-treatment periphyton (attached algae) sample will be collected in representative wadeable stream habitats upstream and downstream of the treatment area, as shown in Table 6, if the stream meets sampleability criteria (see Section 11.4 for definition of sampleability). If more than three transects in the representative upstream and/or downstream habitat are dry at pre-treatment sampling time, and the reach(es) cannot be shifted slightly upstream or downstream to reduce the number of dry transects, then the reach(es) will not be sampled for periphyton.

If sampleable reaches are present, periphyton sampling will be conducted within seven days prior to commencement of the lanthanum-modified clay application in Lake Henshaw and within 30 days of post-application. Post-application periphyton monitoring is not required if no discharge from the treated waterbody occurs during application or within 30 days after the completion of the application. Data collected as part of the periphyton bioassessment monitoring will be used to address question 2 in Section 2, “Does the discharge of lanthanum-modified clay cause or contribute to an exceedance of the “no toxics in toxic amounts” narrative toxicity objective?”. The toxicity objective in the Basin Plan states “all waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in human, plant, animal, or aquatic life” (San Diego Regional Water Quality Control Board 2021). Physical and chemical water quality data (Section 11.3) will be used in combination with benthic macroinvertebrate (Section 11.4) and periphyton bioassessment monitoring to determine whether the discharge of lanthanum-modified clay caused an exceedance of the Basin Plan narrative toxicity objective.

Table 6. Periphyton sampling location descriptions.

Site ID	Location	Description
SLR-US*	Upstream	Upstream of Lake Henshaw on San Luis Rey River
SLR-DS*	Downstream	Downstream of Lake Henshaw Dam on the San Luis Rey River between the dam and the Rey River Ranch (approximately 4.5 miles downstream of the dam)

* Latitude and longitude will be determined following reconnaissance surveys to determine representative stream lengths for upstream and downstream comparison.

Periphyton samples will be collected using *Standard Operating Procedures (SOP) for the Collection of Field Data for Bioassessments of California Wadeable Streams: Benthic Macroinvertebrates, Algae, and Physical Habitat* (Ode et al. 2016). Laboratory identification and quantification of specimens in the benthic stream algal communities shall follow the latest *SWAMP Standard Operating Procedures for Laboratory Processing, Identification, and Enumeration of Stream Algae* (Stancheva et al. 2015), which prescribes methods for separate analysis of 1) diatoms and 2) soft algae (including cyanobacteria). Algal Stream Condition Index (ASCI) scores shall be calculated using (Boyle et al. 2020): 1) the diatom index, D_ASCI, 2) the soft-algae index, S_ASCI, and 3) the “hybrid” index, H_ASCI, which incorporates metrics from both the diatom and soft-algae assemblages. Data shall be reported in the SWAMP format and uploaded into the California Environmental Data Exchange Network (CEDEN).

12 SELF-MONITORING REPORT (SMR)

A Self-Monitoring Report (SMR) will be prepared that will summarize and discuss results for all monitoring specified in this WQMP according to the schedule in Table 7.

Table 7. Monitoring periods and reporting schedule.

Report Type	Sampling Frequency	Monitoring Period Begins On	Monitoring Period	SMR Due Date
Event	Background (Pre-event), Event, and Post-event, as noted above	Notice of Enrollment Authorization Date	Background (Pre-event) through Post-Event, as noted above	45 days following the end of the Monitoring Period of each application event*
Annual	All sampling events for each application event occurring during the previous year	Notice of Enrollment Authorization Date or all data collected since the past Annual report was submitted	One year	April 1 st following one year of application events

* Event SMR will follow the 45-day requirement for bioassessment monitoring if analytical laboratories are able to process samples and deliver results within this timeframe without additional fees.

Event report shall include the following information:

- The date, exact place, and time of sampling or measurements;
- The individuals who performed the sampling or measurements;
- The dates analysis were performed;
- The individuals who performed the analyses;
- The analytical techniques or methods used; and
- Results of analyses.

The annual report shall include the following components:

- a) A summary of all application events and monitoring results for the previous year including trend analysis;
- b) A discussion, evaluation, and interpretation of the data including interpretations and conclusions as to whether applicable receiving water limitations in this Order have been attained;
- c) A discussion addressing the questions proposed in Section 8.1 of this MRP;
- d) A list of potential sources of the reportable priority pollutant(s);
- e) A summary of all actions undertaken pursuant to the control strategy;
- f) A description of actions to be taken in the following year; and
- g) A certification statement that all receiving water monitoring data has been timely uploaded to CEDEN.

