MINUTES OF THE REGULAR MEETING OF THE
BOARD OF DIRECTORS OF
VISTA IRRIGATION DISTRICT

December 6, 2023

A Regular Meeting of the Board of Directors of Vista Irrigation District was held on Wednesday, December 6, 2023 at the offices of the District, 1391 Engineer Street, Vista, California.

1. CALL TO ORDER

President MacKenzie called the meeting to order at 9:00 a.m.

2. ROLL CALL

Directors present: Miller, Vásquez, Kuchinsky, Sanchez, and MacKenzie.

Directors absent: None.

Staff present: Brett Hodgkiss, General Manager; Lisa Soto, Secretary of the Board; Don Smith, Director of Water Resources Engineering; Randy Whitmann, Director of Engineering; Frank Wolinski, Director of Operations and Field Services; Shallako Goodrick, Director of Administration; Jessica Sherwood, Water Resources Assistant; and Ramae Ogilvie, Administrative Assistant. Present via teleconference were Lesley Dobalian, Director of Water Resources, and Greg Keppler, Engineering Project Manager. General Counsel Elizabeth Mitchell of Burke, Williams & Sorensen was also present.

Other attendees: Maia Singer, Stillwater Sciences; Don Lincoln and Reed Harlan, City of Escondido; and LaVonne Peck, San Luis Rey Indian Water Authority. Present via teleconference were Stephanie Zehren, San Luis Rey Indian Water Authority; JP Semper, Brown and Caldwell; and Holly Roberson, Kronick.

Family and friends of the retiring employees Don Smith, Richard Setter and Lisa Soto.

3. PLEDGE OF ALLEGIANCE

Director Kuchinsky led the Pledge of Allegiance.

4. APPROVAL OF AGENDA

23-12-131	***Upon motion by Director Sanchez, seconded by Director Miller and unanimously carried (5 ayes: Miller, Vásquez, Kuchinsky, Sanchez, and MacKenzie), the Board of Directors approved the agenda as presented.***

5. ORAL COMMUNICATIONS

No public comments were presented on items not appearing on the agenda.

6. CONSENT CALENDAR

Regarding Item 6.A, General Manager Brett Hodgkiss clarified that the agreement with InfoSend, Inc. is being amended to add FedEx delivery services specifically for discontinuation notices. This change is needed in order to comply with provisions of Senate Bill 998, the Water Shut-off Protection Act, which requires discontinuation notices to be mailed to properties rather than hand-delivered.

Regarding Item 6.C, Director Kuchinsky suggested that staff investigate whether the District might qualify for exemptions set forth in Assembly Bill 1594 regarding medium- and heavy-duty zero-emission vehicles for public agency utilities.

Regarding Item 6.D, Director of Operations and Field Services Frank Wolinski clarified that the registers on the water meters being purchased can be changed to encoded registers for automatic meter reading should the District wish to make use of this technology in the future.

Regarding Item 6.H, Director of Administration Shallako Goodrick provided clarification regarding expenditures related to live bee removal from meter boxes.

23-12-132	***Upon motion by Director Kuchinsky, seconded by Director Vasquez and unanimously carried (5 ayes: Miller, Vásquez, Kuchinsky, Sanchez, and MacKenzie), the Board of Directors approved the Consent Calendar, including Resolution Nos. 2023-44 and 2023-45 approving the Compensation Schedule and disbursements, respectively.***

A. Utility billing and mailing services

See staff report attached hereto. Staff recommended and the Board authorized the General Manager to amend the agreement with InfoSend, Inc. for utility billing and mailing services to include FedEx delivery services.

B. Revisions to Compensation Schedule

The Board adopted Resolution No. 2023-44 approving revisions to the Compensation Schedule effective January 1, 2024, by the following roll call vote:

AYES:	***Directors Miller, Vásquez, Kuchinsky, Sanchez, and MacKenzie***
NOES:	***None***
ABSTAIN:	***None***
ABSENT:	***None***

Resolution No. 2023-44 is on file in the official Resolution book of the District.

C. Vehicle purchase

See staff report attached hereto. Staff recommended and the Board approved the purchase of a 2024 F-650 Ford truck from Downtown Ford Sales in the amount of $84,112.09.

D. Water meter purchase

See staff report attached hereto. Staff recommended and the Board approved the purchase of Zenner water meters from iFlow Inc. in the amount of $61,285.48.

E. Materials for mainline replacement

See staff report attached hereto. Staff recommended and the Board approved the purchase of pipeline materials from Ferguson Waterworks for mainline replacement on Independence Way (D-2382; DIV NO 3) in the amount of $244,239.62.

F. Paving services

See staff report attached hereto. Staff recommended and the Board authorized the General Manager to execute an agreement with Joe's Paving, Inc. for paving services on Olive Avenue (D-2376; DIV NO 2) in an amount of $75,475.35.

G. Minutes of Board of Directors meeting on November 15, 2023

The minutes of November 15, 2023 were approved as presented.

H. Resolution ratifying check disbursements

RESOLUTION NO. 2023-45

BE IT RESOLVED, that the Board of Directors of Vista Irrigation District does hereby approve checks numbered 73467 through 73627 drawn on US Bank totaling $1,491,853.40.

FURTHER RESOLVED that the Board of Directors does hereby authorize the execution of the checks by the appropriate officers of the District.

PASSED AND ADOPTED unanimously by a roll call vote of the Board of Directors of Vista Irrigation District this 6th day of December 2023.

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7. RESOLUTION HONORING RETIRING VISTA IRRIGATION DISTRICT EMPLOYEE RICHARD SETTER

See staff report attached hereto.

Mr. Wolinski spoke about retiring Vista Irrigation District employee Richard Setter stating that he will retire on December 28, 2023 with 23 years of exemplary service to the District. He reviewed the high points of Mr. Setter's career with the District and commented that Mr. Setter is a highly skilled Equipment Operator and a dedicated and effective crew leader, teacher and mentor to his coworkers. Mr. Wolinski thanked Mr. Setter for his service, as did the Board and Mr. Hodgkiss, and congratulated him on his impending retirement.

23-12-133 ***Upon motion by Director Sanchez, seconded by Director Miller, the Board of Directors adopted Resolution 2023-46 honoring Equipment Operator Richard Setter for over 23 years of service to the District and its customers, by the following roll call vote:***

AYES:	***Directors Miller, Vásquez, Kuchinsky, Sanchez and MacKenzie***
NOES:	***None***
ABSTAIN:	***None***
ABSENT:	***None***

A copy of Resolution 2023-46 is on file in the official Resolution Book of the District.

Mr. Setter was presented a framed copy of the resolution adopted in his honor and a gift from the Board. He thanked the Board and the District.

8. RESOLUTION HONORING RETIRING VISTA IRRIGATION DISTRICT EMPLOYEE DON SMITH

See staff report attached hereto.

Mr. Hodgkiss spoke about Mr. Smith noting his passion and enthusiasm for his work and his stewardship of Lake Henshaw and the Warner Ranch, which has benefited the District and its customers. Mr. Hodgkiss and the Board members each expressed their appreciation for Mr. Smith stating that he will be sorely missed. Mr. Hodgkiss thanked Mr. Smith for his service, as did the Board, and congratulated him on his impending retirement.

23-12-134 ***Upon motion by Director Sanchez, seconded by Director Kuchinsky, the Board of Directors adopted Resolution 2023-47 honoring Director of Water Resources Engineering Don Smith for over 23 years of service to the District and its customers, by the following roll call vote:***

AYES:	***Directors Miller, Vásquez, Kuchinsky, Sanchez and MacKenzie***
NOES:	***None***
ABSTAIN:	***None***
ABSENT:	***None***

A copy of Resolution 2023-47 is on file in the official Resolution Book of the District.

Mr. Smith was presented a framed copy of the resolution adopted in his honor and a gift from the Board. He thanked the Board stating that he has thoroughly enjoyed his time with the District and appreciated all of the wonderful and interesting aspects of his job over the years.

9. RESOLUTION HONORING RETIRING VISTA IRRIGATION DISTRICT EMPLOYEE LISA SOTO

See staff report attached hereto.

Mr. Hodgkiss spoke about Ms. Soto stating that she is the longest consecutive serving Board Secretary in the 100 year history of the District and has worked for four General Managers. He noted that he had the opportunity to work with Ms. Soto on various projects and committees at the District over the years, and the one thing that stood out was her willingness to do whatever it took for projects to be completed or for an event to be successful. Mr. Hodgkiss thanked her, adding that she will be sorely missed.

The Board each spoke to and about Ms. Soto, commending, thanking, and congratulating her.

23-12-135 ***Upon motion by Director Kuchinsky, seconded by Director Miller, the Board of Directors adopted Resolution 2023-48 honoring Executive Assistant and Board Secretary Lisa Soto for over 27 years of service to the District and its customers, by the following roll call vote:***

AYES:	***Directors Miller, Vásquez, Kuchinsky, Sanchez and MacKenzie***
NOES:	***None***
ABSTAIN:	***None***
ABSENT:	***None***

A copy of Resolution 2023-48 is on file in the official Resolution Book of the District.

Ms. Soto was presented a framed copy of the resolution adopted in her honor and a gift from the Board. She thanked the Board for its service to the District and its customers, adding that she is grateful for her career with the District and it has been her pleasure to serve as the Board Secretary.

At this time a break was taken from 9:55 a.m. to 10:20 a.m.

10. DIVISION REPORTS

See staff report attached hereto.

Mr. Smith provided clarification regarding the increased recreational activities at the Lake Henshaw Resort. He also provided background regarding a letter that the District sent to the Metropolitan Water District of Southern California (MWD) supporting its response to the Water Resource Foundation's request for proposal for guidance in algaecide application in source waters.

11. MANAGEMENT AND MITIGATION OF HARMFUL ALGAL BLOOMS IN LAKE HENSHAW – PHASE II

See staff report attached hereto.

Dr. Maia Singer with Stillwater Sciences presented the findings and recommendations of the *Lakes Henshaw and Wohlford HABs Management – Phase II Synthesis Report* for the Harmful Algal Blooms (HABs) Management and Mitigation Project (Project) through the use of a PowerPoint presentation (attached hereto as Exhibit A). She provided background regarding how and why HABs occurs in lakes such as Lake Henshaw. Dr. Singer reviewed Phase I of the Project which was to develop short-term solutions and plans for monitoring and mitigating HABs in the Lakes Henshaw and Wohlford and to gather data for Phase II of the Project.

Dr. Singer provided an overview of the recommendations for the prevention and mitigation efforts to take place in Phase II of the Project. She reviewed recommendations for algaecide treatments and chemical sediment sealing through the use of lanthanum-modified clay treatments targeting deep and mid-depth areas. Dr. Singer also discussed the recommended additional steps to prevent the introduction of phosphorus to the lakes from external sources. She noted that another strategy for the control of phosphorus in Lake Henshaw would be to prevent lake-bottom sediments from going anoxic by keeping lake-bottom waters high in oxygen. Dr. Singer said that the recommendation would be to implement a full-scale trial to introduce supersaturated dissolved oxygen into Lake Henshaw bottom waters to improve overall oxygen levels, thereby minimizing phosphorus release from sediments in the lake.

Dr. Singer discussed algaecide treatments used in Lake Henshaw to date, noting that the recommendation is to continue to use frequent low doses of peroxide-based algaecide treatment during spring, summer, and early fall when the chl-a and cyanobacteria are relatively low and to consider the use of copper based algaecide at low to moderate doses when chl-a and/or cyanobacteria are relatively high. She reviewed other recommendations related to algaecide treatments in Lake Henshaw.

The Board received clarifications as needed and thanked Dr. Singer for her report.

12. LAKE HENSHAW TREATMENTS FOR HARMFUL ALGAL BLOOMS

See staff report attached hereto.

Mr. Smith said that while copper-based algaecides have proven to be effective at reducing cyanobacterial cell counts and cyanotoxin concentration levels at Lake Henshaw, the most recent use of copper in July 2023 had the undesirable effect of preventing releases from Lake Henshaw until August 23, 2023. He said that it is for this reason the District is prioritizing the use of frequent low-dose peroxide-based algaecide treatments to fight HABs in Lake Henshaw. He said that the proposed amendment to the agreement with Aquatechnex is needed in order to implement this recommendation.

23-12-136	***Upon motion by Director Miller, seconded by Director Vásquez and unanimously carried (5 ayes: Miller, Vásquez, Kuchinsky, Sanchez, and MacKenzie), the Board of Directors authorized the General Manager to amend the as-needed services agreement to provide services related to the treatment of harmful algal blooms in Lake Henshaw with Aquatechnex LLC for Fiscal Year 2024 in amount not to exceed to $2,403,195.***

13. MATTERS PERTAINING TO THE ACTIVITIES OF THE SAN DIEGO COUNTY WATER AUTHORITY

See staff report attached hereto.

Director Miller reported that the San Diego County Water Authority (Water Authority) has decided to drop its lawsuit against San Diego Local Agencies Formation Commission related to the reorganizations of the Fallbrook Public Utility District and Rainbow Municipal Water District. He also reported on a three party water exchange agreement between the Water Authority, the Imperial Irrigation District (IID) and MWD.

14. MEETINGS AND EVENTS

See staff report attached hereto.

Directors Miller, Kuchinsky, Vásquez, Sanchez, and MacKenzie all reported on their attendance at the recent Association of California Water Agencies (ACWA) Conference. Directors Miller and MacKenzie were complimentary of the presentation provided by JB Hamby, Vice President of IID, regarding the history of the Colorado River. Director Sanchez reported that he attended meetings of the ACWA Joint Powers Insurance Authority (JPIA) and a Federal Affairs Committee meeting while at the ACWA Conference. Director Kuchinsky said that while at the ACWA Conference he attended the ACWA JPIA session on cyber security. Director Vásquez said that the two committee meetings (Groundwater and Water Quality) that he attended while at the ACWA Conference were quite informative.

Director Vásquez said that he was scheduled to attend the San Diego Chapter, California Special Districts Association (CSDA) quarterly meeting on November 16, 2023; however he was unable to attend due to illness and requested forgiveness of the prepaid cost of the meal served at the meeting.

President MacKenzie and Director Miller requested tentative authorization to attend the upcoming meeting of the Council of Water Utilities (COWU) on January 16, 2024 in San Diego. They both said that they will confirm their attendance at the January 3, 2024 Board meeting.

Director Vásquez requested to attend the City of Vista State of the Community Luncheon in Vista on January 22, 2024 and the Urban Water Institute Spring Conference, February 21-23, 2024 in Palm Springs.

23-12-137	***Upon motion by Director Miller, seconded by Director Sanchez and unanimously carried (5 ayes: Miller, Vásquez, Kuchinsky, Sanchez, and MacKenzie), the Board of Directors authorized the following: forgiveness of the cost of the November 16, 2023 CSDA Quarterly meeting, which was missed by Director Vásquez due to illness; President MacKenzie and Director Miller to attend the Council of Water Utilities meeting on January 16, 2024 in San Diego; and Director Vásquez to attend the City of Vista State of the Community Luncheon on January 22, 2024 in Vista and the Urban Water Institute's Spring Water Conference, February 21-23, 2024 in Palm Springs.***

15. ITEMS FOR FUTURE AGENDAS AND/OR PRESS RELEASES

See staff report attached hereto.

A future agenda item was requested to update the Board (annually) on the District's cyber security efforts.

A press release was requested regarding the absence of per- and polyfluoroalkyl substances (PFAS) in the District's potable water supply; staff recommended that it be issued once the District receives results from its fourth quarter Fifth Unregulated Contaminant Monitoring Rule testing. A press release was also requested regarding the District's Scholarship Contest.

16. COMMENTS BY DIRECTORS

Director Kuchinsky commended staff for a great Employee Appreciation Event the previous day. Director Kuchinsky also mentioned that Assemblywoman Laurie Davies was having an open house from 3:00 p.m. to 5:30 p.m. that afternoon.

President MacKenzie wished everyone happy holidays and reiterated how much she will miss Mr. Smith and Ms. Soto, and wished them well in their retirements.

17. COMMENTS BY GENERAL COUNSEL

None were presented.

18. COMMENTS BY GENERAL MANAGER

Mr. Hodgkiss reminded the Board about the Special Board meeting scheduled for Monday, December 11, 2023 at 1:30 p.m. He also commented that while at the ACWA Conference the Vista Irrigation District Board met with the Otay Water District (Otay) Board of Directors for lunch; Otay's General Manager expressed that their Board enjoyed meeting with the Vista Irrigation District Board. Mr. Hodgkiss wished everyone happy holidays.

19. ANNUAL ORGANIZATIONAL MEETING

See staff report attached hereto.

President MacKenzie presided over the Board elections for 2024, noting that as First Vice President, Director Vásquez would be next in the rotation to be Board President for 2024.

23-12-138	***Upon motion by Director Miller, seconded by Director Kuchinsky and unanimously carried (5 ayes: Miller, Vásquez, Kuchinsky, Sanchez, and MacKenzie), the Board of Directors elected Richard Vasquez as Board President for 2024.***

Director Vásquez nominated Director Sanchez to be First Vice President for 2024.

23-12-139	***Upon motion by Director Vásquez, seconded by Director MacKenzie and unanimously carried (5 ayes: Miller, Vásquez, Kuchinsky, Sanchez, and MacKenzie), the Board of Directors elected Patrick Sanchez as First Vice President for 2024, to preside in the absence of the President.***

President MacKenzie nominated Directors Kuchinsky, Miller, and MacKenzie to serve as Vice Presidents for 2024.

23-12-140	***Upon motion by Director MacKenzie, seconded by Director Vásquez and unanimously carried (5 ayes: Miller, Vásquez, Kuchinsky, Sanchez, and MacKenzie), the Board of Directors elected Directors Kuchinsky, Miller, and MacKenzie to serve as Vice Presidents for 2024.***

Director Vásquez moved to approve staff's recommendation for the positions of Secretary of the Board, Assistant Secretaries of the Board, Treasurer, and Assistant Treasures.

23-12-141	***Upon motion by Director Vásquez, seconded by Director Sanchez and unanimously carried (5 ayes: Miller, Vásquez, Kuchinsky, Sanchez, and MacKenzie), the Board of Directors designated Ramae Ogilvie to serve as Secretary of the Board with Brett Hodgkiss designated as Assistant Secretary of the Board. Shallako Goodrick was designated to serve as Treasurer with Brett Hodgkiss designated as Assistant Treasurer.***

Director Sanchez congratulated and welcomed Ramae Ogilvie as the new Board Secretary for 2024. Director Vásquez requested that his fellow Directors think about what Committees they would like to serve on in 2024 and let him know as Committee appointments will be made at the January 3, 2024 Board meeting.

20. ADJOURNMENT

There being no further business to come before the Board, at 12:44 p.m. President MacKenzie adjourned the meeting.

Richard L. Vásquez, President

ATTEST:

Ramae Ogilvie, Secretary
Board of Directors
VISTA IRRIGATION DISTRICT

VISTA IRRIGATION DISTRICT

STAFF REPORT

Agenda Item: 6.A

Board Meeting Date:	**December 6, 2023**
Prepared By:	**Shallako Goodrick**
Approved By:	**Brett Hodgkiss**

SUBJECT: UTILITY BILLING AND MAILING SERVICES

RECOMMENDATION: Authorize the General Manager to amend the agreement with InfoSend, Inc. for utility billing and mailing services to include FedEx delivery services.

PRIOR BOARD ACTION: None.

FISCAL IMPACT: The estimated annual cost of FedEx delivery services is $105,000; this cost will be fully offset by revenue generated by the Mailed Discontinuation Notice Fee which was adopted by the Board at its October 17, 2023 meeting and becomes effective January 1, 2024. There is a one-time set-up fee of $350 to add this service.

SUMMARY: InfoSend, Inc. (Infosend) has successfully provided utility bill printing and mailing services to the District since 2010. Over time, the District has added optional services offered by InfoSend including electronic bill presentment and payment. At this time, staff is requesting to amend the agreement with InfoSend to add FedEx delivery services so that discontinuation notices can be mailed to properties rather than hand delivered.

Currently, discontinuation notices are prepared and hand delivered to a property by District staff; adding the FedEx delivery services would allow discontinuation notices to be prepared and delivered via mail (two-day delivery) to a property. InfoSend will create and mail the discontinuation notice along the District's Discontinuation of Water Service Policy in multiple languages pursuant with the set forth in Health and Safety Code Section 116900 et seq. (enacted by Senate Bill 998, the Water Shut-off Protection Act). As noted above, the cost of the FedEx delivery service will be paid for by revenue generated by the Mailed Discontinuation Fee.

VISTA IRRIGATION DISTRICT **STAFF REPORT**	**Agenda Item: 6.B** **Board Meeting Date:** **December 6, 2023** **Prepared By:** **Shallako Goodrick** **Approved By:** **Brett Hodgkiss**

SUBJECT: REVISIONS TO COMPENSATION SCHEDULE

RECOMMENDATION: Adopt Resolution No. 2023-XX approving revisions to the Compensation Schedule effective January 1, 2024.

PRIOR BOARD ACTION: At least annually, the Board approves a Compensation Schedule for all employees to facilitate California Public Employees' Retirement System (CalPERS) reporting requirements under state pension law. Most recently, the Board adopted revisions to the Compensation Schedule on April 5, 2023.

FISCAL IMPACT: Revisions to the Compensation Schedule effective January 1, 2024 will increase annual labor costs by approximately $360,000.

SUMMARY: CalPERS retirement law requires that the governing body of all public agencies approve a salary schedule and any revisions thereto for all employees in an open public forum.

DETAILED REPORT: The California Code of Regulations (CCR) at Section 570.5 requires public agencies to make duly adopted and approved pay schedules publicly available prior to including the compensation as a part of the members' retirement benefit. CCR Section 570.5 requires that the employee pay rate be limited to the amount listed on a pay schedule that has been duly approved and adopted by the employer's governing body in accordance with the requirements of applicable public meeting laws.

Increases in the proposed 2024 schedule reflect negotiated salary adjustments in accordance with the Board approved Memorandum of Agreement with the Teamsters Union, which also established terms and conditions of employment for unrepresented employees, for a three year term beginning on January 1, 2022 and ending on December 31, 2024. The economic terms that were negotiated with the new employee agreements include a salary range adjustment effective January 1, 2024; the salary adjustment is equal to 95% of the San Diego Consumer Price Index for All Urban Consumers for the twelve-month period ended June 30, 2023 (cap of 4%) resulting in an increase of 4%.

At its April 5, 2023, the Board approved adding the position of Director of Water Resources Engineering (to be filled by the incumbent Director of Water Resources) to Water Resources Division, allowing the Director of Water Resources to be filled in advance of the incumbent's retirement; the Compensation Schedule was revised to reflect the new position. With the Director of Water Resources Engineering retiring in December 2023, the position is no longer needed and is being eliminated and removed from the Compensation Schedule. This change will decrease the maximum staffing level from 89 to 88.

ATTACHMENT: Resolution No. 2023-XX

RESOLUTION NO. 2023-XX

RESOLUTION OF THE BOARD OF DIRECTORS OF
VISTA IRRIGATION DISTRICT
APPROVING REVISIONS TO THE COMPENSATION SCHEDULE
EFFECTIVE JANUARY 1, 2024

WHEREAS, Vista Irrigation District's negotiating team completed meet and confer labor negotiations for 2022, 2023 and 2024 salaries and benefits as set forth in a Memorandum of Agreement for represented employees and a Resolution for unrepresented employees; and

WHEREAS, the District has previously negotiated and the Board of Directors has previously approved in each of these labor agreements certain adjustments to salary for each of the three years of the contract term; and

WHEREAS, California Code of Regulations (CCR) Section 570.5 requires public agencies to have a pay schedule duly approved and adopted by the employer's governing body in accordance with requirements of applicable public meeting laws in order for CalPERS to consider pay as "compensation earnable" for purposes of calculating a member's retirement benefit.

NOW, THEREFORE, BE IT RESOLVED that the Board of Directors of Vista Irrigation District does hereby approve and adopt revisions to the Compensation Schedule to reflect changes as set forth in the attached "Exhibit A", incorporated herein by reference.

BE IT FURTHER RESOLVED that the Board of Directors has authorized execution of documents by the General Manager and Human Resources Manager that may be required to carry out this Resolution.