12.1 Reporting Protocols

The event and annual SMR shall report the results of analytical determinations for the presence of chemical constituents in a sample using the following reporting protocols:

- a) The SMR will include with each sample result the applicable Reporting Level (RL) and the current Method Detection Limit (MDL).
- b) Sample results greater than or equal to the reported RL shall be reported as measured by the laboratory (i.e., the measured chemical concentration in the sample).
- c) Sample results less than the RL, but greater than or equal to the laboratory's MDL, shall be reported as "Detected, but Not Quantified," or DNQ. The estimated chemical concentration of the sample shall also be reported. For the purposes of data collection, the laboratory shall write the estimated chemical concentration next to DNQ as well as the words "Estimated Concentration" (may be shortened to "Est. Conc."). The laboratory may, if such information is available, include numerical estimates of the data quality for the reported result. Numerical estimates of data quality may be percent accuracy (+/- a percentage of the reported value), numerical ranges (low to high), or any other means considered appropriate by the laboratory.
- d) Sample results less than the laboratory's MDL shall be reported as "Not Detected," or ND.
- e) The analytical laboratories will be instructed to establish calibration standards so that the RL value (or its equivalent if there is differential treatment of samples relative to calibration standards) is the lowest calibration standard. Analytical data derived from extrapolation beyond the lowest point of the calibration curve will not be used.
- f) The Discharger shall arrange all reported data in a tabular format. The data shall be summarized to clearly illustrate whether the discharge is in compliance with receiving water limitations and BMP requirements. The Discharger is not required to duplicate the submittal of data that is entered in a tabular format within CIWQS. When electronic submittal of data is required and CIWQS does not provide for entry into a tabular format within the system, the Discharger shall electronically submit the data in a tabular format as an attachment. All reported data will be presented in a tabular format and contain data as specified in Tables 1 through 3.
- g) A cover letter will be prepared that clearly identify violations of the WDRs, discuss corrective actions taken or planned, and the proposed time schedule for corrective actions. Identified violations must include a description of the requirement that was violated and a description of the violation.
- h) The SMR report shall be electronically submitted using the State Water Board's California Integrated Water Quality System (CIWQS) Program website (https://www.waterboards.ca.gov/water_issues/programs/ciwqs).
- i) Records will be retained for all monitoring information, including all calibration and maintenance records, copies of all reports, and records of all data used for a period of at least three (3) years from the date of the sample, measurement, report, or application.

13 REFERENCES

- Beutel, M. W., and S. Defeo. 2021. Lake Henshaw and Lake Wohlford Sediment Flux Study. Report to Stillwater Sciences, December 2021.
- Boyle, T., R. D. Mazon, A. C. Rehn, S. Theroux, M. Beck, M. Sigala, C. Yang, P.R. Ode. 2020. Instructions for calculating bioassessment indices and other tools for evaluating wadeable streams in California: The California Stream Condition Index (CSCI), Algal Stream Condition Index (ASCI) and Index of Physical Integrity (IPI) SWAMP-SOP-2020- 0001
- Ode, P. R., A. E. Fetscher, and L. B. Busse. 2016. Standard Operating Procedures (SOP) for the collection of field data for bioassessments of California wadeable streams: benthic macroinvertebrates, algae, and physical habitat.
- Ode, P., A. Rehn, and J. May. 2005. A quantitative tool for assessing the integrity of southern coastal California streams. *Environmental Management* 35: 493–504.
- San Diego Regional Water Quality Control Board. 2021. Water Quality Control Plan for the San Diego Basin. San Diego, California.
https://www.waterboards.ca.gov/sandiego/water_issues/programs/basin_plan/
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- Stancheva, R., L. Busse, J. P. Kocielek, and R. G. Sheath. 2015. Standard Operating Procedures for Laboratory Processing, Identification, and Enumeration of Stream Algae. California State Water Resources Control Board Surface Water Ambient Monitoring Program (SWAMP) SOP-2015-0003.
- Stillwater Sciences. 2022a. Lake Henshaw and Lake Wohlford Harmful Algal Blooms Management and Mitigation Plan. Technical Memorandum. Prepared for Vista Irrigation District and City of Escondido.
- Stillwater Sciences. 2022b. Assessment of August 2022 Algaecide Treatment Effectiveness for Lake Henshaw. Technical Memorandum. Prepared for Don Smith, Vista Irrigation District.
- Woodard, M. E., J. Slusark, and P. R. Ode. 2012. Standard Operating Procedures for Laboratory Processing and Identification of Benthic Macroinvertebrates in California. California State Water Resources Control Board Surface Water Ambient Monitoring Program (SWAMP) Bioassessment SOP 003.