PASSED AND ADOPTED by the Board of Directors this 6th day of December 2023, by the following roll call vote:

AYES:
NOES:
ABSTAIN:
ABSENT:

____
Jo MacKenzie, President

ATTEST:

____
Lisa Soto, Secretary
Board of Directors
Vista Irrigation District

EXHIBIT A

Vista Irrigation District
COMPENSATION SCHEDULE
Effective January 1, 2024

Job Title	Range - Monthly			Non-Exempt	Exempt
Accountant	$7,652	-	$9,301	X	
Accounts Payable Clerk	$5,426	-	$6,595	X	
Administrative Assistant	$6,828	-	$8,299	X	
Administrative Secretary	$5,678	-	$6,901	X	
Construction Worker (New Series)	$5,426	-	$6,595	X	
Construction Worker (Terminal)	$5,678	-	$6,901	X	
Customer Service Representative (New Series)	$5,426	-	$6,595	X	
Customer Service Representative (Terminal)	$5,678	-	$6,901	X	
Engineering Aide	$6,828	-	$8,299	X	
Engineering Inspector	$8,188	-	$9,953	X	
Engineering Specialist I	$7,652	-	$9,301	X	
Engineering Specialist II	$8,188	-	$9,953	X	
Equipment Mechanic	$6,528	-	$7,935	X	
Equipment Operator	$6,528	-	$7,935	X	
Executive Assistant/Secretary of the Board	$8,188	-	$9,953	X	
Facilities Locator	$6,039	-	$7,341	X	
Facilities Office Assistant	$5,678	-	$6,901	X	
Facilities Worker	$6,528	-	$7,935	X	
GIS Specialist	$7,652	-	$9,301	X	
GIS Systems Associate	$8,633	-	$10,493	X	
Heavy Equipment Operator	$6,828	-	$8,299	X	
Human Resources Office Assistant	$6,039	-	$7,341	X	
Information Technology System Administrator	$8,633	-	$10,493	X	
Inventory Control Clerk	$5,426	-	$6,595	X	
Maintenance Worker	$5,426	-	$6,595	X	
Management Analyst	$8,633	-	$10,493	X	
Meter Reader	$4,687	-	$5,697	X	
Meter Reader Trainee	$4,463	-	$5,425	X	
Meter Repair Technician	$5,678	-	$6,901	X	
Purchasing Agent	$7,652	-	$9,301	X	
Receptionist/Cashier	$5,426	-	$6,595	X	
Safety & Risk Administrator	$10,018	-	$12,177	X	
Senior Accountant	$8,633	-	$10,493	X	
Senior Construction Worker	$7,652	-	$9,301	X	
Senior Customer Service Representative	$6,039	-	$7,341	X	
Senior Equipment Mechanic	$7,652	-	$9,301	X	
Senior Facilities Worker	$7,652	-	$9,301	X	
Senior System Operator	$7,652	-	$9,301	X	
System Controls Technician I	$7,652	-	$9,301	X	
System Controls Technician II	$8,188	-	$9,953	X	
System Controls Technician III	$8,633	-	$10,493	X	
System Operator I	$6,828	-	$8,299	X	
System Operator II	$7,233	-	$8,792	X	
Utility Worker (New Series)	$4,921	-	$5,982	X	
Utility Worker (Terminal)	$5,426	-	$6,595	X	

EXHIBIT A

Vista Irrigation District
COMPENSATION SCHEDULE
Effective January 1, 2024

Job Title	Range - Monthly			Non-Exempt	Exempt
Utility Worker Trainee	$4,687	-	$5,697	X	
Water Conservation Specialist I	$7,652	-	$9,301	X	
Water Conservation Specialist II	$8,188	-	$9,953	X	
Water Quality Operator I	$6,828	-	$8,299	X	
Water Quality Operator II	$7,233	-	$8,792	X	
Water Quality Operator III	$7,652	-	$9,301	X	
Water Resources Aide	$6,039	-	$7,341	X	
Water Resources Assistant	$7,233	-	$8,792	X	
Water Resources Office Assistant	$5,678	-	$6,901	X	
Welder I	$6,828	-	$8,299	X	
Welder II	$7,233	-	$8,792	X	
Welder/Equipment Operator	$7,233	-	$8,792	X	
Construction Supervisor	$10,018	-	$12,177		X
Customer Service Supervisor	$9,028	-	$10,973		X
Director of Administration	$14,451	-	$17,566		X
Director of Engineering	$16,564	-	$20,134		X
Director of Operations and Field Services	$14,451	-	$17,566		X
Director of Water Resources	$16,564	-	$20,134		X
Engineering Project Manager	$13,333	-	$16,206		X
Engineering Services Manager	$13,333	-	$16,206		X
Facilities Supervisor	$10,018	-	$12,177		X
Finance Supervisor	$10,018	-	$12,177		X
General Manager	$22,920		$22,920		X
Human Resources Manager	$13,333	-	$16,206		X
Information Technology Supervisor	$10,018	-	$12,177		X
System Controls Supervisor	$10,018	-	$12,177		X
Water Distribution Supervisor	$10,018	-	$12,177		X
Water Resources Supervisor	$7,975	-	$9,694		X

VISTA IRRIGATION DISTRICT **STAFF REPORT**	**Agenda Item: 6.C** **Board Meeting Date:** **December 6, 2023** **Prepared By:** **Frank Wolinski** **Approved By:** **Brett Hodgkiss**

SUBJECT: VEHICLE PURCHASE

RECOMMENDATION: Approve the purchase of a 2024 F-650 Ford truck from Downtown Ford Sales in the amount of $84,112.09.

PRIOR BOARD ACTION: A heavy-duty flatbed, Class 6 vehicle was included in the Fiscal Year 2024 Budget (budgeted amount – $105,000).

FISCAL IMPACT: $84,112.09.

SUMMARY: The District needs to replace a 1998 Ford F-800 diesel flatbed truck equipped with a crane. Staff recommends replacing the Ford F-800 with a new, gasoline-powered F-650 flatbed truck. District staff proposes to utilize the State purchasing program to procure this vehicle.

DETAILED REPORT: The Ford F-800 flatbed was purchased in February 1998 for $36,309 and was later equipped with a 3.5-ton crane costing $27,680 in the same year; in 2012, the vehicle was fitted with a diesel particulate filter in order to meet emissions compliance. Currently, the Ford F-800 has close to 54,000 miles, suffers from numerous oil and hydraulic leaks and the longevity of the diesel particulate filter is uncertain. Staff is proposing to replace the 1998 Ford F-800 with a 2024 Ford F-650 flatbed without a crane (no longer needed), thus reducing costs and adding payload capacity; the 2024 Ford F-650 flatbed will be ordered with a 7.3-liter gasoline engine, six-speed automatic transmission and an 8-foot by 18-foot flatbed body.

The District sourced this vehicle through Statewide Commodity Contracts that are made available by the State to special districts and other government entities. When desired vehicles are available, the District has historically used this program to purchase vehicles at a lower cost than can be otherwise obtained through traditional procurement procedures. In this case, the base price of a 2024 F-650 truck provisioned through the State is approximately $10,000 less than the base manufacturer's suggested retail price available through local fleet retailers. Ford brand vehicles are provided under the program for vehicles and trucks, and Downtown Ford Sales is the sole vendor available for this truck model.

VISTA IRRIGATION DISTRICT	Agenda Item: 6.D
	Board Meeting Date: December 6, 2023
	Prepared By: Christina Moyer
	Reviewed By: Shallako Goodrick
STAFF REPORT	Approved By: Brett Hodgkiss

SUBJECT: WATER METER PURCHASE

RECOMMENDATION: Approve the purchase of Zenner water meters from iFlow Inc. in the amount of $61,285.48.

PRIOR BOARD ACTION: On October 6, 2021, the Board approved the purchase of water meters from Ferguson Waterworks and Meter & Automation Group in the amount of $73,913.64.

FISCAL IMPACT: $ 61,285.48 includes tax and freight.

SUMMARY: It is anticipated that the District will need to purchase 502 meters to supplement its current inventory, which is being used for meter change-outs and new installations. The District will be purchasing meters ranging in size from 5/8" to 2".

DETAILED REPORT: The District recently solicited pricing for meters from six manufacturers in order to continue to secure the most advantageous prices for the District. Pricing was obtained from iFlow Inc. (Zenner meters), Ferguson Waterworks Meter & Automation Group (Neptune meters), Badger Meter, Inc. (Badger meters) and Iconix Waterworks (Mueller meters). Aqua Metric Sales Company (Sensus meters) and HydroPro Solutions (Master meters) declined to submit bids because their respective meters could not meet the District's required specifications.

The total pricing submitted by iFlow Inc. was based on the District purchasing 104 – 5/8", 318 – 3/4", 40– 1", 20 –1.5", 20 –2" meters. The actual number of meters purchased may change slightly based on the actual needs of the District.

BID SUMMARY

iFlow Inc.	$61,285.48
Iconix Waterworks	$90,110.00
Ferguson Waterworks Meter & Automation Group	$93,062.53
Badger Meter, Inc.	$95,592.54

VISTA IRRIGATION DISTRICT	Agenda Item: 6.E
STAFF REPORT	**Board Meeting Date:** **December 6, 2023** **Prepared By:** **Frank Wolinski** **Approved By:** **Brett Hodgkiss**

SUBJECT: MATERIALS FOR MAINLINE REPLACEMENT

RECOMMENDATION: Approve the purchase of pipeline materials from Ferguson Waterworks for mainline replacement on Independence Way (D-2382; DIV NO 3) in the amount of $244,239.62.

PRIOR BOARD ACTION: None.

FISCAL IMPACT: $244,239.62, including tax and freight.

SUMMARY: The District solicited bids from three vendors: Core & Main, Ferguson Waterworks and Pacific Pipeline Supply. Ferguson Waterworks and Pacific Pipeline Supply submitted responsive bids; Core & Main did not submit a bid. Ferguson Waterworks submitted the lowest overall bid.

DETAILED REPORT: This bid represents approximately half of the material needed to replace the planned 6,100 feet of various sizes of steel, asbestos cement and PVC (2.5-inch) pipe in Independence Way, Sherman Way, Monte Mar Road, Elm Drive and Dolphin Circle that was installed between the mid-1930s and 1980. The reason for splitting material bids for this project is due to storage limitations at the project's staging area and District headquarters. Staff recommends the replacement of this mainline, as it will eliminate a segment of steel pipe with an elevated leak history that has reached the end of its useful life.

Materials being purchased for this phase project include 4-inch, 6-inch, 8-inch and 12-inch PVC pipe and various fittings.

Bid Results:	Ferguson Waterworks	$244,239.62
	Pacific Pipeline Supply	$251,557.04

CALIFORNIA ENVIRONMENTAL QUALITY ACT (CEQA): This purchase is for a mainline replacement project that staff previously determined to be exempt under Class 2 of the State CEQA Guidelines section 15302 (Replacement or Reconstruction), 14 CCR § 15302(c) because it consists of replacement or reconstruction of an existing utility system and/or facilities involving negligible or no expansion of capacity and there is no potential for the project to cause either a direct or a reasonably foreseeable indirect physical change in the environment.

VISTA IRRIGATION DISTRICT	Agenda Item: 6.F
STAFF REPORT	**Board Meeting Date:** **December 6, 2023** **Prepared By:** **Frank Wolinski** **Approved By:** **Brett Hodgkiss**

SUBJECT: PAVING SERVICES

RECOMMENDATION: Authorize the General Manager to execute an agreement with Joe's Paving, Inc. for paving services on Olive Avenue (D-2376; DIV NO 2) in an amount of $75,475.35.

PRIOR BOARD ACTION: None.

FISCAL IMPACT: Not to exceed $75,475.35.

SUMMARY: The District solicited bids from eleven contractors for final asphalt repairs for this project. Four contractors attended the mandatory job walk, and three responsive bids were received. Joe's Paving, Inc. responded with the lowest bid.

DETAILED REPORT: District staff installed approximately 950 feet of various sizes of PVC pipe in Olive Avenue to complete the final phase of this project. Paving requirements for this project include approximately 4,500 square feet of paving and 2,400 lineal feet of striping. The bid results were as follows:

Joe's Paving, Inc.	$75,475.35
RAP Engineering, Inc.	$102,431.07
Kirk Paving, Inc.	$117,748.00

Based on the bid results and past performance, staff recommends executing an agreement with Joe's Paving, Inc. for paving services on Olive Avenue.

CALIFORNIA ENVIRONMENTAL QUALITY ACT (CEQA): This agreement is for a phase of the mainline replacement project, which is a project that staff previously determined to be exempt under Class 2 of the State CEQA Guidelines section 15302 (Replacement or Reconstruction), 14 CCR § 15302(c), because it consists of replacement or reconstruction of an existing utility system and/or facilities involving negligible or no expansion of capacity and there is no potential for the project to cause either a direct or a reasonably foreseeable indirect physical change in the environment.

Cash Disbursement Report

Payment Dates 11/2/2023 - 11/21/2023

Payment Number	Payment Date	Vendor	Description	Amount
73467 - 73469	11/08/2023	Refund Checks 73467 - 73469	Customer Refunds	7,465.70
73470	11/08/2023	ACWA/JPIA	Medical & Dental Insurance 08/2023 - Cobra	69.09
	11/08/2023		Medical & Dental Insurance 08/2023 - Cobra	69.09
	11/08/2023		Medical & Dental Insurance 08/2023 - Cobra	69.09
	11/08/2023		Medical & Dental Insurance 08/2023 - Cobra	33.72
	11/08/2023		Medical & Dental Insurance 08/2023 - Cobra	(33.72)
	11/08/2023		Medical & Dental Insurance 08/2023 - Cobra	69.09
	11/08/2023		Medical & Dental Insurance 08/2023 - Cobra	69.09
	11/08/2023		Medical & Dental Insurance 08/2023 - Cobra	69.09
	11/08/2023		Medical & Dental Insurance 12/2023 - Employees	179,464.48
	11/08/2023		Medical & Dental Insurance 12/2023 - Retirees	39,461.07
	11/08/2023		Medical & Dental Insurance 12/2023 - P Kuchinsky	1,537.77
	11/08/2023		Medical & Dental Insurance 12/2023 - J MacKenzie	1,537.77
	11/08/2023		Medical & Dental Insurance 12/2023 - P Sanchez	1,537.77
	11/08/2023		Medical & Dental Insurance 12/2023 - M Miller	1,537.77
	11/08/2023		Medical & Dental Insurance 12/2023 - R Vasquez	2,021.67
73471	11/08/2023	ACTenviro	Hazardous Waste Disposal	1,314.73
73472	11/08/2023	Amazon Capital Services	Utility Cart	59.62
	11/08/2023		Seat Bottom Cushion - Truck 65	216.49
	11/08/2023		Retirement Gift	322.43
	11/08/2023		Battery T8	36.42
	11/08/2023		Rolling Measuring Wheel	118.77
	11/08/2023		Adjustable Release Buckles	(5.52)
	11/08/2023		Binders (10)	75.80
	11/08/2023		High Pressure Swivel Fittings - VE2	41.92
	11/08/2023		Air Valve Extensions (2)	25.96
	11/08/2023		Bellows for Wacker	77.93
73473	11/08/2023	Auto Specialist Warehouse	Rear Brake Pads - Truck 40	84.03
	11/08/2023		Park Brake Shoes - Truck 40	54.94
73474	11/08/2023	BAVCO	Backflow Replacement - WCRH	756.77
73475	11/08/2023	Bennett-Bowen & Lighthouse Inc	Strobe Lamps (5) , Work Lamps (1)	299.79
73476	11/08/2023	Bryan and the Bee's	Live Bee Removal (1)	192.50
	11/08/2023		Live Bee Removal (1)	192.50
	11/08/2023		Live Bee Removal (1)	192.50
73477	11/08/2023	CDW Government Inc	FortiAP Access Points (8)	2,644.76

Payment Number	Payment Date	Vendor	Description	Amount
73478	11/08/2023	Cecilia's Safety Service Inc	Traffic Control - Olive Ave	4,512.50
	11/08/2023		Traffic Control - Camino Loma Verde	4,940.00
	11/08/2023		Traffic Control - Beaumont Dr	950.00
	11/08/2023		Traffic Control - Deerhaven Dr	831.25
73479	11/08/2023	Citi Cards	Dog Biscuits for Meter Readers/Field Personnel	32.45
	11/08/2023		Kitchen & Restroom Supplies	1,213.39
	11/08/2023		Service Award Gift Cards (17)	1,989.48
	11/08/2023		Refreshments - Health Fair & Training	578.34
73480	11/08/2023	City Of Escondido	San Pasqual Underground Project 07/2023 - 09/2023	130,653.79
73481	11/08/2023	Akeso Occupational Health	New Hire Physical	168.00
	11/08/2023		Rapid PCR	169.00
73482	11/08/2023	Complete Office of California, Inc	Office Supplies	132.13
73483	11/08/2023	Core & Main	DI Spool (1)	454.02
	11/08/2023		4"x3" 90 Degree Ell (1)	111.51
	11/08/2023		12" PO 45 Ell (2)	1,015.84
73484	11/08/2023	County of San Diego	Permit Fees 09/2023	45.50
73485	11/08/2023	Direct Energy	Electric 10/2023 - Henshaw Buildings & Grounds	811.48
	11/08/2023		Electric 10/2023 - Henshaw Wellfield	749.40
73486	11/08/2023	EDCO Waste & Recycling Services Inc	Trash Service 10/2023	463.30
73487	11/08/2023	Electrical Sales Inc	Parts to Repair SCADA - CX28	3,736.37
73488	11/08/2023	Flyers Energy, LLC	Fuel	89.29
73489	11/08/2023	Grainger	Media Sandblaster	74.99
73490	11/08/2023	Hach Company	Chlorine Analyzer for Station 12	3,799.58
73491	11/08/2023	Joe's Paving	Final Patch Paving - Marlin Dr & Cabrillo Circle	13,545.05
	11/08/2023		Asphalt Repair & Striping - Olive Dr	56,669.00
73492	11/08/2023	Jan-Pro of San Diego	Janitorial Services 09/2023	4,497.00
	11/08/2023		Janitorial Services 10/2023	4,497.00
73493	11/08/2023	Ken Grody Ford Carlsbad	Rear Brake Cable, Actuator Pawl - Truck 40	121.91
73494	11/08/2023	Lightning Messenger Express	Messenger Service 10/27/23	88.00
73495	11/08/2023	Makelele Systems Landscape & Maintenance, Inc	Landscape Services 10/2023	1,650.00
73496	11/08/2023	NAPA Auto Parts	Threaded Rod	20.56
73497	11/08/2023	North County Auto Parts	Rear Brake Rotors - Truck 40	328.78
	11/08/2023		Spray Paint - T23	13.14
	11/08/2023		Chemicals - Garage	100.54
	11/08/2023		Hoses (3) - Truck 5	(71.94)
	11/08/2023		Parts - Truck 5	(73.10)
73498	11/08/2023	Pacific Pipeline Supply	2" Compression Couplings (4)	626.58
	11/08/2023		4" Pass Thru Plug (1)	183.72
	11/08/2023		Pipe Supports (2)	191.33
73499	11/08/2023	Paychex of New York LLC	Onboarding/Recruiting/Flex Benefits Svc 11/2023	812.50

Payment Number	Payment Date	Vendor	Description	Amount
73500	11/08/2023	Phenova Inc	Micro Proficiency Testing	510.41
73501	11/08/2023	Revive: A Corporate Wellness Movement, LLC	Health Fair 2023	2,310.00
73502	11/08/2023	San Diego Chapter CSDA	CSDA Dinner Meeting - R Vasquez	70.00
	11/08/2023		CSDA Dinner Meeting - B Hodgkiss	70.00
73503	11/08/2023	San Diego Gas & Electric	Gas 10/2023	440.37
	11/08/2023		Electric 10/2023 - Henshaw Buildings & Grounds	241.46
	11/08/2023		Electric 10/2023 - Henshaw Wellfield	13,174.69
	11/08/2023		Electric 10/2023 - VID Headquarter	7,913.63
	11/08/2023		Electric 10/2023 - Warner Ranch House	12.75
73504	11/08/2023	SePro Corporation	HABs Lab Analysis	510.00
73505	11/08/2023	SiteOne Landscape Supply, LLC	Irrigation Parts	5.76
73506	11/08/2023	Southern Counties Lubricants, LLC	Fuel 10/16/23 - 10/31/23	9,625.32
73507	11/08/2023	State Water Resources Control Board	ELAP Certification Renewal	4,615.00
73508	11/08/2023	Hot Taps Unlimited	Hot Tapping Services - Olive Ave	690.00
73509	11/08/2023	Stillwater Sciences	HABs Consulting 09/2023	1,444.00
73510	11/08/2023	Sunbelt Rentals	Concrete	292.75
73511	11/08/2023	The UPS Store 0971	Shipping 10/31/23	1,832.68
73512	11/08/2023	Bend Genetics, LLC	HABs Lab Analysis	2,271.00
73513	11/08/2023	Midas Service Experts	Tires (2), Alignment - Truck 40	672.01
73514	11/08/2023	Trench Shoring Company	Railroad Spikes, Non Skid Paint	454.65
73515	11/08/2023	T.S. Industrial Supply	Fill Hose (1)	172.12
73516	11/08/2023	Umpqua Bank	E Reservoir Replace & Pump Sta 7/23-8/23-Retainage D2346	14,321.97
73517	11/08/2023	UniFirst Corporation	Uniform Service	263.87
73518	11/08/2023	Verizon Wireless	SCADA Remote Access	408.33
73519	11/08/2023	Vulcan Materials Company and Affiliates	Cold Mix Asphalt	3,181.32
73520 - 73522	11/15/2023	Refund Checks 73520 - 73522	Customer Refunds	1,325.58
73523	11/15/2023	Amazon Capital Services	Labels for Label Maker (2)	52.40
	11/15/2023		Notebooks, Headphones	49.03
	11/15/2023		American Flag for the Dam	289.96
73524	11/15/2023	American Water Works Association	Membership Dues 2024	7,624.00
73525	11/15/2023	Boot World Inc	Footwear Program (2)	311.07
73526	11/15/2023	Brown and Caldwell	Flume Replacement Alignment Study 8/25/23 - 9/28/23	160,471.15
73527	11/15/2023	Bryan and the Bee's	Live Bee Removal (1)	192.50
	11/15/2023		Live Bee Removal (1)	192.50
	11/15/2023		Live Bee Removal (1)	192.50
	11/15/2023		Live Bee Removal (1)	192.50
	11/15/2023		Live Bee Removal (1)	192.50
	11/15/2023		Live Bee Removal (1)	192.50
	11/15/2023		Live Bee Removal (1)	192.50
	11/15/2023		Live Bee Removal (1)	192.50

Payment Number	Payment Date	Vendor	Description	Amount
	11/15/2023		Live Bee Removal (1)	192.50
73528	11/15/2023	Burke, Williams & Sorensen, LLP	Legal 10/2023 - General	120.00
	11/15/2023		Legal 10/2023 - General	288.00
	11/15/2023		Legal 10/2023 - General	2,760.00
	11/15/2023		Legal 10/2023 - Litigation/Claims	232.00
73529	11/15/2023	California Department of Justice	Fingerprinting	49.00
73530	11/15/2023	Canon Solutions America, Inc	Canon Services & Supplies	32.39
73531	11/15/2023	Cecilia's Safety Service Inc	Traffic Control - Waxwing Dr	1,615.00
	11/15/2023		Traffic Control - Ridge Road	1,235.00
	11/15/2023		Traffic Control - North Avenue	1,377.40
	11/15/2023		Traffic Control - Olive Ave	4,987.50
	11/15/2023		Traffic Control - Camino Loma Verde	3,040.00
73532	11/15/2023	City of Vista	Permit Fees 07/2023 - 09/2023	16,698.50
73533	11/15/2023	Complete Office of California, Inc	Office Supplies	17.71
73534	11/15/2023	Core & Main	Coupling 6" Repair PVC C900 (4)	226.46
	11/15/2023		Reducer 6x4 DI FL (1)	129.90
	11/15/2023		Coupling 6" Deflection C900 (4)	197.23
	11/15/2023		Fire Hydrant Rod 15"x.5" Break Off SS (4)	294.44
	11/15/2023		Ell 10" DI PO 45 Degree (1)	343.15
	11/15/2023		Flange 1.5" Brass for Meter (15)	535.82
	11/15/2023		Coupling 10" Repair PVC C900 (2)	575.89
	11/15/2023		Pipe 8" PVC DR-14 C900 (20)	606.20
	11/15/2023		Coupling 4" Macro (2)	677.65
	11/15/2023		Sleeve 8"x12" Galvanized Top Sections (100)	1,244.88
	11/15/2023		Coupling 10" Deflection C900 (6)	1,779.63
	11/15/2023		Fire Hydrant LB400 Check Valve (2)	3,983.60
	11/15/2023		Pipe 10" PVC DR-14 C900 (120)	5,715.60
	11/15/2023		Adapter 4" DI FLxPO (1)	98.51
	11/15/2023		Pipe 1.5" PVC Schedule 40 (40)	73.61
	11/15/2023		Flange 6" SOW 6-hole (5)	205.68
	11/15/2023		Ell 10" DI PO 45 Degree (1)	343.15
	11/15/2023		Ell 10" DI POxFL 11.25 Degree (1)	322.59
	11/15/2023		Clamp 1.5x6 Repair Full Circle Copper SS Romac (1)	127.73
	11/15/2023		Clamp 1x6 Repair Full Circle Orangeberg SS Romac (1)	124.49
	11/15/2023		Pipe 6" CMLC #10 Steel (40)	1,732.00
	11/15/2023		Angle Ball Valve 2" FNPT X MNPT (CurbStop)(3)	1,149.62
	11/15/2023		Coupling 1"x1" Female Flare x Super Grip (10)	313.93
73535	11/15/2023	Craneworks Southwest Inc	Maintenance Kit - Trk 65 Air Compressor	405.09
	11/15/2023		Broom Hoses (4) - B10 & B20	669.24
	11/15/2023		Hi Pressure Water Line - VE2	167.09

Payment Number	Payment Date	Vendor	Description	Amount
73536	11/15/2023	Diamond Environmental Services	Portable Restroom Service	135.08
	11/15/2023		Portable Restroom Service	84.23
	11/15/2023		Portable Restroom Service	108.01
	11/15/2023		Portable Restroom Service	100.57
73537	11/15/2023	EDCO Waste & Recycling Services Inc	Trash Service 10/2023	489.31
73538	11/15/2023	Electrical Sales Inc	Split Bolts / SK8 / Greaves 10-10130 (300)	766.41
73539	11/15/2023	Employee Relations, Inc	Background Check	77.50
73540	11/15/2023	Employment Development Department	Unemployment Insurance 07/2023 - 09/2023	3,481.75
73541	11/15/2023	Trace3. LLC	Trace3 Service agreement - VxRail Install	9,918.00
73542	11/15/2023	FedEx	Express Shipping	37.90
73543	11/15/2023	Ferguson Waterworks	Angle Ball Valve 2" FNPT X MNPT (CurbStop) (2)	776.00
	11/15/2023		Corp Stop 1" MIP X Flare (22)	1,888.29
	11/15/2023		Gate Valve 6" FL Butterfly (2)	2,565.53
	11/15/2023		10" Pipe Restraints / Sigma 10" PWM-C10 (8)	878.12
	11/15/2023		5/8" x 2.5" Brass Bolts (100)	649.50
	11/15/2023		4" Sewer Pipe / SDR-35 (40)	116.91
	11/15/2023		12" Pipe Restraints / Sigma 12" PWM-C12 (14)	1,643.86
	11/15/2023		8" / PO / Rubber Gaskets (20)	166.71
	11/15/2023		6" / PO / Rubber Gaskets (20)	140.73
	11/15/2023		10" / PO / Rubber Gaskets (10)	125.03
	11/15/2023		5/8" Brass Nuts (100)	243.56
73544	11/15/2023	Flyers Energy, LLC	Fuel	98.49
73545	11/15/2023	Gateway Pacific Contractors, Inc	E Reservoir Replacement & Pump Station 09/2023	84,494.04
73546	11/15/2023	Grainger	Battery Charger - Henshaw Dam Bubbler	191.29
	11/15/2023		Electrical Gloves (7 pair)	788.89
73547	11/15/2023	Hawthorne Machinery Co	Parts for Wacker	152.56
	11/15/2023		Hydraulic Hose - B24	44.58
73548	11/15/2023	Home Depot Credit Services	Tools/Batteries	312.78
	11/15/2023		Batteries for Cordless Tools	258.72
	11/15/2023		Batteries for Cordless Tools, Screwdriver	191.47
	11/15/2023		Foam Material	15.89
	11/15/2023		Tools	81.12
	11/15/2023		Tools/Parts	213.66
	11/15/2023		Parts	24.19
	11/15/2023		Thinset, Parts	50.49
	11/15/2023		Concrete & Supplies - Road House Garage	851.77
	11/15/2023		Concrete - Road House Garage	486.15
	11/15/2023		Concrete/Concrete Mesh - Road House Garage	369.22
	11/15/2023		Concrete - Road House Garage	217.14
	11/15/2023		Concrete - Road House Driveway	547.68

Payment Number	Payment Date	Vendor	Description	Amount
	11/15/2023		Warehouse Supplies	107.96
	11/15/2023		Freight Credit from 09/23 statement	(107.17)
	11/15/2023		Concrete Rapid Set 60lb bag (50)	785.24
	11/15/2023		Concrete 60lb bag (168)	850.89
73549	11/15/2023	Jackson & Blanc	Boiler Repair - VID Headquarter	1,366.86
73550	11/15/2023	Jeff McNeal Productions	On Hold Messaging	220.00
73551	11/15/2023	Kronick Moskovitz Tiedemann & Girard	Legal 09/2023	6,333.00
73552	11/15/2023	Major League Pest	Monthly Pest Control	225.00
73553	11/15/2023	Mallory Safety and Supply, LLC	Boots sz 11 Knee-high Steel Toe (1)	21.60
	11/15/2023		Lime Hi-Viz Vest LG (3)	67.06
	11/15/2023		Lime Hi-Viz Vest MED (6)	134.12
73554	11/15/2023	Moodys	Dump Fees (5)	1,500.00
73555	11/15/2023	North County Auto Parts	Oil & Brake Cleaner	182.41
	11/15/2023		Water Pump, Parts - Truck 5	202.85
	11/15/2023		Fuel Pump - F1	95.75
	11/15/2023		Green Coolant - Truck 5	109.04
	11/15/2023		Bolt - Truck 5	4.57
	11/15/2023		Protective Sleeves for Hydraulic Hoses (25)	10.29
	11/15/2023		Sealant - Truck 5	14.19
	11/15/2023		Coolant Hoses - Truck 5	97.64
73556	11/15/2023	North County Pool Center Inc	Chlorine (8) - H Reservoir	82.27
73557	11/15/2023	Pacific Pipeline Supply	Ball Meter Valve 1.5" FLG X FIP DD & Lockwing (4)	1,231.15
	11/15/2023		Angle Ball Valve 2" FNPT X MNPT (CurbStop)(12)	5,412.80
	11/15/2023		Union 1" CTS COMP X PEP (6)	448.67
	11/15/2023		Corp Stop 2" MIP X FIP (1)	371.01
	11/15/2023		Restrainer Kit for 10" Angle (1)	206.76
	11/15/2023		Compression Couplings (10)	383.64
73558	11/15/2023	Pacific Safety Center	Confined Space Awareness Training (2)	390.00
	11/15/2023		Confined Space/Permit Required Training (2)	550.00
73559	11/15/2023	Peter Kuchinsky	Reimburse - CSDA	439.06
73560	11/15/2023	Raven Fire Protection	Refund Overpayment - Fire Flow Fee	36.00
73561	11/15/2023	Raymond Handling Solutions Inc	Scheduled Maintenance - F1	98.00
73562	11/15/2023	Registry	License Plate for 2007 Zieman Trailer	67.00
73563	11/15/2023	SePro Corporation	HABs Lab Analysis	510.00
73564	11/15/2023	Spok, Inc	Pagers	51.06
73565	11/15/2023	Stillwater Sciences	HABs Management Plan - Phase II	12,183.00
73566	11/15/2023	Bend Genetics, LLC	HABs Lab Analysis	1,929.00
73567	11/15/2023	The San Diego Union-Tribune LLC	Notice of Public Hearing - Fees	1,080.03
73568	11/15/2023	Umpqua Bank	E Res Replacement & Pump Sta 09/23 - Retainage D2346	4,447.05
73569	11/15/2023	UniFirst Corporation	Uniform Service	268.35

Payment Number	Payment Date	Vendor	Description	Amount
73570	11/15/2023	T.S. Industrial Supply	Pyramex Safety Glasses - Blk / Smk Frame (10)	102.84
	11/15/2023		Black Pipe Wrap Tape / 2" x 100' / 10 Mil (42)	397.82
	11/15/2023		Striping Paint Blue #750 (12)	99.37
	11/15/2023		Striping Paint White #710 (12)	99.37
	11/15/2023		Striping Paint Black #770 (24)	198.75
	11/15/2023		Striping Paint Yellow #720 (12)	99.37
	11/15/2023		Nemesis Safety Glasses - Smk / Blk Frame (10)	63.76
	11/15/2023		Striping Stick / Aervoe 1745 (1)	42.38
	11/15/2023		Max Ear Plug / Uncorded / #Max1 (box of 200) (1)	38.97
	11/15/2023		Blue Stake Chasers (bundles of 25) (8)	36.37
	11/15/2023		Twine / Nylon / Pink / 275' (3)	9.26
	11/15/2023		Marking Paint / Fluorescent Pink #229 (12)	69.63
	11/15/2023		Abrasive Mesh Roll 120G (10)	233.28
	11/15/2023		Locks 2029 Master (15)	227.33
	11/15/2023		Measuring Tape 25' Engineering (5)	104.46
	11/15/2023		Curb Stop Key .75-1" CS310 (1)	59.10
	11/15/2023		Blade 14" Diamond Concrete (2)	467.64
	11/15/2023		Digging Bar Heavy Duty (2)	387.54
	11/15/2023		Bits for Rivet Buster (4)	116.91
	11/15/2023		Construction Marking Paint White #255 (12)	55.73
	11/15/2023		Wire Brush -Stainless Steel/7 3/4" /Plastic Handle (20)	48.06
	11/15/2023		Duct Tape #398 / 2" x 60 yd (4)	47.98
	11/15/2023		Striping Paint Blue #750 (24)	198.75
	11/15/2023		Striping Paint Black #770 (24)	198.75
	11/15/2023		Electrical Tape / 3/4" x 60' / 7 Mil (20)	31.39
	11/15/2023		White Paint Brush / 3" (20)	30.31
	11/15/2023		Wire Brush / Wood Handle / 4 x 19 (6)	24.23
	11/15/2023		Striping Paint White #710 (24)	198.75
	11/15/2023		Sqwincher Fruit Punch / 6 oz / 4 boxes of 50 (4)	107.82
	11/15/2023		Black Pipe Wrap Tape / 2" x 100' / 10 Mil (24)	227.33
	11/15/2023		Utility Knife/ Stanley Quick Change / Metal (10)	86.06
	11/15/2023		Towel Wypall X80 (5)	248.16
	11/15/2023		Hammer 10" Tomahawk (4)	223.00
	11/15/2023		Shovel Round Point (3)	107.17
	11/15/2023		Pruner 26" (1)	69.28
	11/15/2023		Extension Cord 25' (1)	61.70
	11/15/2023		Mirror 3.25" Diameter Telescopic (2)	57.70
	11/15/2023		Socket 1.125" Deep .5" Drive (1)	20.35
	11/15/2023		Cutter 7" Hand Cutter Wire (2)	56.61
	11/15/2023		Mirror 2"x3.5" Telescopic (1)	26.63

Payment Number	Payment Date	Vendor	Description	Amount
	11/15/2023		Gloves Thickster Nitrile XL 100 per box (10)	281.45
	11/15/2023		Pump Utility 36" with hose (10)	736.10
73571	11/21/2023	Refund Check 73571	Customer Refund	2,484.00
73572	11/21/2023	Refund Check 73572	Customer Refund	2,123.07
73573	11/21/2023	Refund Check 73573	Customer Refund	35.15
73574	11/21/2023	A-1 Irrigation, Inc	Nails, Trowel, Sponge	34.39
73575	11/21/2023	Airgas USA LLC	Silver Solder 050x1/8" x 20" SAFETYSILV 15 (25lb)	2,568.22
	11/21/2023		Welding Rod	293.62
73576	11/21/2023	Amazon Capital Services	HDMI Cable	15.57
	11/21/2023		Air Hoses	53.88
	11/21/2023		Retirement Gift	202.95
	11/21/2023		Warehouse Supplies	318.15
	11/21/2023		Brother Printer	432.98
	11/21/2023		Retirement Gift	76.85
	11/21/2023		Rolling Measuring Wheel	85.29
73577	11/21/2023	AT&T	3680/CALNET 10/13/23 - 11/12/23	523.45
	11/21/2023		0230/CALNET 10/13/23 - 11/12/23	10.10
73578	11/21/2023		Voice & Data Service	1,183.96
73579	11/21/2023	Best Best & Krieger LLP	Legal 10/2023	242.00
73580	11/21/2023	CA-NV Section AWWA	Certificate Renewal	100.00
73581	11/21/2023	Cecilia's Safety Service Inc	Traffic Control - Olive Ave	2,185.00
	11/21/2023		Traffic Control - Camino Loma Verde	1,377.50
	11/21/2023		Traffic Control - Camino Loma Verde	2,992.50
	11/21/2023		Traffic Control - Hacienda Dr	1,805.00
73582	11/21/2023	City Of Escondido	Escondido Water Treatment Plant 09/2023 - 10/2023	310,075.00
73583	11/21/2023	Coastal Chlorination & Backflow	Chlorination of Water Main - Olive Ave	490.00
73584	11/21/2023	Complete Office of California, Inc	Office Supplies	115.24
73585	11/21/2023	Consor North America, Inc	Deodar Reservoir Rehabilitation 09/2023	4,830.36
73586	11/21/2023	Core & Main	12"x6" Tapping Sleeve (1)	1,043.02
73587	11/21/2023	CoreLogic Solutions Inc	RealQuest Online Services	300.00
73588	11/21/2023	Direct Energy	Electric 10/2023 - VID Headquarter	4,631.26
73589	11/21/2023	Dudek	E Reservoir Replacement Pump Station 08/2023	16,021.35
73590	11/21/2023	Evoqua Water Technologies LLC	DI Bottle Rental	444.34
73591	11/21/2023	Ferguson Waterworks	Corp Stop 2" MIP X FIP (5)	1,612.32
	11/21/2023		Corp Stop 2" MIP X FIP (5)	1,343.60
	11/21/2023		Corp Stop 2" MIP X FIP (8)	2,149.76
	11/21/2023		Corp Stop 2" MIP X FIP (5)	1,452.17
	11/21/2023		1.25" PVC Pipe / Sch 40 (40)	49.80
	11/21/2023		Fire Hydrant Spool 6x24 DI (4)	1,054.14
	11/21/2023		Coupling 12" Deflection C900 (3)	1,051.64

Payment Number	Payment Date	Vendor	Description	Amount
	11/21/2023		Nipple 2x12 Brass (2)	87.51
	11/21/2023		Nipple 2x8 Brass (3)	88.85
	11/21/2023		Nipple 4x6 Brass (1)	91.04
	11/21/2023		Coupling 1" CTSxCTS (4)	106.43
	11/21/2023		Flange 4" SOW (7)	117.45
	11/21/2023		Flange 6" SOW 8-hole (5)	122.05
	11/21/2023		Gate Valve 4" FL R/W (1)	690.64
	11/21/2023		Pipe Lube 5 gal (2)	160.21
	11/21/2023		Nut Bolt Gasket Kit 4" (4" gasket) (12)	164.32
	11/21/2023		Adapter 4" DI FLxPO (2)	207.93
	11/21/2023		Tee 6" DI POxFL (1)	250.36
	11/21/2023		Ell 4" DI FL 90 Degree (2)	257.79
	11/21/2023		Adapter 12" DI FLxPO (1)	432.83
	11/21/2023		Adapter 2" Copper x MIP (24)	462.44
	11/21/2023		Nut Bolt Gskt Kit 6"-8" (6" gskt) 3/4 x 3 1/4 (24)	500.12
	11/21/2023		Grease No-Oxide 1 gal (6)	527.00
	11/21/2023		Fire Hydrant 6" Break Off Spool LB400 (2)	568.31
	11/21/2023		Tee 10x8 DI Flange (1)	634.92
	11/21/2023		Adapter 6" DI POxFL (1)	162.31
	11/21/2023		Plastic Wrap Clear 8 mil 3'x100' (Visqueen) (30)	1,104.15
	11/21/2023		Gate Valve 6" FL R/W (1)	923.23
	11/21/2023		Fire Hydrant LB400 Check Valve (3)	6,186.49
	11/21/2023		Gate Valve 6" POxFL R/W (2)	1,852.05
	11/21/2023		Tubing 1" Copper Soft 60' (300)	2,289.49
73592	11/21/2023	Frank Wolinski	Reimburse - Cross Connection Specialist Certification	100.00
73593	11/21/2023	Garda CL West, Inc	Armored Transport 12/2023	449.97
73594	11/21/2023	Grainger	Tri-Flow Spray Lubricant	196.02
73595	11/21/2023	USABlueBook	Wooden Plugs (14)	154.99
73596	11/21/2023	Hi-Line Inc	Shop Supplies	209.81
73597	11/21/2023	InfoSend Inc	Backflow Notices	233.09
	11/21/2023		Support & Storage 10/2023	1,724.43
73598	11/21/2023	Inland Kenworth (US) Inc	Diesel Exhaust Fluid	122.30
73599	11/21/2023	Joe's Paving	Patch Paving	30,979.80
	11/21/2023		Patch Paving	12,581.90
73600	11/21/2023	Lanair Technology Group	SECURE Breach Prevention Platform - 100 Users	180.00
73601	11/21/2023	Leon Perrault Trucking & Materials	Trucking & Material 10/2023	13,480.50
73602	11/21/2023	Mark Sauer Construction Inc	Repairs to the Warner-Carrillo Ranch House	76,000.00
73603	11/21/2023	McMaster-Carr Supply Company	Wire Duct - SCADA	91.84
73604	11/21/2023	MRC, Smart Technology Solutions	Manage Printer Services	1,008.98
73605	11/21/2023	Mutual of Omaha	LTD/STD/Life Insurance 12/2023	5,534.30

Payment Number	Payment Date	Vendor	Description	Amount
73606	11/21/2023	NAPA Auto Parts	Sway Bar Links, Filters	145.10
	11/21/2023		Coolant Hose - Truck 5	27.05
	11/21/2023		Hose - Truck 5	41.48
	11/21/2023		Coolant Hose - Truck 5	22.18
	11/21/2023		Filter - G24	90.79
	11/21/2023		Filter - G24	(15.28)
	11/21/2023		Filter - G24	15.28
	11/21/2023		Filter - G24	21.78
	11/21/2023		Wheel Balancing Weights	44.48
73607	11/21/2023	NIGP - National Institute of Govt Purchasing	Membership Renewal	195.00
73608	11/21/2023	North County Auto Parts	Coolant (8)	150.81
73609	11/21/2023	North County Pool Center Inc	Chlorine (4)	41.14
73610	11/21/2023	O'Reilly Auto Parts	Battery Warranty Credit - Truck 40	(210.94)
	11/21/2023		Trailer Light Cord Adapter	45.98
	11/21/2023		Battery - Truck 69	169.38
	11/21/2023		Battery - Truck 10	210.94
73611	11/21/2023	Parkhouse Tire Inc	Tire (1) - Truck 44	407.69
	11/21/2023		Tires (40) - Truck 66	1,295.57
73612	11/21/2023	Ramae Ogilvie	Reimburse - Board Secretary Conference	163.58
73613	11/21/2023	RC Auto & Smog	Smog Inspection - Truck 61	90.00
	11/21/2023		Smog Inspection - Truck 63	50.00
73614	11/21/2023	S & R Towing	Towing - Truck 49	200.00
73615	11/21/2023	Volvo Construction Equipment & Services	Hydraulic Fluid	66.01
	11/21/2023		Cushion Cover - E1	(158.89)
	11/21/2023		Digging Teeth, Hardware - Excavators	1,032.72
73616	11/21/2023	San Diego Gas & Electric	Electric 10/2023- T&D	(131.33)
	11/21/2023		Electric 10/2023 - Reservoirs	115.55
	11/21/2023		Electric 10/2023 - Cathodic Protection & T&D	(21.82)
	11/21/2023		Electric 10/2023 - Reservoirs	(134.82)
	11/21/2023		Electric 10/2023 - Pump Stations	14,337.23
	11/21/2023		Electric 10/2023 - Plants	(104.56)
73617	11/21/2023	SePro Corporation	HABs Lab Analysis	510.00
73618	11/21/2023	Technology Unlimited	Maintenance & Software License Renewal	3,105.00
73619	11/21/2023	Bend Genetics, LLC	HABs Lab Analysis	1,400.00
73620	11/21/2023	Trench Shoring Company	Primer, Non Skid Paint	411.35
73621	11/21/2023	Underground Service Alert of Southern California	New DigAlert Tickets 10/2023	437.00
	11/21/2023		Safe Excavation Board Fees	153.74
73622	11/21/2023	UniFirst Corporation	Uniform Service	309.40
73623	11/21/2023	Verizon Wireless	Air Cards	152.05
73624	11/21/2023	West Coast Civil, Inc	Waterline Improvements - McGavran Dr (TO 03)	1,400.00

Payment Number	Payment Date	Vendor	Description	Amount
	11/21/2023		Water Main Abandonment - Independence Way (TO 01)	1,520.00
73625	11/21/2023	T.S. Industrial Supply	Striping Paint Asphalt Black #770 (40)	397.50
	11/21/2023		Cable Reel Parts - Truck 65	84.29
73626	11/21/2023	T.S. Industrial Supply	Locks 2029 Master (15)	227.33
	11/21/2023		Boyer Gun Pointed Bits (4)	136.40
73627	11/21/2023	WM LampTracker Inc	Disposal of Old Light Bulbs	119.00
			Grand Total:	**1,491,853.40**

VISTA IRRIGATION DISTRICT **STAFF REPORT**	**Agenda Item: 7** **Board Meeting Date:** **December 6, 2023** **Prepared By:** **Frank Wolinski** **Approved By:** **Brett Hodgkiss**

SUBJECT: RESOLUTION HONORING RETIRING VISTA IRRIGATION DISTRICT EMPLOYEE RICHARD SETTER

RECOMMENDATION: Adopt Resolution No. 2023-XX honoring Richard Setter for 23 years of service to the District and its customers.

PRIOR BOARD ACTION: None.

FISCAL IMPACT: None.

SUMMARY: Richard will retire with 23 years of exemplary service to the District and its customers on December 28, 2023. The District would like to honor Richard by passing the attached resolution.

DETAILED REPORT: Richard started his career with the District on November 20, 2000, as a Temporary Utility Worker I. Due to his strong work ethic and demonstrated skills from his previous employment in the construction industry, Richard was hired as a regular Utility Worker I less than a month later. During Richard's early tenure at the District, he worked in Construction performing mainline installations before being promoted into the Construction Maintenance section as a Construction Worker in 2001. As he learned quickly and gravitated to equipment operation, Richard was promoted to Welder Helper in 2002. As a Welder Helper, Richard began to further hone his equipment operator skills by repairing water services, fire hydrants and mainlines. In 2006, Richard lateral transferred to a vacant Equipment Operator position.

Throughout his career as an Equipment Operator, Richard has been responsible for excavating and repairing countless leaks to help maintain the 429 miles of mainline, 29,000 service connections and 3,800 fire hydrants within the District's infrastructure. He is an exceptionally talented equipment operator and Class A driver and his dedication to the District is unwavering. Richard is an effective crew leader and has an inherent desire to teach and mentor others. He has trained many of the District's current construction and facilities staff in the "tricks of the trade" when it comes to leak repair, mainline replacement, pipeline locating and equipment operation. His institutional knowledge and vibrant character will be greatly missed.

Richard's last day with the District will be December 28, 2023. In retirement, Richard plans to build a deck on his house, catch up on things he has "been meaning to get to" and follow his dreams.

ATTACHMENT: Resolution No. 2023-XX.

RESOLUTION NO. 2023-XX

RESOLUTION OF THE BOARD OF DIRECTORS OF
VISTA IRRIGATION DISTRICT
HONORING RICHARD SETTER
FOR 23 YEARS OF SERVICE TO THE DISTRICT

WHEREAS, Richard Setter, starting as a temporary Utility Worker I and progressively advancing to the position of Equipment Operator, has provided the District and its customers with 23 years of exemplary service; and

WHEREAS, serving in his many capacities, Richard was charged with the installation, repair and maintenance of the District's extensive infrastructure, facilities and equipment; and

WHEREAS, Richard's integrity, dedication and strong work ethic has enabled the District to provide exemplary customer service and superior system reliability; and

WHEREAS, his extensive knowledge of equipment operations, leak repair techniques and water main replacement has contributed to the District's impeccable reputation for effectively managing its aging infrastructure; and

WHEREAS, Richard's inherent ability to mentor and teach others has had a resounding impact on his coworkers and will extend to the next generation of workers at the District; and

WHEREAS, Richard's wide range of abilities, institutional knowledge, resourcefulness and good-natured personality will be sorely missed at the District.

NOW, THEREFORE, BE IT RESOLVED that the Board of Directors of the Vista Irrigation District does hereby wish Richard Setter a long, healthy and prosperous retirement and expresses its appreciation for his dedication to the District and to its customers for the past 23 years.