Appendices

Appendix A

Vertical Water Quality Profiles for Lake Henshaw

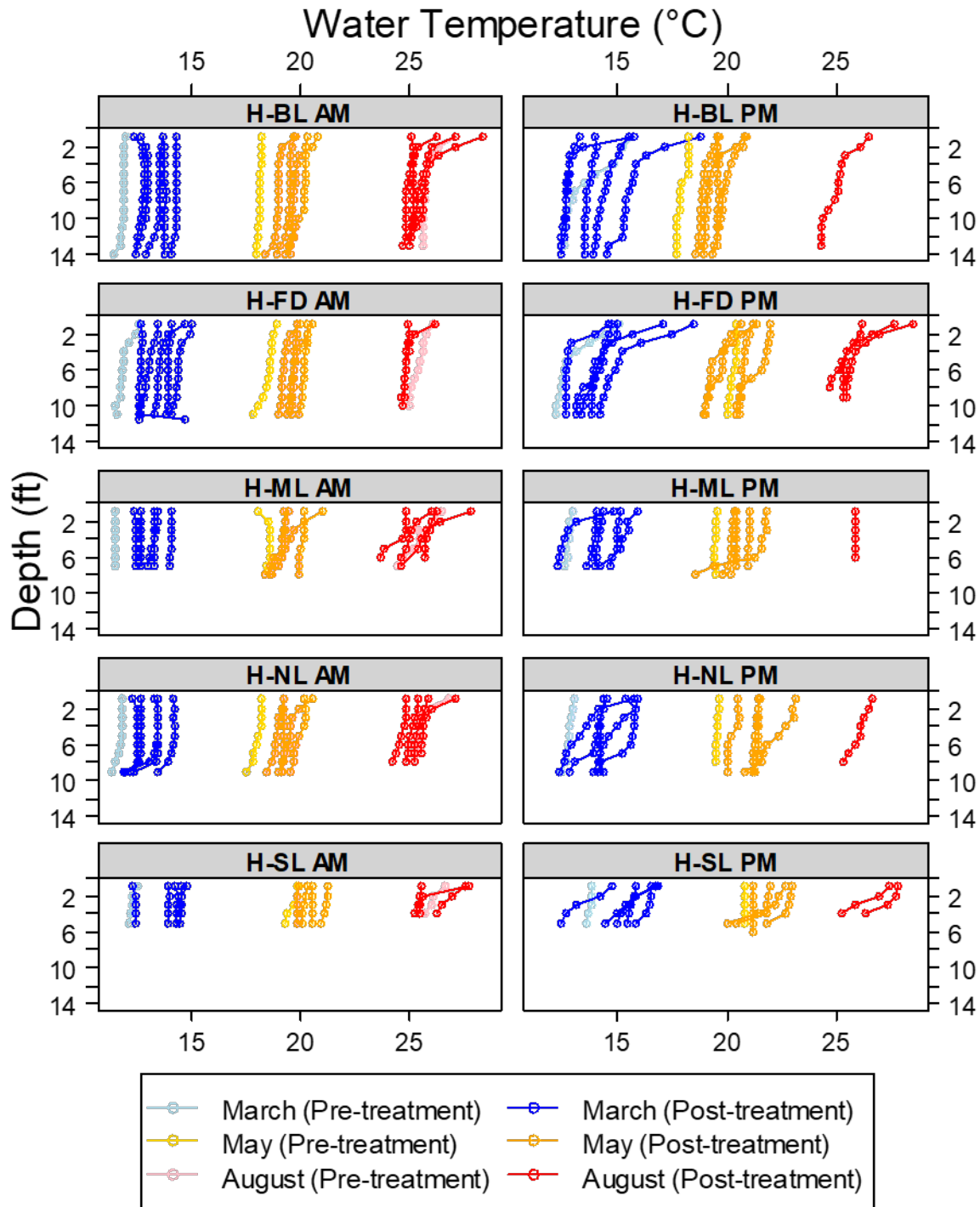
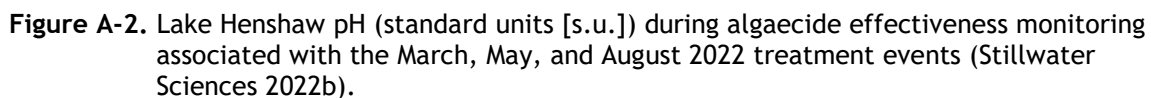


Figure A-1. Lake Henshaw water temperature during algaecide effectiveness monitoring associated with the March, May, and August 2022 treatment events (Stillwater Sciences 2022b).