PASSED AND ADOPTED by the following roll call vote of the Board of Directors of Vista Irrigation District this 6th day of December 2023.

AYES:
NOES:
ABSTAIN:
ABSENT:

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Jo MacKenzie, President

ATTEST:

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Lisa Soto, Secretary
Board of Directors
VISTA IRRIGATION DISTRICT

VISTA IRRIGATION DISTRICT	Agenda Item: 8
STAFF REPORT	**Board Meeting Date:** **December 6, 2023** **Prepared By:** **Brett Hodgkiss**

SUBJECT: RESOLUTION HONORING RETIRING VISTA IRRIGATION DISTRICT EMPLOYEE DON SMITH

RECOMMENDATION: Adopt Resolution No. 2023-XX honoring Director of Water Resources Don Smith for 23 years of service to the District and its customers.

PRIOR BOARD ACTION: None.

FISCAL IMPACT: None.

SUMMARY: Don will retire with over 23 years of service to the District and its customers on December 14, 2023. The District would like to honor Don by passing the attached resolution.

DETAILED REPORT: Don started his career with the District on October 30, 2000 as the District's Director of Water Resources. During his tenure as Director of Water Resources, Don has shown tremendous dedication and professionalism in conducting himself while directing, planning, and supervising the development and management of the District's local water system including Lake Henshaw, Warner wellfield and ditch system, and Escondido-Vista Water Treatment Plant (EVWTP). Don has also been the steward of the District's 43,000-acre Warner Ranch, overseeing grazing, recreation and other activities taking place on the property; when giving tours of the Warner Ranch, Don would often start the tour at a scenic overlook with a panoramic view of Warner Ranch and say "welcome to my office".

Don has accomplished many important goals during his tenure, highlighted by the resolution of 47-year old dispute with local Indian Bands over the use of Lake Henshaw water rights. His diligence, hard work, and organizational skills were instrumental in bringing closure to a multitude of issues vital to the finalization of the San Luis Rey Indian Water Rights Settlement (Settlement); for his efforts, Don received a resolution from the Board commending his exemplary service to the District with regard to the Settlement. Other milestones in his career include implementing the San Luis Rey Settlement Agreement, managing Harmful Algal Blooms at Lake Henshaw, and working with the City of Escondido managing the conveyance of water from Lake Henshaw to the EVWTP at Lake Dixon. Don's commitment to the District, its employees and customers will be sorely missed.

Don's last day with the District will be December 14, 2023. In retirement, Don and his wife, Michele, plan on camping and traveling, both locally and abroad. Retirement will also include spending time with friends, putting miles on his bicycle, and relaxing with a good book. We wish Don health and happiness as he embarks into retirement.

ATTACHMENT: Resolution No. 2023-XX

RESOLUTION NO. 2023-XX

RESOLUTION OF THE BOARD OF DIRECTORS OF
VISTA IRRIGATION DISTRICT
HONORING DON SMITH
FOR 23 YEARS OF SERVICE TO THE DISTRICT

WHEREAS, Don Smith, Director of Water Resources, has provided the District and its customers with over 23 years of exemplary service; and

WHEREAS, Don was charged with directing, planning, and supervising the development and management of the District's local water system including Lake Henshaw, Warner wellfield and ditch system, and Escondido-Vista Water Treatment Plant; and

WHEREAS, Don was the steward of the District's 43,000-acre Warner Ranch, overseeing grazing, recreation and other activities taking place on the property; and

WHEREAS, during his tenure with the District, highlights of Don's achievements include resolution of 47-year old dispute with local Indian Bands over the use of Lake Henshaw water rights; implementing the San Luis Rey Settlement Agreement; managing Harmful Algal Blooms at Lake Henshaw; and working with the City of Escondido managing the conveyance of water from Lake Henshaw to the Escondido-Vista Water Treatment Plant at Lake Dixon; and

WHEREAS, Don has continually demonstrated a remarkable service ethic and commitment to the District during the entirety of his career; and

WHEREAS, Don's positive, can-do attitude and supportive nature will be sorely missed.

NOW, THEREFORE, BE IT RESOLVED that the Board of Directors of the Vista Irrigation District does hereby wish Don Smith a long, healthy and prosperous retirement and expresses its appreciation for is dedication to the District and its customers for the past 23 years.

PASSED AND ADOPTED by the following roll call vote of the Board of Directors of Vista Irrigation District this 6th day of December 2023.

AYES:
NOES:
ABSTAIN:
ABSENT:

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Jo MacKenzie, President

ATTEST:

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Lisa Soto, Secretary
Board of Directors
VISTA IRRIGATION DISTRICT

VISTA IRRIGATION DISTRICT **STAFF REPORT**	**Agenda Item: 9** **Board Meeting Date:** **December 6, 2023** **Prepared By:** **Brett Hodgkiss**

SUBJECT: RESOLUTION HONORING RETIRING VISTA IRRIGATION DISTRICT EMPLOYEE LISA SOTO

RECOMMENDATION: Adopt Resolution No. 2023-XX honoring Executive Assistant/Board Secretary Lisa Soto for 27 years of service to the District and its customers.

PRIOR BOARD ACTION: None.

FISCAL IMPACT: None.

SUMMARY: Lisa will retire with 27 years of service to the District and its customers on December 28, 2023. The District would like to honor Lisa by passing the attached resolution.

DETAILED REPORT: Lisa started her career with the District on January 11, 1996 as an Administrative Secretary and was promoted Interim Executive Assistant in September 2006. She became Executive Assistant/Board Secretary in January 2007. Lisa has always exhibited a positive, cheery attitude and shown a high level professionalism.

Lisa has provided support to staff as well as the Board, effectively prioritizing her workload to meet the expectations of both groups. She coordinated activities for the District's Phase I Records Management Project to scan and make searchable important and historic District documents (nearly 900,000 pages of images), played a key support role in the restoration of the Warner-Carrillo Ranch House, a National and State historic landmark, and provided creativity and organizational skills in the development of the trademarked and innovative drink tap water campaign, *Love Tap!*. Lisa also prepared the District's applications for the Special Districts Leadership Foundation's District of Distinction and District Transparency Certificate of Excellence programs; the District has consistently earned the top honors with every renewal since each program's inception.

Lisa is a people person and has been an active participant on various employee committees, helping out with whatever needed to be done including serving as a committee chair; she also was part of the 75th Anniversary and Groundbreaking (current District headquarters) planning team. Lisa cares about her coworkers and has always been committed to making the District a great place to work. She also cared about the community in which she worked, participating in the Lead Vista Program and on the District's team of volunteers in the Vistans Revitalizing Our Community event to help beautify North Citrus Avenue in Vista. Lisa's commitment to the District, its employees and customers will be sorely missed.

Following retirement, Lisa intends to sleep every day until the late, late hour of 7:00 AM. She plans to explore all the beautiful bike trails around San Diego County on her new bike and re-open her workshop (her garage) established during the pandemic where she enjoys painting and upcycling small furniture items and other accent pieces for the home. We wish Lisa health and happiness as she embarks into retirement.

ATTACHMENT: Resolution No. 2023-XX

RESOLUTION NO. 2023-XX

RESOLUTION OF THE BOARD OF DIRECTORS OF
VISTA IRRIGATION DISTRICT
HONORING LISA SOTO
FOR 27 YEARS OF SERVICE TO THE DISTRICT

WHEREAS, Lisa Soto, starting as the Administrative Assistant and advancing to the position of Executive Assistant/Board Secretary, has provided the District and its customers with 27 years of exemplary service; and

WHEREAS, Lisa has tirelessly provided support to staff as well as the Board, effectively prioritizing her workload to meet the expectations of both groups; and

WHEREAS, Lisa coordinated activities for the District's Phase I Records Management Project to scan and make searchable important and historic District documents (nearly 900,000 pages of images), played a key support role in the restoration of the Warner-Carrillo Ranch House, a National and State historic landmark, and provided creativity and organizational skills in the development of the trademarked and innovative drink tap water campaign, *Love Tap!*; and

WHEREAS, Lisa prepared the District's applications for the Special Districts Leadership Foundation's District of Distinction and District Transparency Certificate of Excellence programs, consistently earning the District top honors with every renewal since each program's inception; and

WHEREAS, Lisa has been an active participant on various employee committees, helping them organize and carryout successful events and activities; and

WHEREAS, Lisa cared about the community in which she worked, participating in the Lead Vista Program and on the District's team of volunteers in the Vistans Revitalizing Our Community event to help beautify North Citrus Avenue in Vista; and

WHEREAS, Lisa's positive, cheery attitude and professionalism will be sorely missed.

NOW, THEREFORE, BE IT RESOLVED that the Board of Directors of the Vista Irrigation District does hereby wish Lisa Soto a long, healthy and prosperous retirement and expresses its appreciation for is dedication to the District and its customers for the past 27 years.

PASSED AND ADOPTED by the following roll call vote of the Board of Directors of Vista Irrigation District this 6th day of December 2023.

AYES:
NOES:
ABSTAIN:
ABSENT:

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Jo MacKenzie, President

ATTEST:

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Lisa Soto, Secretary
Board of Directors
VISTA IRRIGATION DISTRICT

VISTA IRRIGATION DISTRICT	Agenda Item: 10
STAFF REPORT	**Board Meeting Date:** December 6, 2023 **Prepared By:** Randy Whitmann, Don Smith, Frank Wolinski & Shallako Goodrick **Approved By:** Brett Hodgkiss

SUBJECT: DIVISION REPORTS

RECOMMENDATION: Note and file informational report.

PRIOR BOARD ACTION: None.

FISCAL IMPACT: None.

SUMMARY: Previous month's and anticipated activities are reported by each division.

ADMINISTRATION DIVISION

November

- Hosted the WaterSmart Landscape Makeover Workshop on November 4, 2023 (39 reservations and 19 participants).
- Completed recruitment for Utility Worker Trainee position; Jorge Macias accepted a job offer for the position.

December

- Coordinate Employee Appreciation Event.
- Begin recruitment for Equipment Operator.

WATER RESOURCES DIVISION

VID Water Production

October 2023

Description	**Current Month Production** (mgd)	(af)	**Average Production of Last 12 Months** (mgd)	(af)	**Total, Fiscal Year-to-Date** (af)
VID's EVWTP Water Production					
Local Water	3.04	289.30	2.49	233.24	1,084.70
SDCWA Raw Water	10.72	1,019.60	8.41	786.03	4,098.60
Subtotal (EVWTP Water Production)	**13.76**	**1,308.90**	**10.89**	**1,019.28**	**5,183.30**
Oceanside Contract Water	2.18	207.60	1.21	112.44	482.30
SDCWA Treated Water	-0.52	-49.90	1.39	130.06	649.60
TOTAL WATER PRODUCTION	**15.42**	**1,466.60**	**13.50**	**1,261.78**	**6,315.20**

Lake Henshaw and Warner Ranch Wellfield statistics are summarized as follows:

Lake Henshaw

Storage as of November 27, 2023:	22,669 af (44% of 51,832 af capacity)
Current releases:	15 cfs
Change in storage for month of October:	1,195 af (loss)
Total releases for month of October:	544 af
Hydrologic year-to-date rain total:	3.25 inches (November 27, 2023)
Percent of yearly average rain:	14% (30-year average: 23.78 inches)
Percent of year-to-date average rain:	87% (30-year average through November: 3.75 in.)

Warner Ranch Wellfield

Number of wells running in November:	0
Total production for month of November:	26 af
Average depth to water table (November):	81 ft (see attached historical water table chart)

November

- Harmful Algal Blooms
  - Performed sampling for Harmful Algal Blooms (HABs) in Lake Henshaw on October 23 and 30, 2023 and November 6 and 13, 2023. Microcystin and anatoxin-a concentrations have consistently remained "non-detect" over this period.
  - Provided a letter of support to the Metropolitan Water District of Southern California (Metropolitan) to include in their grant proposal to the Water Research Foundation (WRF) to develop guidance on algaecide use to address HABs and taste and odor issues. The District letter also expressed willingness to share HABs data from Lake Henshaw with Metropolitan for the WRF project. If Metropolitan is awarded the grant, the project duration would be 18 to 24 months.
- Provided tours of the Warner Ranch for the San Luis Rey Indian Water Authority and the City of Escondido staff.

December

- Perform annual inspection of the Henshaw Dam Outlet Tunnel.

ATTACHMENTS:

- Lake Henshaw Resort, Inc., Activity Reports – September 2023
- VID's Warner Wellfield – Water Table Depth vs. Monthly Wellfield Production
- Fiscal Year 2024 Budget and Expenses related to HABs

OPERATIONS & FIELD SERVICES

November

- Water Quality Call/Incident for November – received one discolored water call. The call was related to a system shutdown and resolved with flushing.
- Received third quarter lab results from the Fifth Unregulated Contaminant Monitoring Rule testing; all samples tested non-detect for 29 Per- and Poly-fluoroalkyl substances (PFASs).
- Inspected and tested 46 new backflow devices that were integrated into the District's cross-connection control program.
- Continued planning for water service line inventory as required by the Environmental Protection Agency's (EPA's) new Lead and Copper Rule revisions.
- Continued mainline replacement of Nipponite pipe on Olive Avenue – install approximately 2,000' of various sizes of PVC pipe, 38 services and 3 hydrant laterals.
  Approximately 95% complete.

- Continued mainline replacement of Nipponite and non-Nipponite AC pipe on Camino Loma Verde and Grandview Road – install approximately 1,850’ of various sizes of PVC pipe, 19 services and 2 hydrant laterals. Approximately 55% complete.
- Completed layout and potholing for mainline replacement on Watson Way.

December

- Continue planning for water service line inventory as required by the EPA’s new Lead and Copper Rule revisions.
- Continue mainline replacement of Nipponite pipe on Olive Avenue – install approximately 2,000’ of various sizes of PVC pipe, 38 services and 3 hydrant laterals.
- Continue mainline replacement of Nipponite and non-Nipponite AC pipe on Camino Loma Verde and Grandview Road – install approximately 1,850’ of various sizes of PVC pipe, 19 services and 2 hydrant laterals.
- Begin mainline replacement of non-Nipponite AC pipe on Watson Way – install approximately 400’ of 8-inch PVC pipe, 8 services and 1 hydrant lateral.
- Begin mainline replacement of non-Nipponite AC pipe on Cabrillo Circle – install approximately 145’ 4-inch PVC pipe and five services.

Electrical Energy Use at VID Headquarters
October 2023

Description	Current Month Production (kWh)	Average of Last 12 Months (kWh)	Total, Fiscal Year-to-Date (kWh)
Solar Production ($0.19 per kWh)	13,950	19,121	47,740
Power purchased from Direct Energy ($0.05 per kWh)	32,139	22,710	141,334
TOTAL ELECTRICAL ENERGY USE	**46,089**	**41,830**	**189,074**

ENGINEERING DIVISION

November

- The District has replaced approximately 10.43 miles of Nipponite pipe since 2002 with 5.49 miles remaining as shown below. Replacement of 0.70 miles of Nipponite pipe is currently in design and 0.39 miles is in construction.

Miles of Nipponite Remaining

Diameter	Risk			Total
	High	Medium	Low	
4-inch	0.04	0.33	0.00	**0.38**
6-inch	0.00	0.10	0.34	**0.44**
8-inch	0.40	1.29	1.03	**2.72**
Sub-total	**0.44**	**1.72**	**1.37**	**3.53**
10-inch	0.39	0.14	0.53	**1.06**
12-inch	0.00	0.00	0.90	**0.90**
Total	**0.84**	**1.86**	**2.79**	**5.49**

- The District has replaced approximately 4,078 feet (0.77 miles) of pipe (steel – 1,284 feet, PVC – 0 feet, non-Nipponite asbestos cement – 558 feet and Nipponite – 2,236 feet) in Fiscal Year 2024.

- Filed California Environmental Quality Act (CEQA) Notice of Exemption for the Cabrillo Circle main line replacement project based on its conformity with Section 15302 (c) of the CEQA Guidelines (replacement or reconstruction of existing utility systems and/or facilities involving negligible or no expansion of capacity).
- Edgehill (E) Reservoir Replacement and Pump Station – Gateway Pacific continued pump station and retaining wall construction, backfilling/grading around the reservoir and site electrical work. As of September 30, 2023, the project was approximately 85.3 percent complete based on time and 75.1 percent complete based on cost ($6.99 million of $9.30 million contract amount has been invoiced).
- Flume Replacement Alignment Study – Brown and Caldwell finalized and submitted Board Workshop No. 3 materials.
- Deodar Reservoir Rehabilitation – Consor finalized and submitted project bid documents; issued construction bid solicitation.
- Projects along Flume
  - The Villages – 380 dwelling unit residential subdivision along Country Club Lane, between Nutmeg Street and Pamela Lane in Escondido. Project is under construction; storm drain work along the Jones Siphon is ongoing and the relocation of an 18-inch transmission main that feeds the Bennett service area has been completed.
  - Nutmeg Homes – 137 dwelling unit residential subdivision along Nutmeg Street between Centre City Parkway and Interstate 15 in Escondido. Project is in the design phase and requires District review and approval of grading, street and utility improvement plans along Nutmeg Street. Draft plans call for additional fill along Nutmeg Street and over approximately 400 feet of the Caldwell Siphon section of the Flume. The District has been requested to allow the additional fill and also to quitclaim the portion of the District's Flume easement over the property. Staff is currently working with the developer to accept their requests.

December

- Mainline Replacement Projects in design (current projects): Independence Wy., Elm Dr., Warmlands Ave., Lonsdale Ln.*, Alta Vista Dr., Vale Terrace Dr., McGavran Dr., Plumosa Ave., Via Christina, Lado De Loma Dr.*, Eddy Dr., Rancho Vista Rd., Indiana Ave.*, Camino Patricia, Camino Corto, Goetting Wy., Oro Avo Dr. *, Shale Rock Rd., Nevada Ave., N. Citrus Ave., Lemon Ave., Hillside Terrace, Buena Creek Rd., Estrelita Dr., Victory Dr., Oak Dr.*, Queens Wy., Watson Wy. (Total length = 7.79 miles).
- Mainline Replacement Projects in planning (future projects): Camino Culebra*, Catalina Ave.*, Friendly Dr.*, E. Vista Wy., Nordahl Rd.*, HN Line - Gopher Canyon Rd. to Fairview Dr., Buena Creek Rd.*, Lower Ln., Easy St.*, West AB Line – Esplendido Ave. and Bella Vista Dr.*, Colavo Dr.*, Rancho Vista Rd., Bandini Pl., HP Line – Hardell Ln. to Camino de las Lomas, Crescent Dr.*, Descanso Ave., San Clemente Ave.* (Total length = 6.69 miles).
- Edgehill (E) Reservoir Replacement and Pump Station – Gateway Pacific to deliver pump skid system for the pump station, continue retaining wall construction, backfilling/grading around the reservoir, and site electrical/plumbing work.
- Flume Replacement Alignment Study – conduct Board Workshop No. 3.
- Deodar Reservoir Rehabilitation – Receive and open construction bids.

*Nipponite pipe

ACHIEVEMENTS – FISCAL YEAR 2024

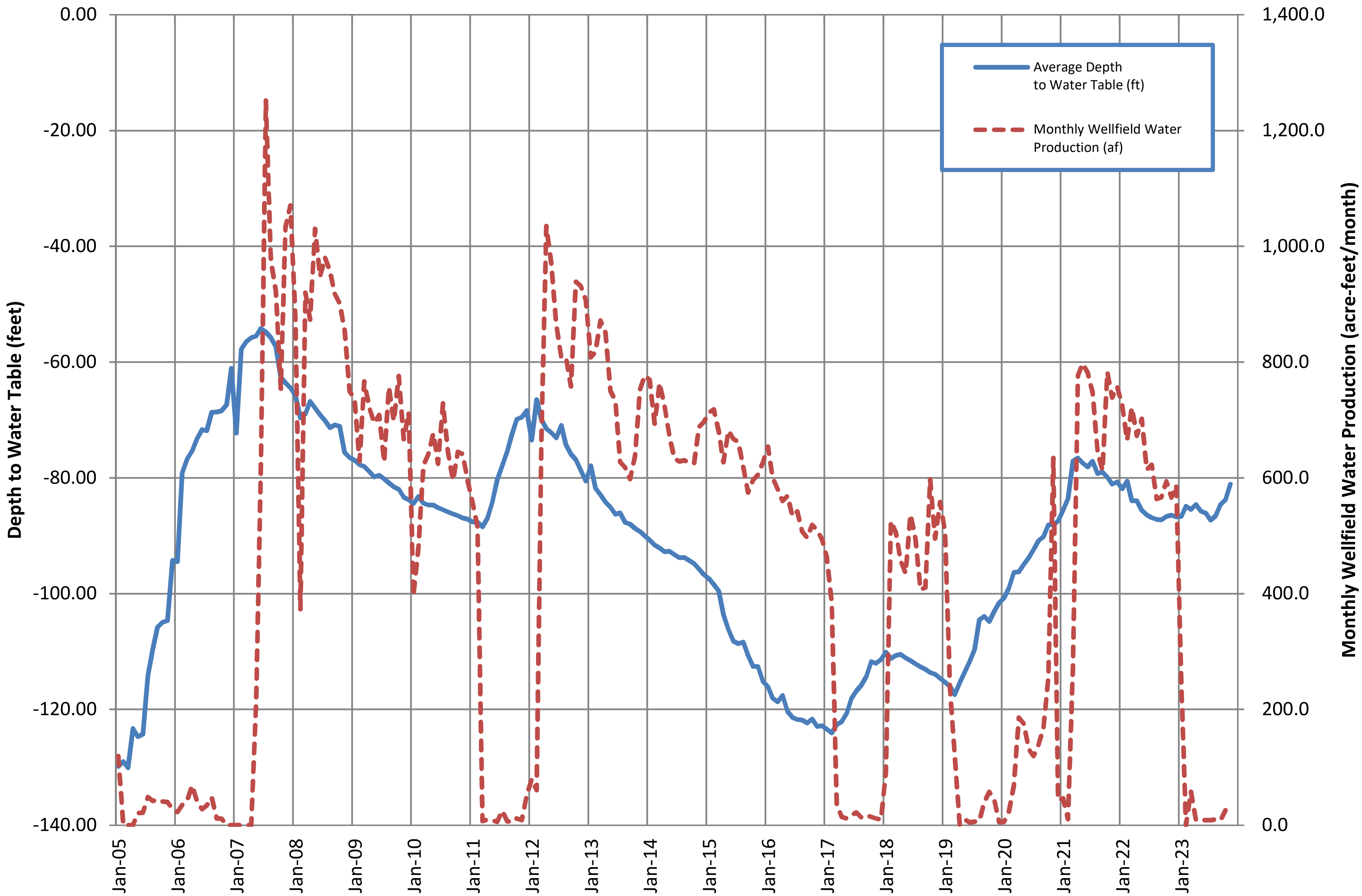
- Recognized at Association of California Water Agencies Joint Powers Insurance Authority (ACWA JPIA) Board meeting; Risk Control Grant project (flow control facility solar panel project) and H.R. LaBounty Safety Award winning submittal (valve maintenance truck flatbed build) highlighted during presentations. Received ACWA JPIA President's Special Recognition Workers' Compensation Program award (November 2023).
- Hosted the WaterSmart Landscape Makeover Workshop (November 2023).
- Received proclamations from Congressman Mike Levin, County of San Diego Board of Supervisors and City of Vista and resolutions from Senator Catherine Blakespear and Assemblywoman Laurie Davies and the Rincon Band of Luiseño Indians recognizing and congratulating the District on its 100^{th} Anniversary (September 2023).
- Received a gift from the San Luis Rey Indian Water Authority in honor of the District's 100^{th} Anniversary (September 2023).
- Held the District's 100^{th} Anniversary Celebration event (September 2023).
- Completed mainline replacement of steel and AC pipe on East Taylor Street and Airborne Drive – installed approximately 1,400' of various-size PVC pipe, 10 services and 1 hydrant lateral (August 2023).
- Reduced Workers' Compensation experience modifier from 1.19 to 0.69, resulting in an annual premium savings of $76,000 (August 2023).
- Received a proclamation from the San Diego County Water Authority and resolution from the Olivenhain Municipal Water District recognizing and congratulating the District on its 100^{th} Anniversary (August 2023).
- Received a resolution from the Santa Fe Irrigation District recognizing and congratulating the District on its 100^{th} Anniversary (July 2023).
- Received Certificate of Achievement for Excellence in Financial Reporting from the Government Finance Officers Association for the Annual Comprehensive Financial Report for the Fiscal Year ended June 30, 2022 (July 2023).
- Received Association of California Water Agencies Joint Powers Insurance Authority 2023 Wellness Grant (July 2023).

Lake Henshaw Resort
(760) 782-3501

LAKE HENSHAW RESORT, INC.
ACTIVITY REPORT
AS OF SEPTEMBER 30, 2023

	2022 Sep	2022 Oct	2022 Nov	2022 Dec	2023 Jan	2023 Feb	2023 Mar	2023 Apr	2023 May	2023 Jun	2023 Jul	2023 Aug	2023 Sep	12 MO AVG
Fishing Permits	324	232	170	73	63	144	166	451	635	1,019	671	441	562	386
Boat Launches	2	0	6	2	2	0	2	24	44	48	37	26	31	19
Motor Boats (full day rental)	3	5	10	8	7	3	0	22	35	43	31	30	29	19
Motor Boats (half day rental)	5	2	2	0	0	0	0	3	8	3	26	9	11	5
Campground/Head Count	517	408	145	86	80	59	868	579	2,157	820	1,318	453	1,002	665
Campground/Cars, Trucks, etc.	472	175	55	40	30	44	51	186	732	268	416	244	426	222
Campground/Recreational Vehicles	0	6	13	3	10	12	7	22	6	0	16	0	1	8
Mobile Home/Spaces	72	72	72	73	70	70	70	70	70	71	72	72	72	71
M.H.P. (Residents/Head Count)	98	98	98	99	101	101	101	101	101	101	101	101	101	100
Storage	6	5	5	6	6	6	6	6	6	6	6	6	6	6
Cabins	174	148	148	162	78	81	180	210	187	51	215	130	235	152
Hunters	0	0	32	142	143	0	0	0	0	0	0	0	0	26

VID's Warner Wellfield
Water Table Depth vs. Monthly Wellfield Production



Printed 11/28/2023

FY 2024 Budget and Expenses related to HABs

as of 11/27/2023

Description		Amount
Water Quality Testing Services & Supplies		
Cyanotoxin/Cyanobacteria Testing - Bend Genetics	$	58,627
Other Lab Testing	$	37,326
Sample bottles, misc. supplies & equipment	$	910
Shipping	$	11,074
Subtotal, approx. total expenses	$	107,937
VID Portion of approximate expenses	$	53,969
VID FY 2024 Budget	$	64,700
Percent of VID Budget		83%
Water Treatment Services & Supplies		
Copper algaecide purchase	$	116,557
Copper algaecide application	$	23,750
Peroxide algaecide purchase	$	393,331
Peroxide algaecide application	$	89,810
Lanthanum-modified clay purchase	$	634,432
Lanthanum-modified clay application	$	49,900
Subtotal, approx. total expenses	$	1,307,780
VID Portion of approximate expenses	$	653,890
VID FY 2024 Budget	$	767,800
Percent of VID Budget		85%
HABs Consultants	$	67,738
VID Portion of approximate expenses	$	33,869
VID FY 2024 Budget	$	105,000
Percent of VID Budget		32%
Total VID Expenses, FY 2024 to date	**$**	**741,727**

VISTA IRRIGATION DISTRICT	Agenda Item: 11
STAFF REPORT	**Board Meeting Date:** **December 6, 2023** **Prepared By:** **Don Smith** **Approved By:** **Brett Hodgkiss**

SUBJECT: MANAGEMENT AND MITIGATION OF HARMFUL ALGAL BLOOMS IN LAKE HENSHAW – PHASE II

RECOMMENDATION: Receive draft report related to implementing alternatives for the long-term management and mitigation of harmful algal blooms in Lake Henshaw.

PRIOR BOARD ACTION: At its January 4, 2023 meeting, the Board authorized the execution of a professional services agreement with Stillwater Sciences related to implementing alternatives for the long-term management and mitigation of harmful algal blooms (HABs) in Lake Henshaw (Phase II HABs Study) in an amount not to exceed $275,000.

FISCAL IMPACT: The Phase II HABs Study addresses ongoing algaecide treatments at Lake Henshaw as well as three primary long-term HABs management strategies: 1) Lake Henshaw chemical sediment sealing; 2) Lake Henshaw source water nutrient control; and 3) Lake Henshaw oxygenation. The cost for these measures will be shared equally by the District and the City of Escondido (Escondido). If implemented as recommended, the budgetary cost ranges for algaecide treatments and the three long-term HABs management strategies are presented below with the District's share of the cost ranges shown in parenthesis:

- Algaecide treatments: $790,000 to $1.6 million per year ($395,000 to $800,000 per year);
- Sediment sealing: $3 to $4 million in chemical and application costs, over the course of 4 to 5 years ($1.5 to $2 million);
- Source water nutrient control: $50,000 to $100,000 in capital costs plus $250,000 to $350,000 per year in chemical costs when the Warner Wellfield is pumping groundwater to Lake Henshaw ($25,000 to $50,000 in capital costs plus $125,000 to $175,000 per year); and
- Oxygenation field trial: $1.6 to $3.5 million for a 9 to 12 month field trial project ($800,000 to $1.75 million).

SUMMARY: The following discussion presents the key recommendations of the Phase II HABs Study; a more comprehensive list of recommendations and cost ranges is presented in Table 6-1 of the Phase II HABs Study.

Lake Henshaw Algaecide Treatments: The background, findings, and recommendations pertaining to Lake Henshaw algaecide treatments are presented in Section 2 of the Phase II HABs Study. The primary recommendations are summarized as follows:

- To avoid disruptive delays in releases from Lake Henshaw due to elevated dissolved copper concentrations, use frequent (every two to three weeks) low-dose peroxide-based algaecide treatments during spring, summer, and early fall when chlorophyll-a concentrations and cyanobacteria cell counts are below specified triggers.
- Use appropriate doses of copper-based algaecide when chlorophyll-a concentrations and cyanobacteria cell counts are above those triggers, or when specific large biovolume or algaecide-resistant cyanobacteria are dominant.
- Before, during and after the use of copper-based algaecides, increase the monitoring of chemical constituents of lake waters (to include hardness, alkalinity, pH, dissolved organic carbon, calcium, magnesium, sodium, potassium, sulfate, chloride, and sulfide) to establish whether the US Environmental Protection Agency's model for determining the toxicity of dissolved copper (referred to as the "biotic ligand model", or BLM) would be more suitable than the hardness-based model currently specified in the National Pollutant Discharge Elimination System (NPDES) permit issued by the State Water Resources Control Board (SWRCB). If so, conduct conversations with the SWRCB about amending the NPDES permit.

Lake Henshaw Chemical Sediment Sealing: The goal of chemical sediment sealing is to keep labile phosphorus stored in lake bottom sediments from being mobilized into the water column where it would be available to support the growth of HABs (HABs growth is limited by the availability of nutrients in general and bioavailable phosphorus in particular). Lanthanum binds with phosphate to produce an insoluble and biologically inert mineral called rhabdophane. As part of a multi-year strategy, the District started applying lanthanum-modified clay to Lake Henshaw in 2023. The background, findings, and recommendations pertaining to Lake Henshaw chemical sediment sealing are presented in Section 3 and Appendix A of the Phase II HABs Study. The primary recommendations are summarized as follows:

- Continue lanthanum-modified clay treatments targeting deep and mid depth lake bottom sediments;
- Conduct multiple lanthanum-modified clay treatments each year and continue over several years; and
- Monitor the effectiveness of the sediment sealing program by conducting an analysis of bioavailable phosphorus fractions in Lake Henshaw bottom sediments every two or three years.

Lake Henshaw Source Water Nutrient Control: In addition to limiting the mobilization of phosphorus from lake bottom sediments, it will be helpful to prevent the introduction of phosphorus to the lake from external sources. Pumped groundwater has modest amounts of naturally occurring dissolved phosphorus, and the treatment of that water source with a phosphorus sequestering chemical is expected to be beneficial. The background, findings, and recommendations pertaining to Lake Henshaw source water nutrient control are presented in Section 4 and Appendix B of the Phase II HABs Study. The primary recommendations are summarized as follows:

- Coordinate with SePro Corporation, other product manufacturers, and the Regional Water Quality Control Board to determine whether and when a phosphorus binding agent is identified that would be considered an allowable additive to raw pumped groundwater feeding Lake Henshaw under the District's existing water supply permit; and
- When such an acceptable additive is established, conduct an operational trial for treatment of pumped groundwater.

Lake Henshaw Oxygenation: A third strategy for the control of phosphorus (with the goal of limiting cyanotoxins produced by HABs) is to prevent lake bottom sediments from going anoxic (dissolved oxygen near zero milligrams per liter). The chemical processes that mobilize phosphorus from sediments into the water column are greatly enhanced in anoxic conditions. By keeping lake bottom waters high in oxygen, the expectation is that much less phosphorus will be released from lake bottom sediments, causing the lack of phosphorus to limit HABs growth. The background, findings, and recommendations pertaining to Lake Henshaw oxygenation are presented in Section 5 and Appendices C, D and E of the Phase II HABs Study. The primary recommendations are summarized as follows:

- Implement a 9 to 12 month experimental management project/field trial of a full-scale oxygenation system in Lake Henshaw, utilizing rented containerized Supersaturated Dissolved Oxygen (SDOX) equipment;
- During the field trial, test three different oxygen addition rates to compare effectiveness of each dose.
- During the field trial, monitor water quality conditions within the lake; and
- Use field trial results to refine estimated costs for a permanent oxygenation system.

DETAILED REPORT: The following discussion presents the status, next steps, and potential implementation time frames of the various elements of the Phase II HABs Study.

Lake Henshaw Algaecide Treatments

- The recommendation to use frequent (every two to three weeks) low-dose peroxide-based algaecide treatments during spring, summer, and early fall is reflected in the current proposed treatment schedule for second half of Fiscal Year 2024. This approach will require an amendment to the as-needed services agreement with Aquatechnex LLC, reference agenda item 12.
- The use of copper-based algaecide when necessary would replace (at reduced cost) one or more peroxide-based algaecide treatments, and would require no change to the Aquatechnex LLC agreement.

- The increased monitoring of chemical constituents before, during and after the use of copper-based algaecides is not presently included in the District budget and will likely cost $3,000 to $5,000 ($1,500 to $2,500 to the District) for each use of copper-based algaecide.
- The cost of professional assistance in discussions with the SWRCB regarding the BLM is not specifically included in a current scope of work, but will likely be accommodated in the current As-needed professional services agreement with Stillwater Sciences.

Lake Henshaw Chemical Sediment Sealing

- Lanthanum-modified clay treatments were initiated in 2023 and are ongoing; additional treatments are included in the Fiscal Year (FY) 2024 budget.
- An analysis of the bioavailable phosphorus fractions in Lake Henshaw bottom sediments and associated assessment of the progress of the sediment sealing program is recommended in the fall of 2024; the cost of these tasks will be included in the FY 2025 budget.

Lake Henshaw Source Water Nutrient Control

- This management strategy is on hold until a satisfactory treatment chemical obtains appropriate National Sanitation Foundation certification. At least one treatment chemical manufacturer is actively seeking such certification and anticipates obtaining it within 8 to 12 months. Given the current quantity of water stored in Lake Henshaw, it is unlikely that the Warner Wellfield will be active until the spring of 2025.
- If groundwater pumping resumes before source water nutrient control can be implemented, ongoing treatments with lanthanum-modified clay may be utilized in Lake Henshaw to sequester external phosphorus contributed by groundwater.

Lake Henshaw Oxygenation

- Permitting requirements are described in Section 2.5 of Appendix E of the Phase II HABs Study.
- At a future date, the District may approve the project, prepare bid documents and solicit bids for: 1) Field Trial Site Improvements; 2) SDOX Equipment Rental; 3) Liquid Oxygen procurement during the Field Trial; and 4) Lake Water Quality Monitoring during the field trial to assess effectiveness.
- The District may also consider whether to undertake hydrodynamic computer modeling as part of the field trial to help interpret the targeted effectiveness monitoring results as well as to size and configure a permanent oxygenation system.
- The field trial should be operational during the period March through October of any given year when HABs are expected to be active. Given the preparation necessary for a successful field trial, and to allow opportunity to offset a portion of the cost of the field trial through grant funding, the earliest feasible date the field trial could be begun is March 2025.

Maia Singer from Stillwater Sciences will be present at the Board meeting to present the findings and recommendations of the Phase II HABs Study and answer questions.

ATTACHMENT: Draft Technical Report – Lake Henshaw and Lake Wohlford Harmful Algal Blooms Management and Mitigation Project – Phase II Synthesis Report (Phase II HABs Study)

DRAFT TECHNICAL REPORT ◦ DECEMBER 2023

Lake Henshaw and Lake Wohlford Harmful Algal Blooms Management and Mitigation Project – Phase II Synthesis Report

PREPARED FOR

Vista Irrigation District
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Brown AND Caldwell

RBI ROBERTSON - BRYAN, INC.
Solutions for Progress

Suggested citation:
Stillwater Sciences. 2023. Lake Henshaw and Lake Wohlford Harmful Algal Blooms Management and Mitigation Project – Phase II Synthesis Report. Prepared by Stillwater Sciences, Berkeley, California for Vista Irrigation District, Vista, California and City of Escondido, Escondido, California.

Cover photos: Lake Henshaw looking south and east (top left) with shoreline cyanobacteria accumulation (bottom left), flooded shoreline vegetation (top right), and lanthanum-modified clay application (bottom right). Lake Henshaw overview photo taken in March 2021 by Stillwater Sciences, cyanobacteria and vegetation photos taken in 2023 by Vista Irrigation District, and lanthanum-modified clay application photo taken in July 2023 by Aquatechnex.

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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 1-1). 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 perennial 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 1-1). 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).

Water released from Lake Henshaw flows for 10 miles in the San Luis Rey River before being diverted into the 14-mile-long Escondido Canal via the Escondido Canal Diversion Dam. The Diversion Dam and the start of the Escondido Canal are located within the La Jolla Reservation (Figure 1-1). The canal supplies the 6,500 AF Lake Wohlford, owned by Escondido. Escondido Canal also supplies water to meet the annual entitlement for the Rincon Indian Reservation, which is diverted from the canal back into the San Luis Rey River at a small measurement flume just downstream of the Diversion Dam. The Warner Ranch Wellfield, local tributaries to Lake Henshaw and the lake itself, the San Luis Rey River (between Henshaw Dam and the Diversion Dam), the Escondido Canal, and Lake Wohlford comprise the Local Water System. Water released from Lake Wohlford is blended with imported water delivered by San Diego County Water Authority before treatment at the Escondido-Vista Water Treatment Plant (EVWTP) as a potable water supply for Escondido and the District. Other designated beneficial uses for Lake Wohlford water include agricultural water supply, hydropower generation, warm freshwater habitat, cold 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/) (California Water Quality Monitoring Council 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.

Since March 2020, routine monitoring and laboratory analysis for cyanobacteria abundance and cyanotoxins in Lake Henshaw have confirmed the seasonal presence of elevated levels of microcystin and anatoxin-a at multiple sites in the lake. Cyanobacteria and cyanotoxins have been measured in Lake Wohlford since July 2020.

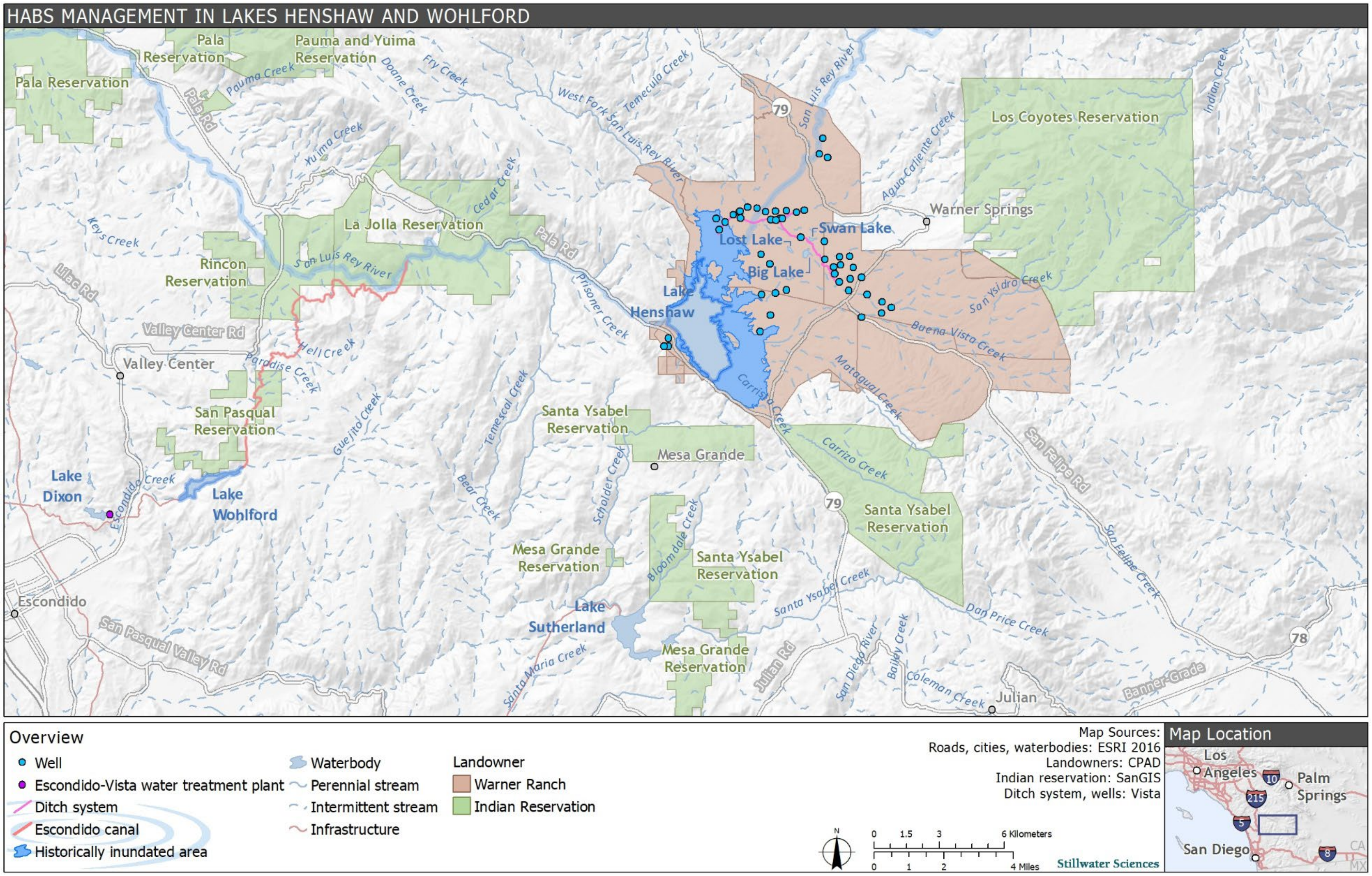

Figure 1-1. Project overview.

In 2021, the District launched the first phase of the Lake Henshaw and Lake Wohlford HABs Management and Mitigation Project (Project). Phase I Project objectives 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, including development of a conceptual model for HABs formation in lakes Henshaw and Wohlford, are documented in the *Lake Henshaw and Lake Wohlford HABs Management and Mitigation Plan* (Stillwater Sciences 2022a).

As detailed in the Plan, algaecides were selected as the most feasible short-term HABs mitigation method for Lake Henshaw. Additionally, phosphorus inactivation via chemical sediment sealing was selected as a Lake Henshaw HABs prevention method with potential to implement in the short term (Stillwater Sciences 2022a). Recommended long-term prevention methods include:

- In-lake: ***phosphorus inactivation/chemical sediment sealing*** to prevent HABs by removing bioavailable phosphorus (i.e., orthophosphate) from the water column and minimizing or eliminating orthophosphate release from lake sediments during low DO conditions through application of a chemical (e.g., alum, lanthanum) to the lake.
- Out-of-lake: ***source water nutrient control*** to prevent HABs by inactivating bioavailable phosphorus (i.e., orthophosphate) in Warner Ranch Wellfield inflows to Lake Henshaw, which will reduce external loading of this nutrient to the lake.
- In-lake: ***oxygenation via Speece Cone or SDOX***[1] to prevent HABs by maintaining positive DO concentrations in the water column and at the sediment/water interface, which will decrease the release of orthophosphate, ammonia, and other oxidation reduction potential (ORP)-sensitive constituents from the reservoir sediments during periods of low DO.

Recommended long-term mitigation methods include:

- Out-of-lake: ***bypass pipeline*** to mitigate HABs by providing cyanotoxin-free water downstream of the Henshaw Dam spillway through the rerouting of groundwater from the Warner Ranch Wellfield around Lake Henshaw and into the San Luis Rey River downstream of Henshaw Dam, thus providing the District, Escondido and the Bands with a reliable and consistent delivery method, added flexibility regarding the timing of water deliveries, and reductions in evaporative losses that occur within Lake Henshaw. Note that the financial viability of the Local Water System relies on runoff into Lake Henshaw as well as wellfield production, hence the construction of a bypass pipeline would also require a strategy to prevent or mitigate in-lake HABs production.
- In-lake: ***algaecide treatment*** to mitigate HABs by controlling the formation and growth of nuisance algae blooms (filamentous, planktonic, benthic, or cyanobacteria) by killing the organisms responsible for poor water quality through the application of a chemical (i.e., copper- or peroxide-based) to the lake.

[1] The two most common types of oxygenation systems for lakes that create water supersaturated with dissolved oxygen (DO) include the non-pressurized Speece Cone technology and the pressurized supersaturated dissolved oxygen (SDOX) system. The ECO_2 System is a Speece Cone system manufactured by ECO_2 (Indianapolis, IN). The SDOX O2® is a patented system manufactured by ChartWater BlueInGreen (Fayetteville, AR).

In 2023, the District launched Phase II of the Project to address the following objectives:

- Continue efforts to collect Lake Henshaw data to inform implementation of the Phase I selected long-term alternatives for this lake; and
- Decide whether to proceed with one or more pilot tests for mitigating and/or preventing HABs in Lake Henshaw.

Consistent with the Phase II objectives, this synthesis report presents summary background, key results, and recommendations associated with Phase II data collection and/or additional planning related to algaecide application (Section 2), phosphorus inactivation/chemical sediment sealing (Section 3), source water nutrient control (Section 4), and oxygenation (Section 5) in Lake Henshaw. This synthesis report also includes an update to the Phase I Lake Henshaw conceptual model to illustrate the hypothesized effects of these mitigation and/or prevention methods on seasonal water temperature, DO, internal and external nutrient loading, and cyanobacteria and cyanotoxin production in Lake Henshaw (Figure 1-2).

Further consideration of the Lake Henshaw bypass pipeline was not included in Phase II of the Project given the relatively high capital costs and extended implementation timeline associated with this out-of-lake long-term method, but the District may still elect to move forward with the bypass pipeline in later phases of the Project. Lake Wohlford HABs control continues to be managed through cyanotoxin monitoring, as-needed treatment with copper-based algaecides, and artificial aeration operating 19 hours a day (i.e., compressor is on between 11 pm and 4 pm), 7 days a week (Stillwater Sciences 2022a).