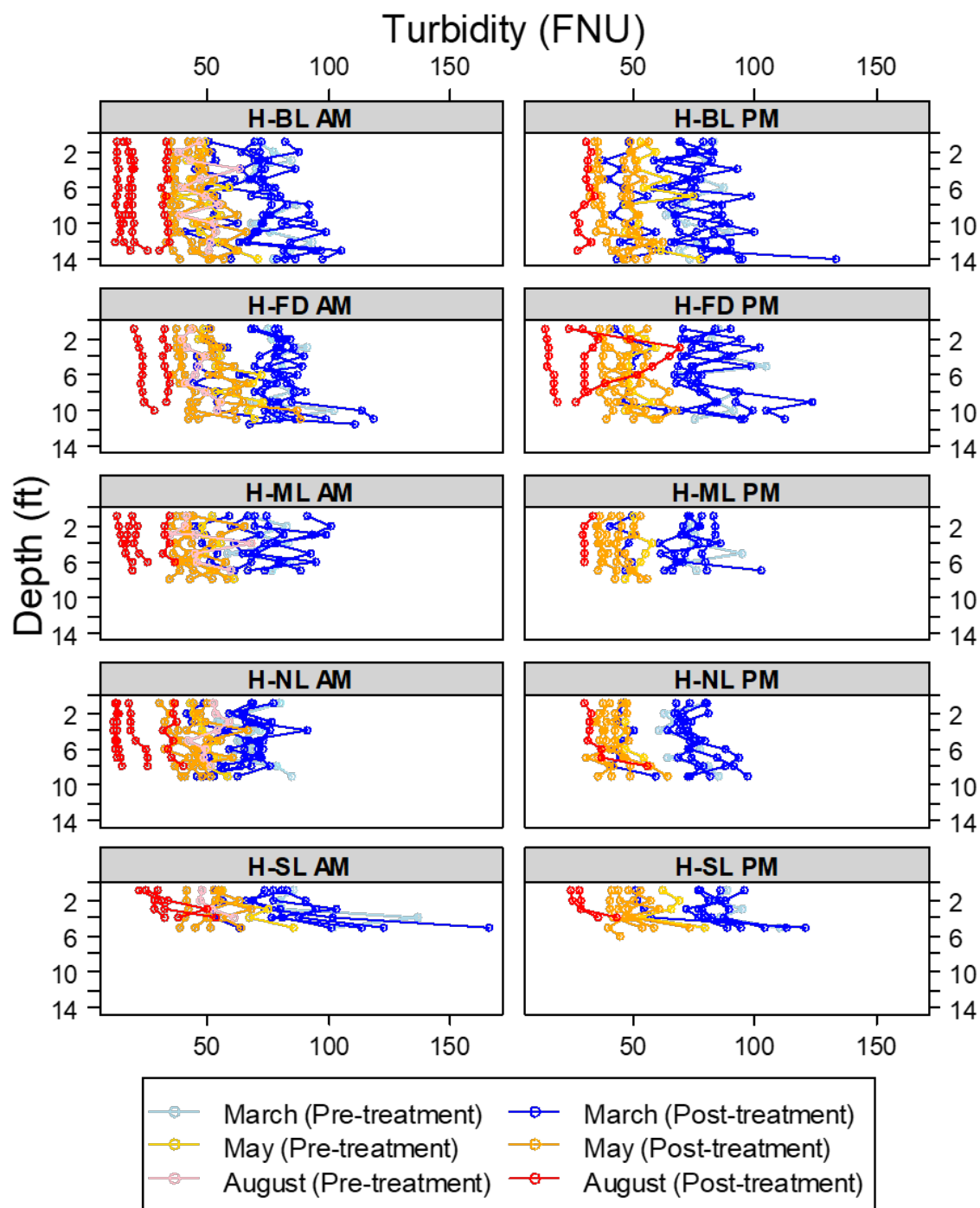


Figure A-3. Lake Henshaw turbidity (Formazin Nephelometric Units [FNU]) during algaecide effectiveness monitoring associated with the March, May, and August 2022 treatment events (Stillwater Sciences 2022b).