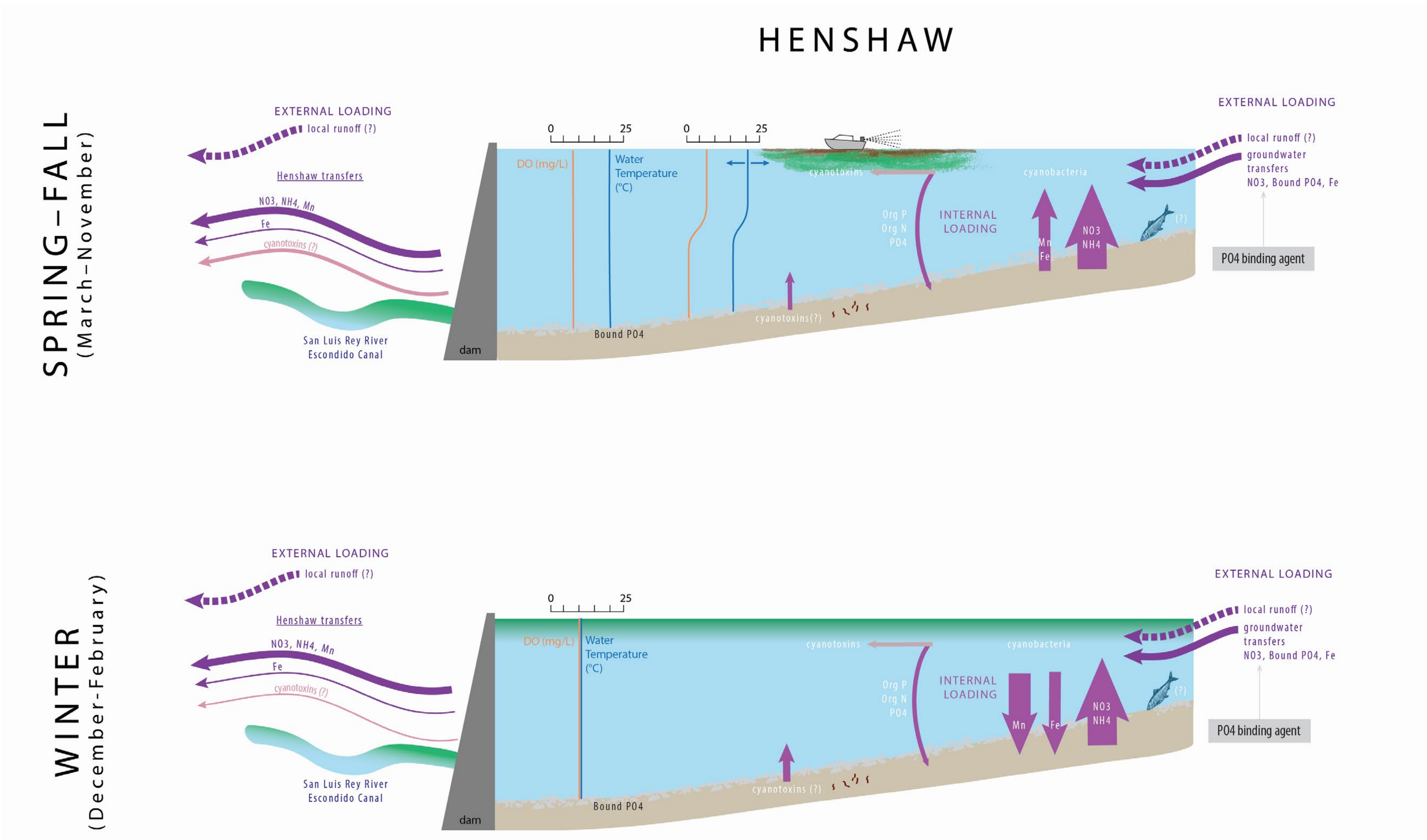

Figure 1-2. Conceptual model illustrating hypothesized effects of algaecide application (short-term mitigation), phosphorus inactivation/chemical sediment sealing (long-term prevention), source water nutrient control (long-term prevention), and oxygenation (long-term prevention) on seasonal water temperature, dissolved oxygen (DO), internal and external nutrient loading, and cyanobacteria and cyanotoxin production in Lake Henshaw.

2 LAKE HENSHAW ALGAECIDE APPLICATION

2.1 Background

Consistent with the *Lake Henshaw and Lake Wohlford HABs Management and Mitigation Plan* (Stillwater Sciences 2022a), in 2023 the District has continued to obtain experience with copper- and peroxide-based algaecide applications in Lake Henshaw. Nine algaecide treatments were undertaken in 2023 (Table 2-1), along with three lanthanum-modified clay treatments that are discussed in Section 3. The July and August lanthanum-modified clay treatments occurred within a few days of peroxide-based algaecide treatments (Table 2-1), potentially resulting in the binding of phosphorus released from dying cyanobacteria that subsequently settles to bottom sediments and is sequestered for the long term (see also Section 3.2).

Table 2-1. Lake Henshaw algaecide and lanthanum-modified clay treatments in 2023.

Date Range	Treatment Type	Dose	Approximate Treatment Area, Location
4/5–4/6	Peroxide (H_2O_2)	2 ppm	750 acres, middle
4/18–4/20	Peroxide (H_2O_2)	2 ppm	750 acres, middle
5/2–5/3	Lanthanum-modified clay (LMC)[1]	90,000 lbs at 10% La	750 acres, middle
5/22–5/25	Peroxide (H_2O_2)	3.25 ppm	750 acres, middle
6/7–6/8	Copper (Cu)	0.25 ppm	750 acres, middle
7/6–7/7	Copper (Cu)	0.38 ppm	750 acres, middle
7/10–7/13	Lanthanum-modified clay (LMC)[1]	92,000 lbs at 10% La	400 acres, deepest
8/3–8/4	Peroxide (H_2O_2)	2 ppm	750 acres, middle
8/7–8/10	Lanthanum-modified clay (LMC)[1]	92,000 lbs at 10% La	400 acres, deepest
8/15–8/16	Peroxide (H_2O_2)	2 ppm	750 acres, middle
8/28–8/29	Peroxide (H_2O_2)	2 ppm	750 acres, middle
9/28–9/29	Peroxide (H_2O_2)	2 ppm	750 acres, middle

[1] Discussed in Section 3.

The District undertook 2023 routine monitoring, algaecide effectiveness monitoring, and lanthanum-modified clay permit compliance monitoring at multiple locations in Lake Henshaw (Table 2-2 and Figure 2-1). Key results of the 2023 algaecide treatments, combined with monitoring results associated with one copper- and two peroxide-based algaecide treatments in 2022, are presented in Section 2.2.

Table 2-2. Lake Henshaw water quality monitoring sites for 2023 algaecide effectiveness monitoring.

Site ID	Location	Type	Latitude	Longitude
H-BL[1]	Buoy line at dam in bottom waters	Routine, algaecide effectiveness	33.23963°N	116.76174°W
H-FD[2]	Southwestern shoreline at the in-water end of the fishing dock in surface waters		33.23544°N	116.75568°W
H-S	Southwestern shoreline at beach adjacent to fishing dock		33.23496°N	116.75617°W
H-ML[3]	Mid-lake in surface waters	Algaecide effectiveness	33.23890°N	116.75275°W
H-NL	Northern portion of lake in surface waters		33.24600°N	116.75300°W
H-SL	Southern portion of lake in surface waters		33.23000°N	116.74400°W
H-1	Open water	Lanthanum-modified clay permit compliance	33.248063°N	116.752269°W
H-2	Open water		33.24427°N	116.75616°W
H-3	Open water		33.24377°N	116.76035°W
H-4	Open water		33.23944°N	116.75768°W
H-5	Open water		33.24167°N	116.75209°W
H-6	Open water		33.24277°N	116.74557°W
H-7	Open water		33.23751°N	116.74166°W
H-8	Open water		33.23486°N	116.74772°W

[1] H-BLS is co-located and represents a surface water grab.
[2] H-FDD is co-located and represents a bottom water grab.
[3] H-MLD is co-located and represents a bottom water grab.

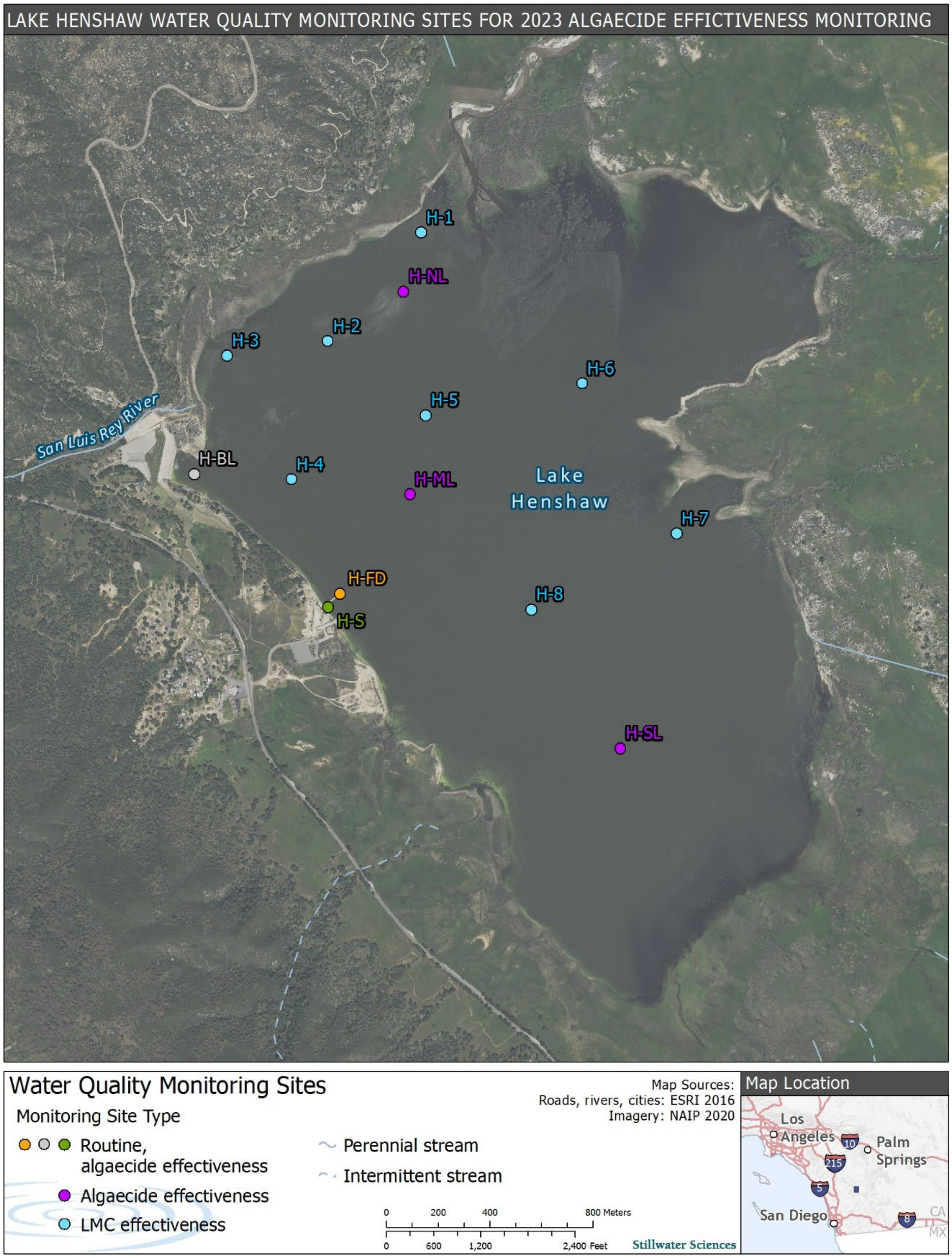

Figure 2-1. Lake Henshaw water quality monitoring sites for algaecide effectiveness monitoring and lanthanum-modified clay permit compliance monitoring in 2023.

2.2 Key Results

2.2.1 Lake Levels and *In Situ* Water Quality

Lake conditions in 2023 were markedly different than those of 2022 due in large part to elevated precipitation and runoff during winter 2023, resulting in the lake volume doubling in late January and tripling in March and early April (Figure 2-2). The deeper 2023 water column exhibited relatively stable thermal stratification in late spring/summer months with surface waters consistently located from 0–15 feet deep and bottom waters located below approximately 15 feet, regardless of site location (Figure 2-4). In comparison, Henshaw's water column in 2022 was relatively shallow and surface and bottom waters were often similar or the same temperatures (Stillwater Sciences 2022b).

Large amounts of organic matter were observed in the lake following substantial runoff inputs in late spring (Figure 2-3), which may have increased dissolved organic carbon (DOC) concentrations relative to 2022. The larger lake volume also flooded many trees and other shoreline vegetation (Figure 2-3). A limited number of lake samples were analyzed for DOC in 2023, with moderate values ranging 1.1 to 4.0 mg/L; however, comparison data for 2022 are not available.

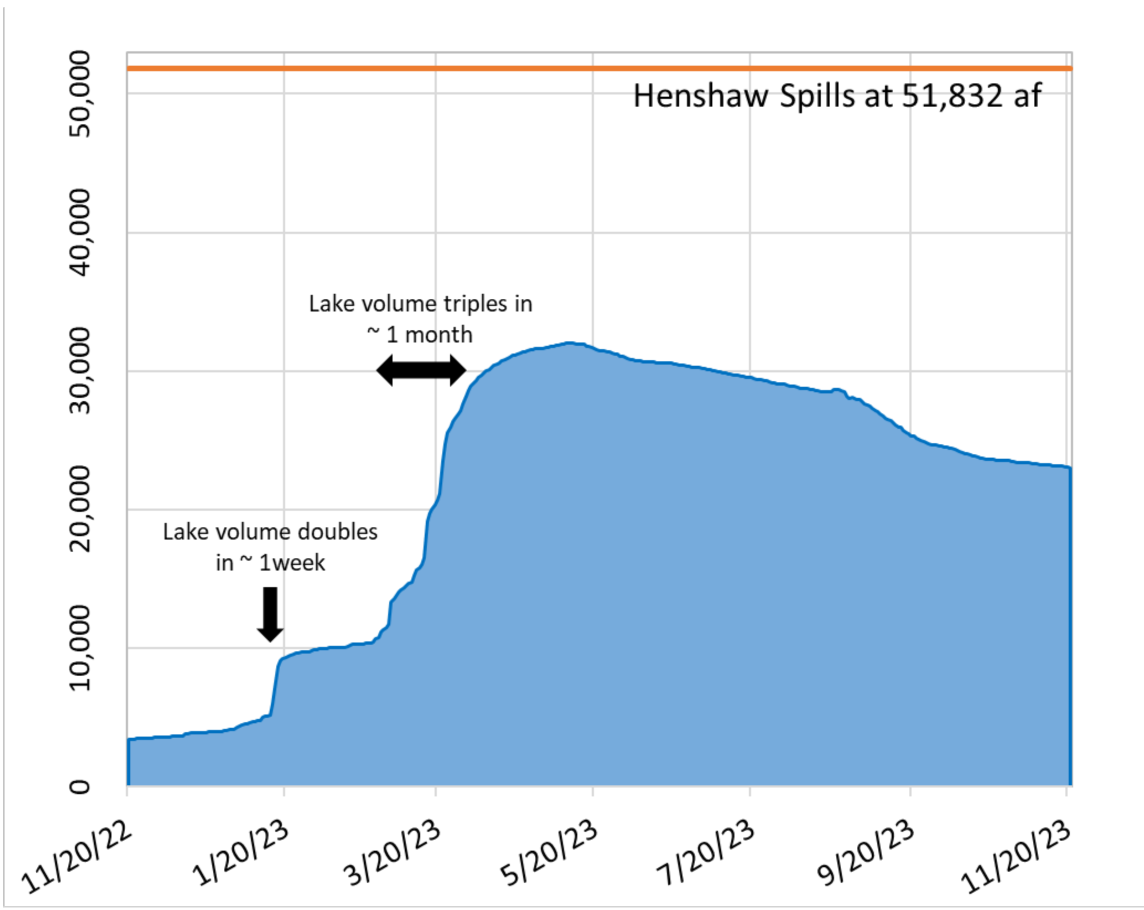

Figure 2-2. Lake Henshaw's volume from September 2022 through September 2023. Lake volume roughly doubled in a week in mid-January, and then lake volume roughly tripled in a month (late-March through late-April).

Figure 2-3. Floating organic matter and detritus from storm runoff along the western shoreline of Lake Henshaw, April 10, 2023 (left) and flooded trees, August 28, 2023 (right).

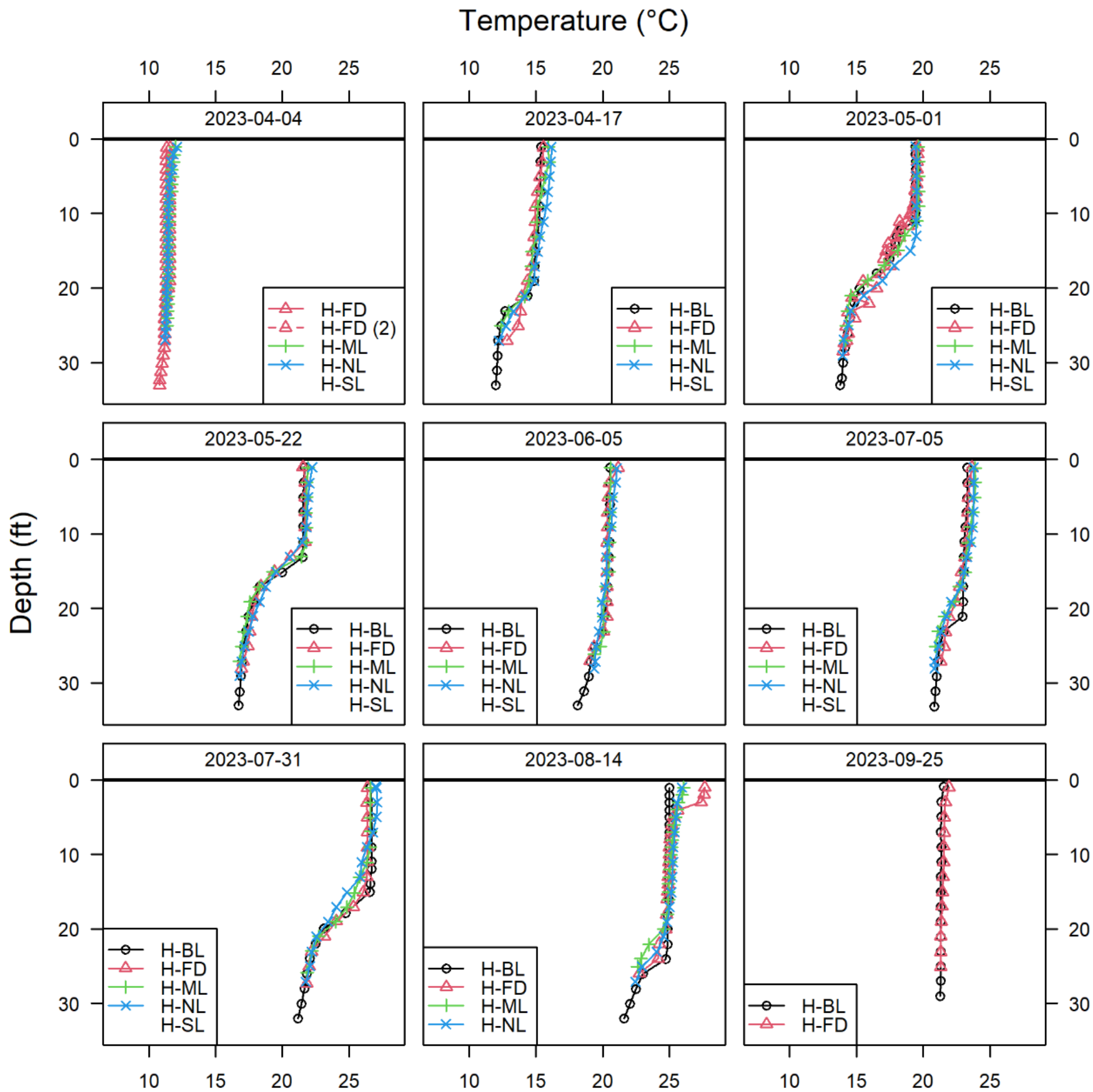

Figure 2-4. *In situ* water temperature (ºC) with depth in Lake Henshaw on dates not influenced by algaecide treatments.

On dates not influenced by a DO sag following algaecide treatments, the deeper Lake Henshaw water column and more stable thermal stratification in 2023 (relative to 2022) supported a steep decline in *in situ* DO concentration through the thermocline, with consistently hypoxic (< 2 mg/L) and even anoxic (0 mg/l) bottom water DO, during May through July (Figure 2-5). DO concentrations with depth tended to behave similarly at the relatively deep sites H-BL and H-FD, whereas concentrations in June, July, and August tended to be lower at mid-depths (15–20 feet) at the shallower sites H-ML and H-NL. *In situ* pH exhibited somewhat similar vertical stratification patterns, with elevated values (> 8 s.u.) in surface waters where rates of photosynthesis would have been high, and circumneutral values (~7 s.u.) in bottom waters where photosynthesis would have been constrained by lack of sunlight penetration (Figure 2-6). pH with depth tended to be similar at the relatively deep sites H-BL and H-FD, whereas relatively higher surface water pH was measured in July and August at sites H-ML and H-NL.

Phycocyanin, the cyanobacterial pigment, exhibited generally higher concentrations in surface waters, but was variable across sites and dates (Figure 2-7).

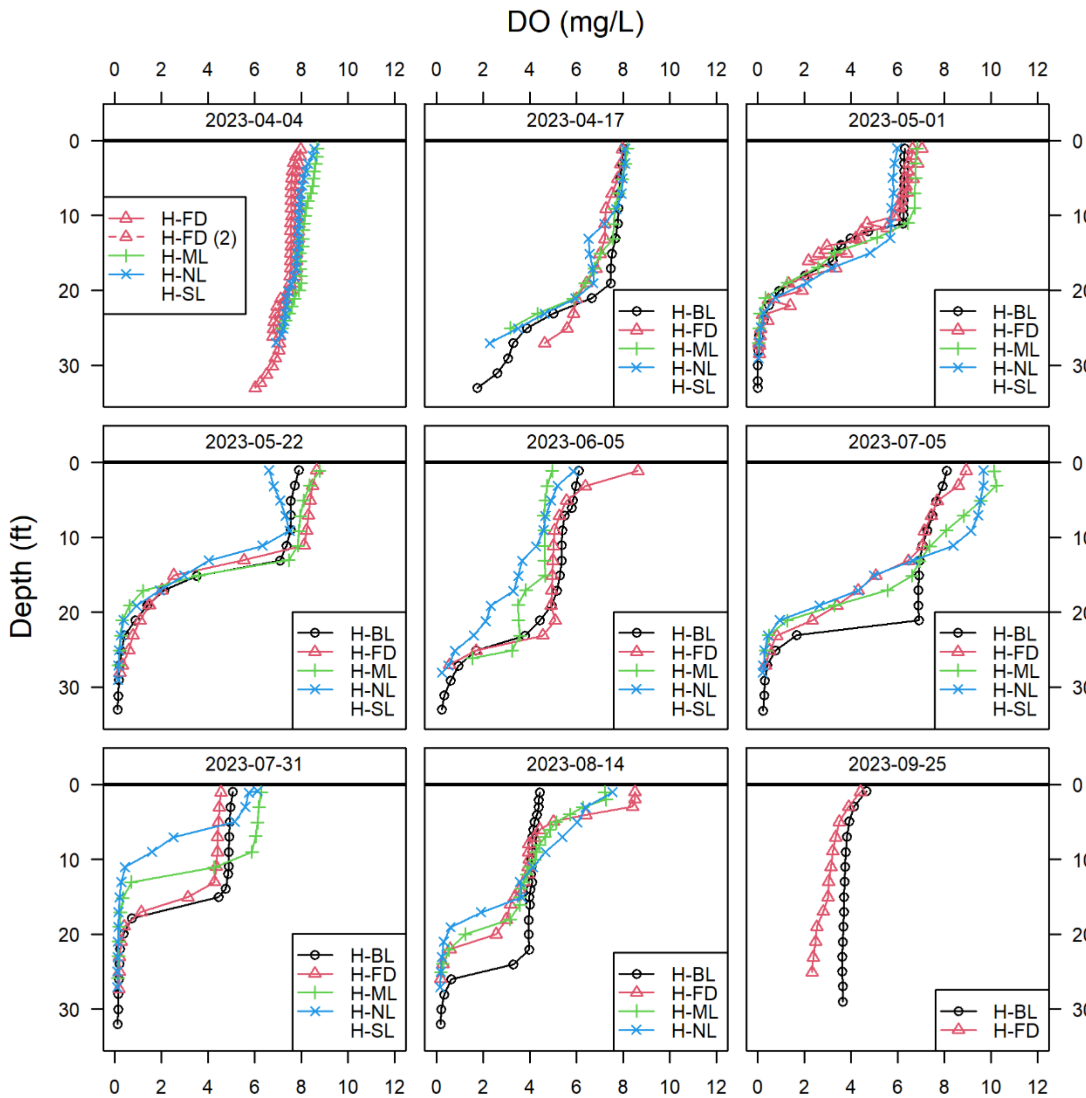

Figure 2-5. *In situ* dissolved oxygen (DO) concentration (mg/L) with depth in Lake Henshaw on dates not influenced by algaecide treatments.

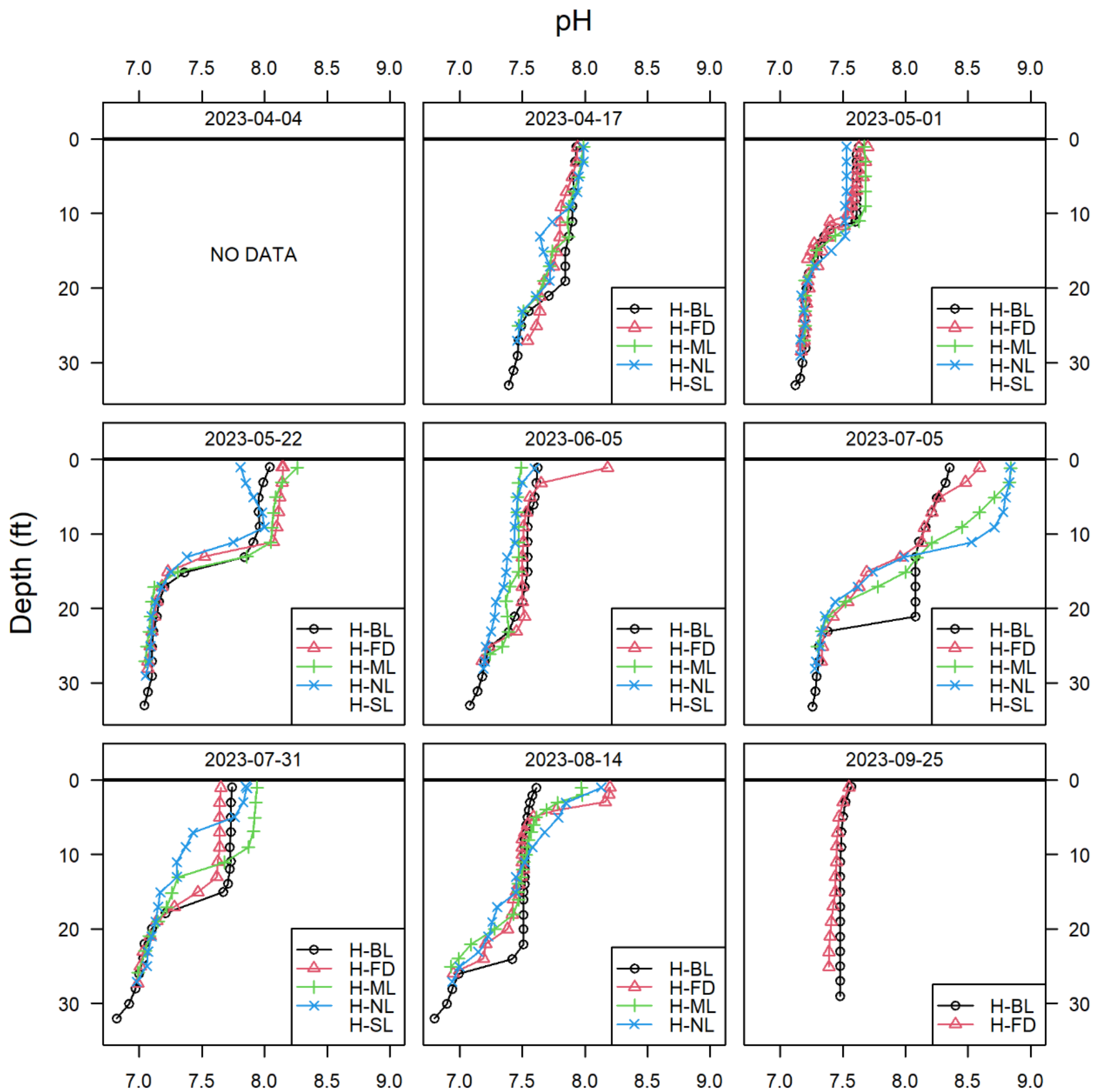

Figure 2-6. *In situ* pH (standard units [s.u]) with depth in Lake Henshaw on dates not influenced by algaecide treatments.

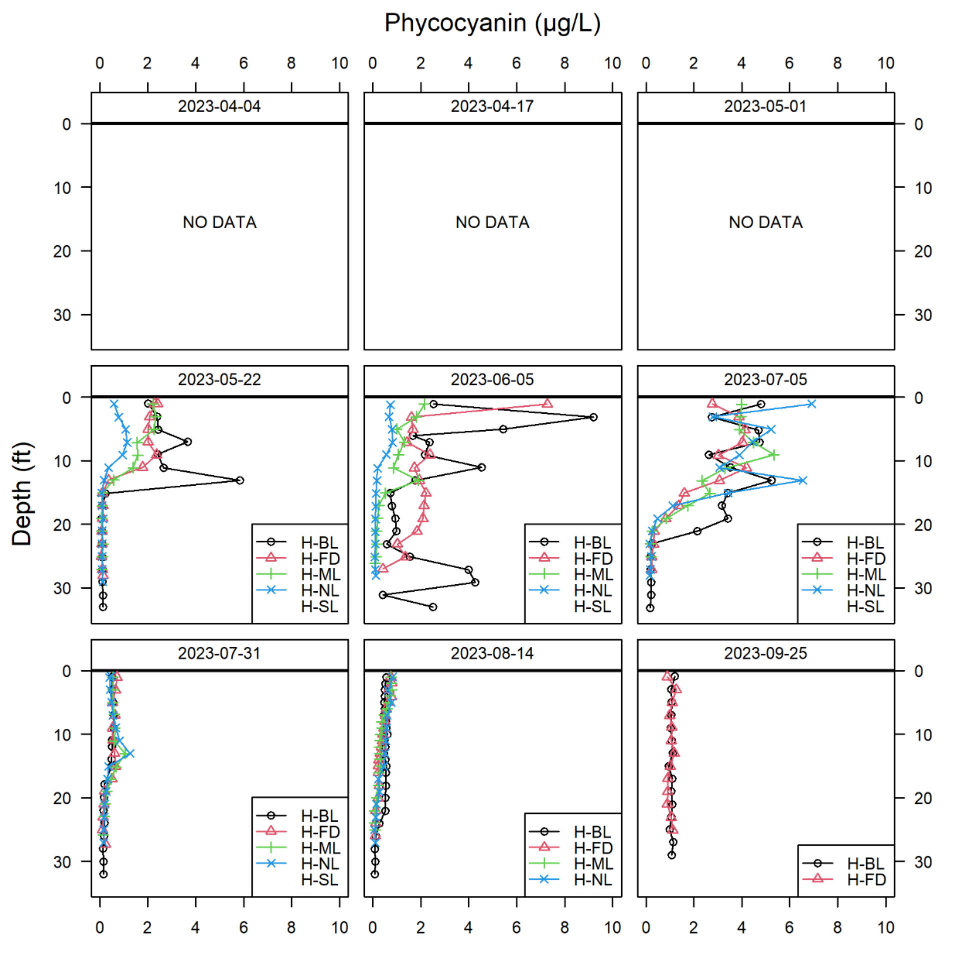

Figure 2-7. *In situ* phycocyanin concentration (ug/L) with depth in Lake Henshaw on dates not influenced by algaecide treatments.

2.2.2 Nutrients

Internal loading of bioavailable forms of nitrogen and phosphorus in Lake Henshaw was also influenced by deeper waters and stronger thermal and chemical stratification in 2023. Orthophosphate (PO_4^{3-}) concentrations in the deepest bottom waters near the dam (Site H-BL) began increasing earlier in the spring 2023 (i.e., mid-March), remained consistently elevated for more time (i.e., approximately six months), and reached higher concentrations (> 0.5 mg/L) than 2021 or 2022 when the lake was approximately six times smaller (in terms of volume) (Figure 2-8, top). While peak 2023 ammonium (NH_4^+) concentrations did not reach those of summer 2022, concentrations also remained elevated for more time (i.e., approximately six months) following the increase in lake volume starting in late January 2023 (Figure 2-8, middle). While regular bottom water DO concentrations are not available for Lake Henshaw (including at Site H-BL) prior to 2023, the period of elevated orthophosphate and ammonium in bottom waters during 2023 corresponds to a four-month period of continuous anoxia (Figure 2-8, bottom), considering DO measurements from all dates (i.e., including dates influenced by a DO sag following algaecide treatments). Limited 2022 bottom water DO concentrations at H-BL in March, May, and August show fewer instances of anoxic conditions (Figure 2-8, bottom). Orthophosphate and ammonium fluxes are discussed in Section 3.

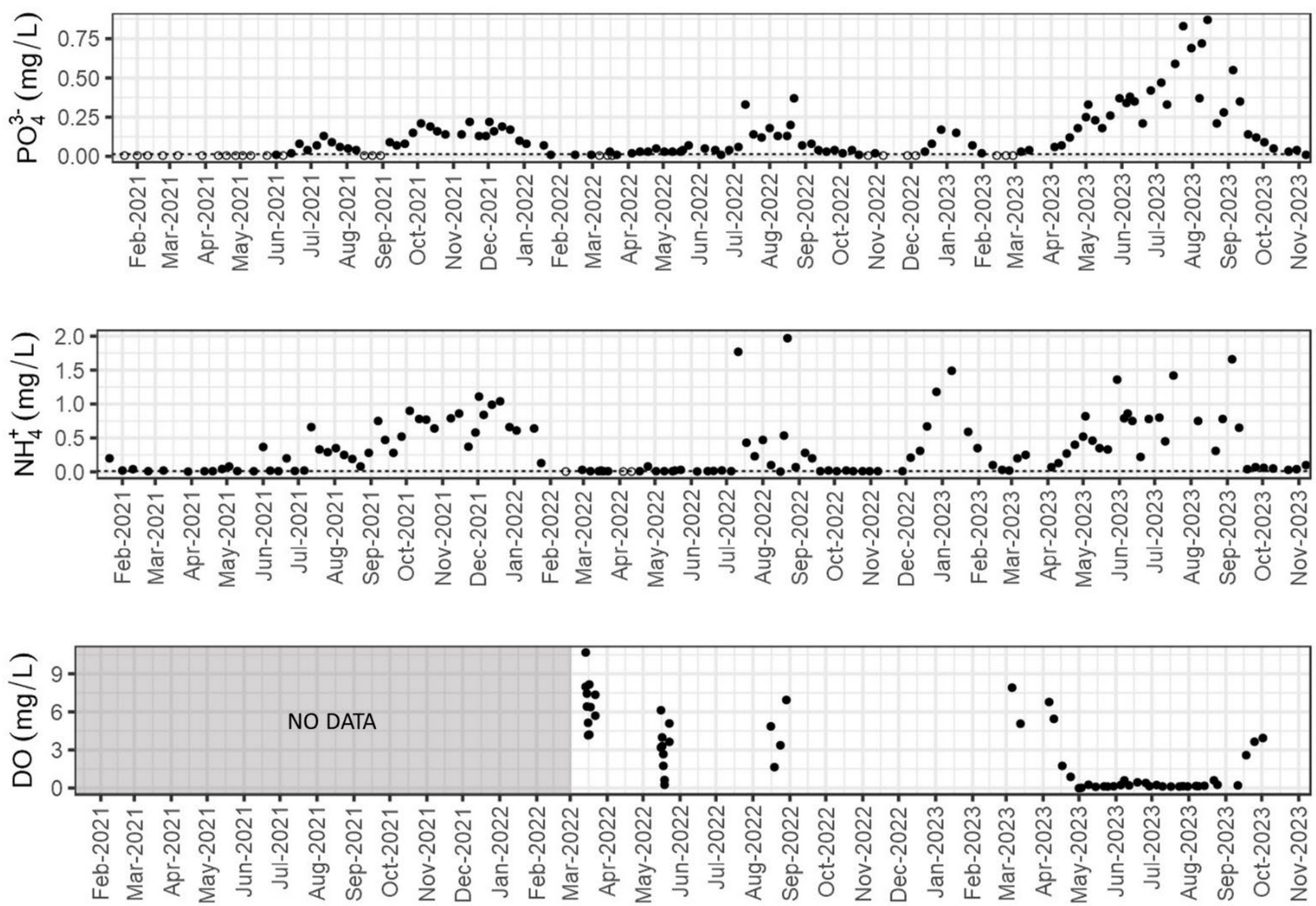

Figure 2-8. Bottom water orthophosphate (PO_4^{3-}; top), ammonium (NH^{4+}; middle), and dissolved oxygen (DO; bottom) at Site H-BL in Lake Henshaw, January 2021 through November 2023. For nutrients, analytical laboratory quantification limits (QLs) are shown as a dashed horizontal line. All results below the QLs 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.

2.2.3 Cyanobacteria and Cyanotoxins

In 2023, chlorophyll-a concentration, a commonly used indicator of algal biomass, was substantially lower than in 2022. While this result may have been in part a response to dilution of concentrations from greater lake volume, given evidence of increased rates of internal nutrient loading to the lake under higher water levels, lower chlorophyll-a was likely primarily due to repeated algaecide treatments that maintained concentrations at most lake sites below 50 ug/L for much of the year (Figure 2-9). Site-to-site variability in 2023 chlorophyll-a concentrations was evident, with the shoreline (H-S) and fishing dock (H-FD) sites exhibiting occasionally higher concentrations than other sites, similar to 2022 (Figure 2-9). Cyanobacteria abundance was also substantially lower in 2023 than in 2022, with cell counts generally below 100,000 cells per milliliter (cells/mL) in 2023 (Figure 2-10). *Planktothrix sp.* dominance receded following the August 2022 heavy copper-based algaecide treatment and did not return in 2023. Suspected cyanotoxin producers *Dolichospermum sp.* and *Microcystis sp.* did return in 2023, but at lower abundance (Figure 2-10, Figure 2-11), which corresponds to overall lower levels of microcystin and anatoxin-a in 2023 relative to 2022 (Figure 2-10 through Figure 2-13).

As discussed in *Lake Henshaw and Lake Wohlford HABs Management and Mitigation Plan* (Stillwater Sciences 2022a), the ability to track progression of a potentially cyanotoxin-causing bloom requires sampling early in HAB development, when water concentrations of cyanobacteria and cyanotoxins may still be relatively low. Because HABs can develop rapidly (i.e., over the course of several days), early warning that a HAB may be forming in Lake Henshaw and/or Lake Wohlford is critical for successful application of algaecides as the current short-term mitigation strategy. Thus, appropriate triggers are needed to allow the District to move from an *operational strategies window*, before a HAB occurs and when multiple options for reservoir operation are still available, to an *early warning window*, when monitoring data suggest that a HAB may be developing, and, as needed, to a *treatment window*, when algaecide application would occur prior to a HAB becoming out of control.

Results of approximately weekly routine sampling associated with nine Lake Henshaw algaecide treatments between April and September 2023 (Table 2-1) indicate that while chlorophyll-a concentrations and cyanobacteria abundance were relatively well controlled in 2023, and microcystin and anatoxin-a concentrations were relatively low, the *operational strategies window* and *early warning window* lasted just two to three weeks combined, such that algaecide applications were generally required within three to four weeks of the prior treatment. Use of peroxide- and copper-based algaecides resulted in different effects on the HAB community depending on bloom intensity, treatment timing, and algaecide dose, as detailed below and shown in Figure 2-9 through Figure 2-13:

- In the four weeks following the second 2-ppm peroxide-based algaecide treatment in April 2023, a *Dolichospermum sp.* and *Aphanizomenon sp.* bloom overwhelmed a subsequent 3.25-ppm peroxide treatment in late May but did respond to a 0.25-ppm copper-based treatment in early June. Microcystin and anatoxin-a were non-detect during this period.
- In the four weeks following the early June 0.25-ppm copper-based algaecide treatment, a *Microcystis sp.* and *Aphanizomenon sp.* HAB, including microcystin production exceeding the 0.8 ug/L cautionary threshold, returned but then responded well to a second 0.38-ppm copper-based treatment in early July.
- Three 2-ppm peroxide-based algaecide treatments undertaken over approximately five weeks in late July through late August held chlorophyll-a concentrations and

cyanobacteria counts relatively low, although microcystin still exceeded the 0.8 ug/L cautionary threshold at some sites between treatments. A large *Aphanocapsa sp.* bloom overcame the repeated peroxide treatments in mid-September, then seemingly crashed on its own prior to the last 2-ppm peroxide-based algaecide treatment of 2023.

Overall, 2023 Lake Henshaw monitoring data suggest that to be effective, low doses (< 5 ppm) of peroxide-based algaecide may need to be applied every two to three weeks during late spring, summer, and early fall, because waiting for a fourth week may result in a rapidly-developing HAB that overwhelms peroxide as an option and then requires copper-based treatment. Due to analytical laboratory and staffing constraints, the shortest Lake Henshaw monitoring interval remained at one week in 2023. Thus, while it may be possible to refine and extend the *operational strategies* and *early warning* windows for Lake Henshaw, more frequent monitoring would need to occur (e.g., every two to three days) and given the lake's behavior in 2023, any extension may not reach beyond one or two weeks regardless.

Lastly, while the District has not yet conducted synoptic monitoring to refine index sites and rapid response monitoring sites, as recommended in the *Lake Henshaw and Lake Wohlford HABs Management and Mitigation Plan* (Stillwater Sciences 2022a), the 2023 algaecide effectiveness and lanthanum-modified clay permit compliance monitoring sites (Table 2-1) and frequency of monitoring (i.e., weekly, as well as pre-, during-, and post-treatment event) are providing the District with a general understanding of the seasonal and spatial variability in *in situ* water quality parameters (i.e., water temperature, DO, pH, phycocyanin), chlorophyll-a, cyanotoxins, and cyanobacteria species. Even under 2023 higher lake levels and relatively more stratified conditions, lake circulation and wind mixing appear to have been sufficient to move blooms around the lake quickly such that the current index (H-BL, H-FD, H-S) and rapid response (H-BL, H-FD, H-S, H-ML, H-NL, H-SL) monitoring sites remain appropriate.

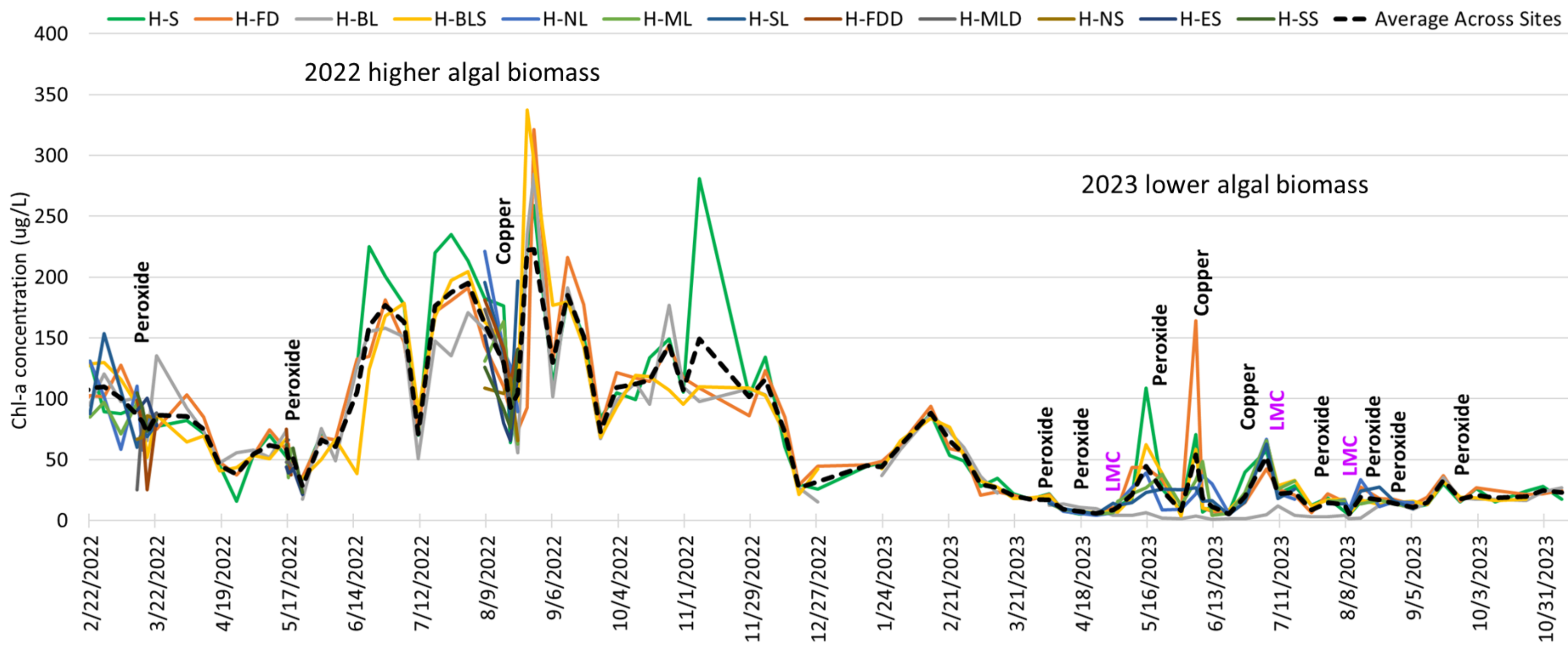

Figure 2-9. Chlorophyll-a concentrations at all monitoring sites in Lake Henshaw, February 2022 through November 2023. The average chlorophyll-a concentration across all sites is shown as a dashed black line. Algaecide (black) and lanthanum-modified clay (purple) treatments are shown with vertical text indicating the type of treatment and timing.

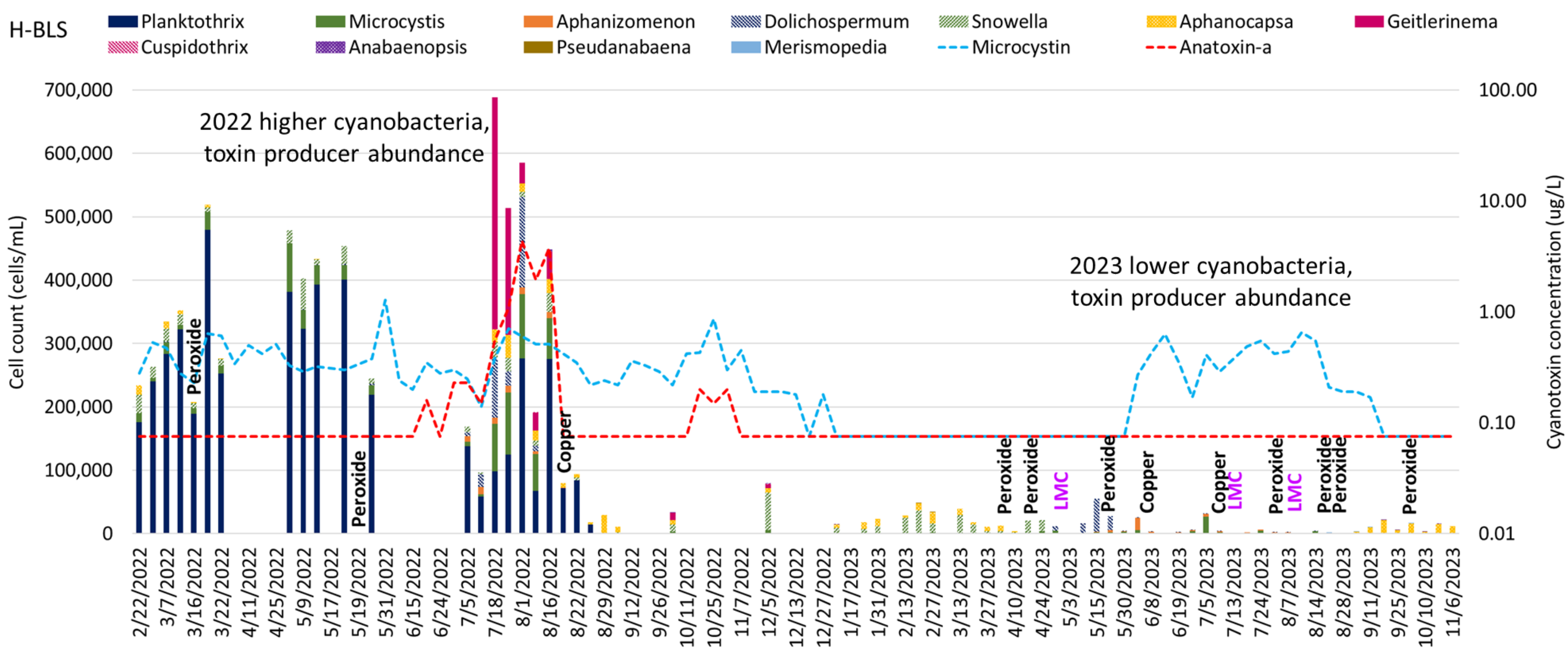

Figure 2-10. Cyanobacterial cell count data from Bend laboratory in surface waters at Site H-BLS in Lake Henshaw February 2022 through November 2023. Cyanotoxin concentration data for corresponding dates (microcystin = blue dashed line and anatoxin-a = red dashed line) is also shown.

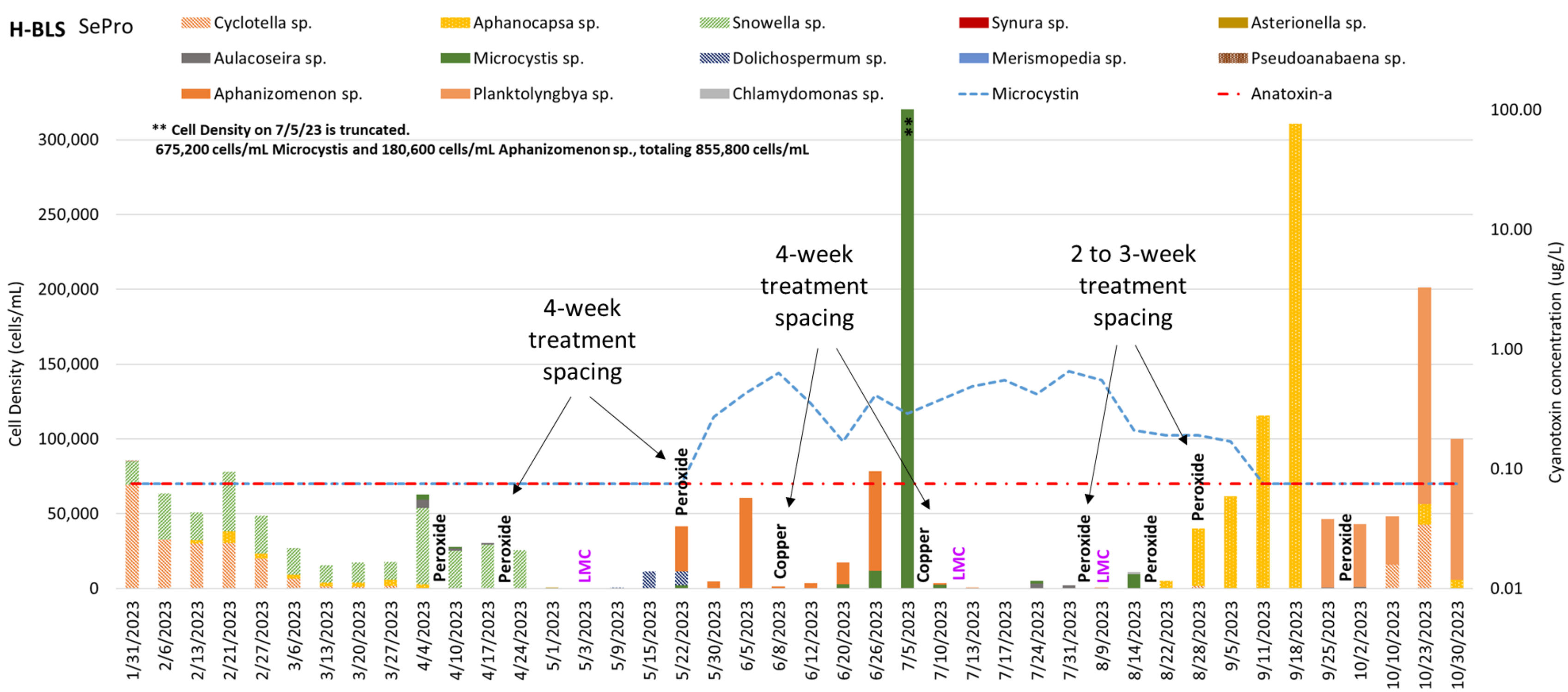

Figure 2-11. Cyanobacterial cell count data from SePro laboratory at buoy line surface site in Lake Henshaw January 2023 through October 2023. Cyanotoxin concentration data for corresponding dates (microcystin as a blue dashed line and anatoxin-a as a red dashed line) is also shown.

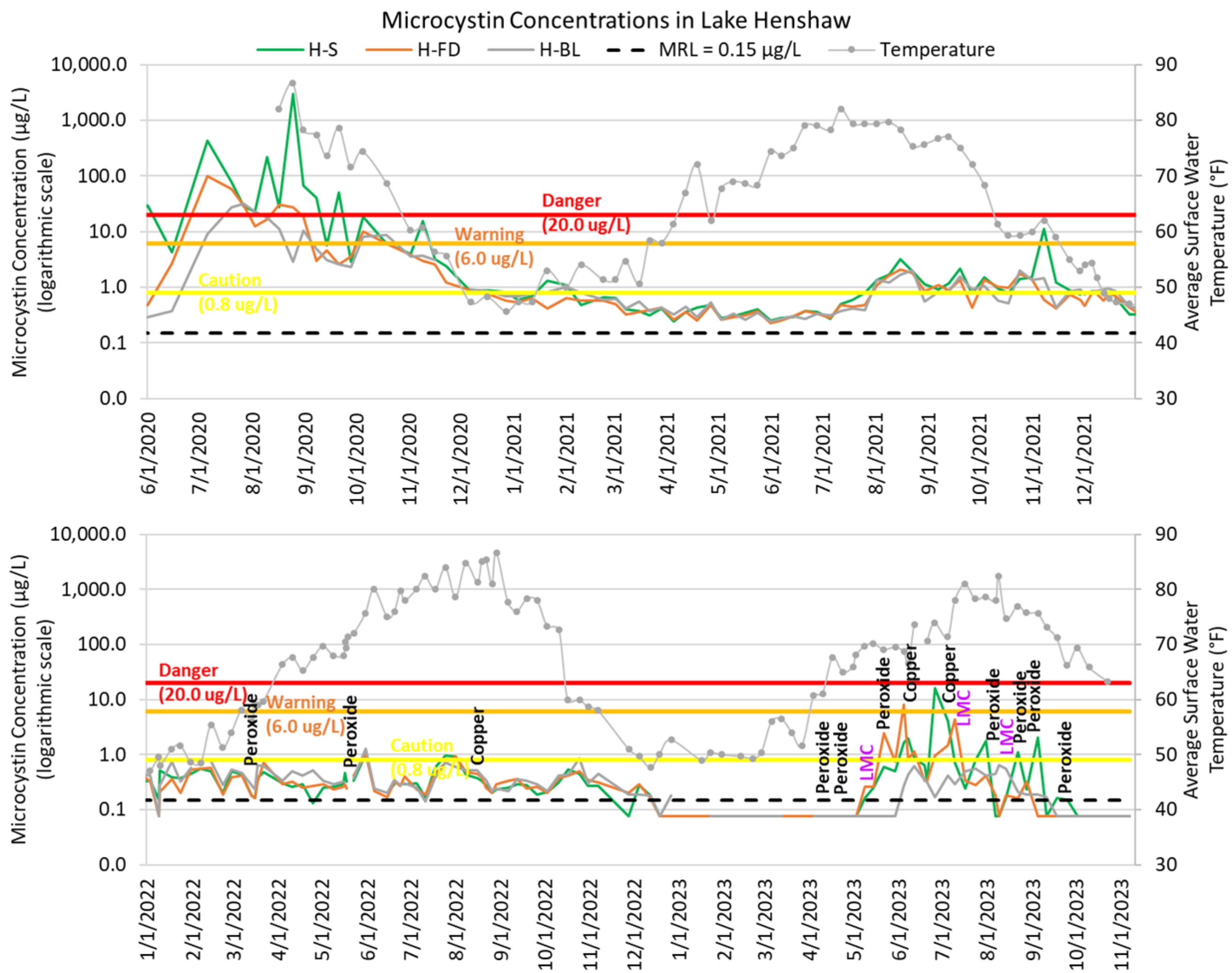

Figure 2-12. Microcystin concentrations at Lake Henshaw Shore (H-S), Fishing Dock Surface (H-FD), Buoy Line Depth (H-BL), and Buoy Line Surface (H-BLS) monitoring sites, June 2020 through November 2023. Algaecide (black) and lanthanum-modified clay (purple) treatments are shown with vertical text indicating the type of treatment and timing.

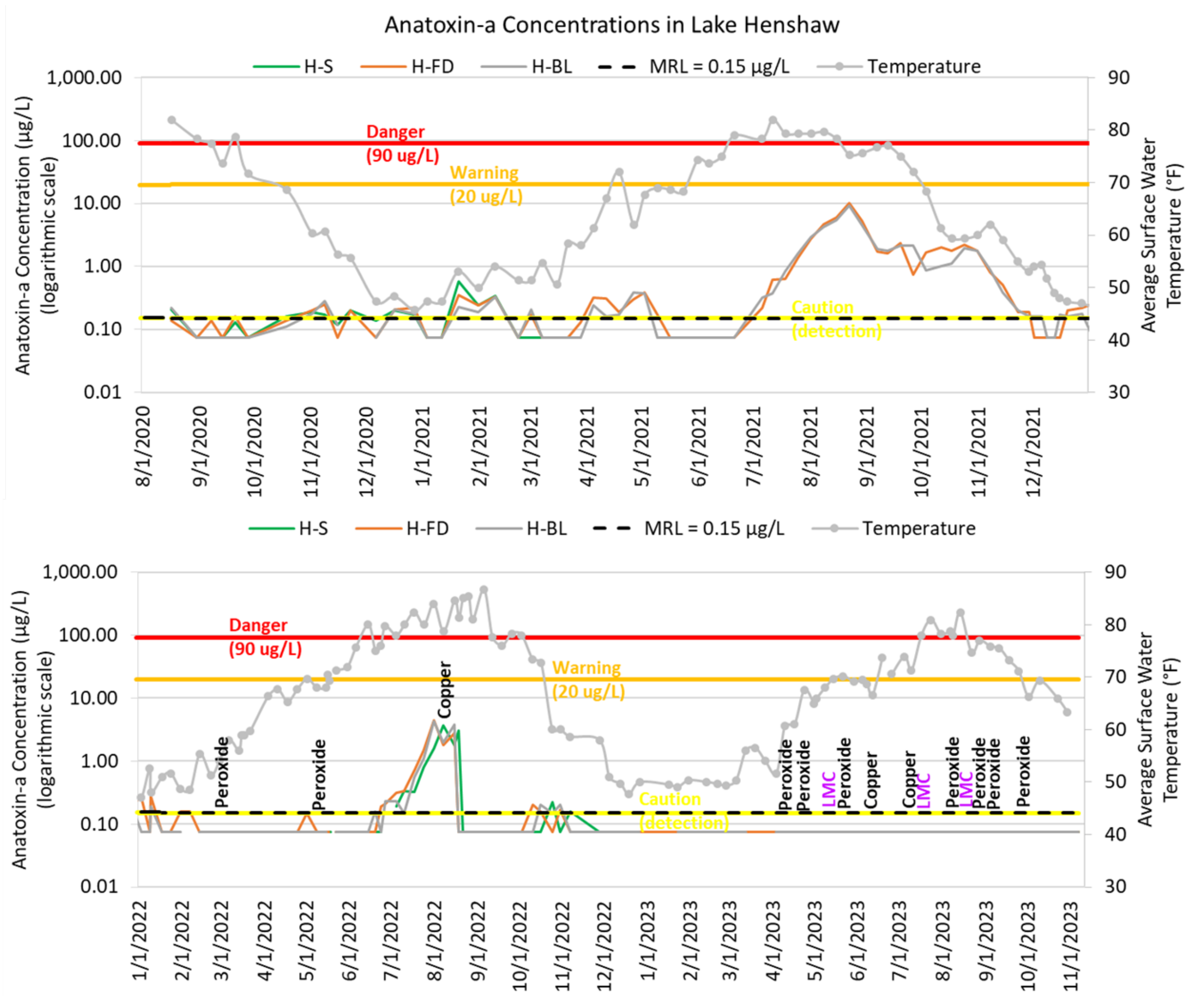

Figure 2-13. Anatoxin-a concentrations at Lake Henshaw Shore (H-S), Fishing Dock Surface (H-FD), Buoy Line Depth (H-BL), and Buoy Line Surface (H-BLS) monitoring sites, June 2020 through November 2023. Algaecide (black) and lanthanum-modified clay (purple) treatments are shown with vertical text indicating the type of treatment and timing.

2.2.4 Copper Residual

In 2023, copper was added to Lake Henshaw in the product "SeClear" as copper sulfate pentahydrate ($CuSO_4 \bullet 5H_2O$), which dissociates in water to cupric ion (Cu^{2+}), sulfate (SO_4^{2-}), and water. Cupric ion is rapidly taken up by algae and cyanobacteria through binding on cell surfaces and transport through cell walls, and it rapidly binds to inorganic and organic ligands in water, including bicarbonate (HCO_3^-), carbonate (CO_3^{2-}), hydroxide (OH^-), hydrous manganese and iron oxides, sulfides, and dissolved organic carbon (DOC). Copper associated with algae and cyanobacteria in the water column is present in particulate form, while copper associated with ligands in water is present as a dissolved form, even if it is complexed with manganese and iron oxides and/or DOC.

Monitoring results for 2023 indicate that an extended copper residual is possible in Lake Henshaw following application of copper-based algaecide. While the August 2022 and June 2023 residual period[2] each ranged 20 days or less, the July 2023 residual period was 41 days (Figure 2-14). The extended residual was not explained by variations in water hardness as $CaCO_3$, the presence of hydroxides as indicated by pH, analytical laboratory methods, or field blanks, and thus may have been related to increased DOC due to organic matter inputs to Lake Henshaw following substantial runoff inputs in late spring as well as flooded trees and other shoreline vegetation (Figure 2-3). The lack of consistent DOC data in Lake Henshaw in 2022 and 2023 make it difficult to determine whether DOC was the culprit with respect to the July 2023 copper-based algaecide treatment, but preliminary calculations using the biotic ligand model (Di Toro et al. 2001, USEPA 2003; BLM) suggest that DOC is likely to be an important ligand for binding dissolved copper in Lake Henshaw and maintaining a water column residual. Dissolved copper bound to DOC is less bioavailable than free dissolved copper (Cu^{2+}) or copper bound to hydroxide ($CuOH^+$) (Di Toro et al. 2001, USEPA 2003), suggesting that the extended copper residual observed in Lake Henshaw in July 2023 may not have resulted in toxicity to downstream aquatic biota, had releases occurred during this period.

[2] The number of days following copper-based algaecide application that dissolved copper concentrations remain greater than the hardness-based maximum dissolved copper criterion included in the District's Aquatic Weed Control Permit, which is covered under the Statewide General National Pollutant Discharge Elimination System (NPDES) Permit # CAG990003.

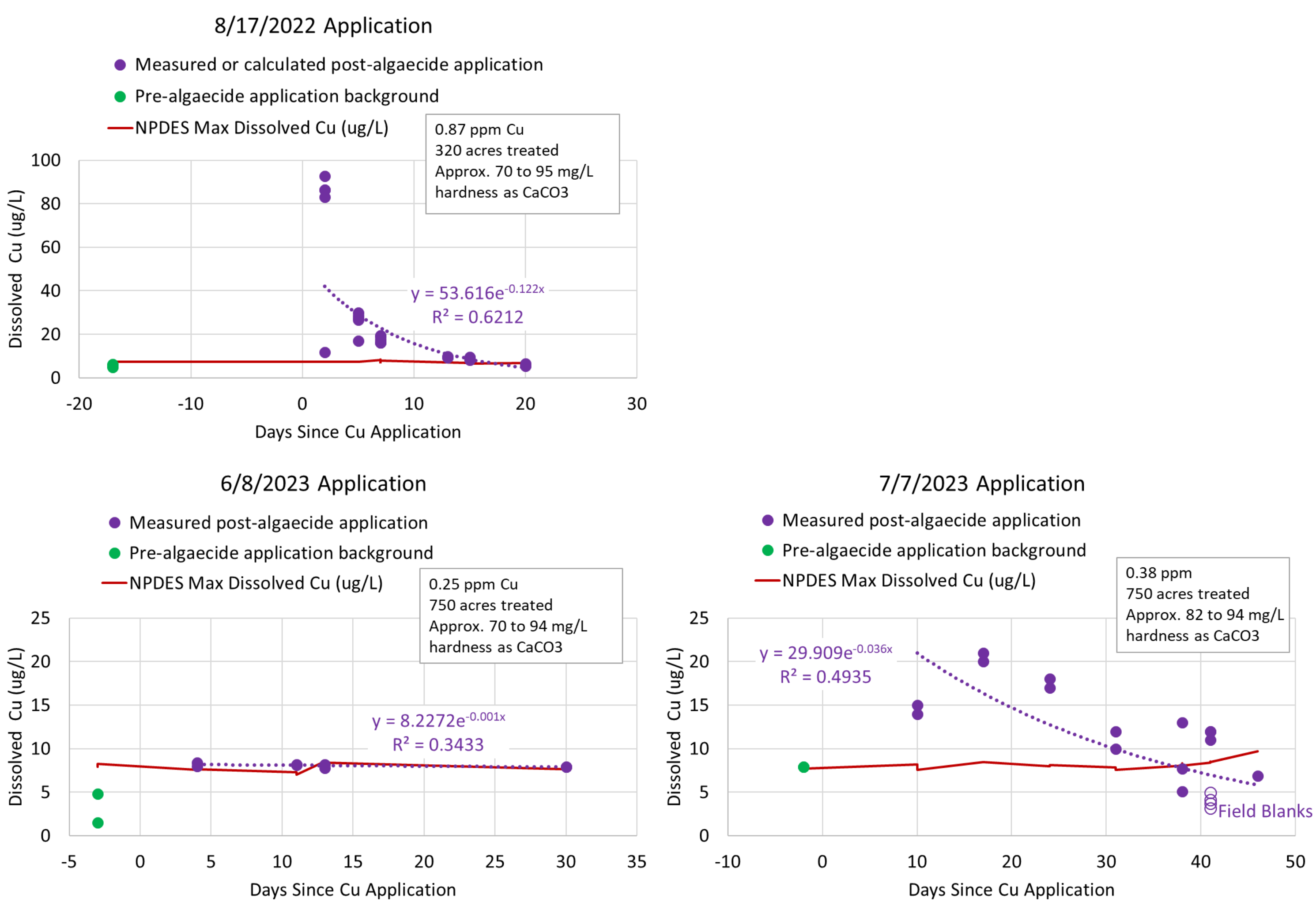

Figure 2-14. Dissolved copper (Cu) data pre- (green) and post- (purple) algaecide applications on August 17, 2022, June 8, 2023, and July 7, 2023, copper algaecide application with trendline shown as dotted purple line. Field blanks are shown as unfilled purple circles. NPDES Max Dissolved Cu concentration shown as continuous red line.

2.3 Recommendations

Based on 2023 water quality monitoring, the following are recommendations related to continued algaecide treatments in Lake Henshaw.

- Routine and effectiveness HABs monitoring, consistent with the *Lake Henshaw and Lake Wohlford HABs Management and Mitigation Plan* (Stillwater Sciences 2022a) and the following 2023 refinements:
  - Conduct weekly cyanobacteria identification and enumeration in surface waters at Site H-BLS (only).
  - Conduct weekly full algal community identification and enumeration during March through October at Site H-BLS, with other sites added if the results of routine and/or effectiveness monitoring for chlorophyll-a concentrations suggests high site-specific variability and the need to investigate bloom patchiness.
- Algaecide treatments (assuming approximately weekly monitoring intervals)
  - Given available budget, undertake frequent (i.e., no more than three weeks apart), low doses (< 5 ppm) of peroxide-based algaecide treatments during spring, summer, and early fall when chlorophyll-a concentrations are less than approximately 35 ug/L, cyanobacteria cell counts are less than approximately 50,000 cells/mL.
  - If chlorophyll-a concentrations exceed approximately 35 ug/L and/or if cyanobacteria cell counts are greater than approximately 50,000 cells/mL and are dominated by large-biovolume genus' such as *Planktothrix sp*, and *Aphanizomenon sp.*, and/or suspected primary toxin producers such as *Dolichospermum sp.*, and *Microcystis sp.*, consider use of a copper-based algaecide at low (≤ 0.25 ppm) to moderate (0.25–0.55 ppm) doses (see also below).
- Copper residual
  - Conduct weekly water temperature, hardness, alkalinity, pH, DOC, calcium, magnesium, sodium, potassium, sulfate, chloride, and sulfide monitoring at least three weeks prior to, during, and following copper-based algaecide treatments at effectiveness monitoring sites H-BL, H-FD, H-ML, H-NL, and H-SL.
    - Run BLM calculations for copper speciation under these conditions and determine whether the BLM-derived acute and/or chronic criteria are greater than the hardness-based criterion included in the District's Aquatic Weed Control Permit, where the latter is covered under the Statewide General National Pollutant Discharge Elimination System (NPDES) Permit # CAG990003. Based on the results of the BLM calculations, initiate a conversation with State Water Board regarding the preliminary BLM calculations for Lake Henshaw and whether the BLM could be used in lieu of the hardness-based dissolved copper criterion included in the District's Aquatic Weed Control Permit.
    - Based on empirical data, analyze whether there is an effect of DOC concentration on the number of days that copper residual exceeds the NPDES hardness-based criterion.

- If possible, and before treatment occurs, based on pre-treatment DOC concentrations, assess whether the residual period is likely to be extended beyond what the District considers reasonable.

– Include at least one field blank every four weeks for future dissolved copper sampling events.

3 LAKE HENSHAW PHOSPHORUS SEQUESTRATION/CHEMICAL SEDIMENT SEALING

3.1 Background

In February 2023, the District conducted a study to better understand the amount and distribution of bioavailable phosphorus[3] (BAP) within Lake Henshaw sediments. Sequestering phosphorus present in lake sediments (sometimes referred to as "sediment sealing") is intended to reduce internal loading of orthophosphate (PO_4^{3-}) during hypoxic (DO < 2 milligrams per liter [mg/L]) and/or anoxic (DO = 0 mg/L) lake conditions, where internal loading is an important source of nutrients fueling HAB development (Stillwater Sciences 2022a). The magnitude of orthophosphate release measured in Lake Henshaw sediment chambers in 2021 was the largest ever measured in similar studies of California reservoirs (Beutel and Defeo 2021). In the case of lanthanum-based P-sequestration, minimizing or eliminating such a high flux occurs through chemical binding of orthophosphate to lanthanum, where the latter is present in a bentonite clay matrix, to form an insoluble and biologically inert mineral called rhabdophane ($La(PO_4)\cdot H_2O$). The applied clay and rhabdophane settles out in a fine layer on lake sediments, usually fractions of a millimeter thick, and is not easily disturbed. This phosphorus management strategy is graphically represented in the conceptual model (Figure 1-2) by grey-white flakes along Lake Henshaw bottom sediments and the absence of PO_4^{3-} in the purple internal loading arrow emanating from the bottom sediments. Targeting the dose of lanthanum-modified clay to closely align with the amount of orthophosphate available to flux out of Lake Henshaw sediments is intended to help control costs and ensure that permitting requirements are met.

The following questions were addressed during the BAP study to refine phosphorus sequestration/chemical sediment sealing dose and cost estimates provided in the *Lake Henshaw and Lake Wohlford Harmful Algal Blooms Management and Mitigation Plan* (Stillwater Sciences 2022a):

1. How much phosphorus, and what chemical form is the P, in Lake Henshaw surficial sediments?
2. What are the physical properties of surficial lake sediments in which phosphorus is found?
3. Is there a correlation between the concentration of BAP in lake bottom sediments and the lake depth at which the sediments are found?

[3] BAP is defined as orthophosphate [PO_4^{3-}] plus chemical forms of phosphorus (P) that are readily converted to orthophosphate, which are discussed in detail in Appendix A.

3.2 Key Results

The BAP study found that while most phosphorus (74% of total phosphorus) in lake surficial[4] sediments is present in mineral and organic forms that are not bioavailable, there are approximately 31,800 pounds (lbs) of BAP (26% of total P), that have the potential to be released to the overlying water column during hypoxic (DO < 2 mg/L) and/or anoxic (DO = 0 mg/L) conditions in summer and fall months. Including an estimated 4,400 lbs of BAP in the springtime water column, the total BAP estimate is 36,200 lbs (Table 3-1). Additional details regarding the chemical form of phosphorus in surficial sediments are provided in Appendix A.

On average, sediments in the deepest portions of the lake (approximately 90 acres at lake elevation 2,670 ft; Table 3-1 and Figure 3-1) exhibit roughly three times the amount of BAP (in lbs P/ac) relative to mid and shallow water depth sediments. Deep lake sediments also possess characteristics that support high effective diffusion rates for BAP from sediment pore waters into the overlying water column (i.e., high porosity, low bulk density, high percent of total and labile organic matter), increasing the potential for internal loading of phosphorus in deeper portions of the reservoir. Sediments at mid water depths (approximately 305 acres at lake elevation 2,670 ft; Table 3-1 and Figure 3-1), while possessing BAP levels only moderately higher than sediments at shallow water depths, exhibit high porosity and moderate bulk density/percent of total and labile organic matter, indicating that these sediments also have potential to support moderate to high internal loading of BAP. Additional details regarding physical properties of lake sediments are provided in Appendix A.

Table 3-1. Total BAP for Lake Henshaw sediment and water column and estimates for lanthanum-modified clay product EutroSORB G needed to inactivate BAP.

Area (Lake Elevation Range[1])	Estimated BAP (lbs/ac)	Approximate Acres [2]	Estimated BAP (lbs)	EutroSORB G (lbs) [3]
Shallow (2,655.1-2,670 ft)	17.57	984	17,300	865,000
Mid (2,650.1-2,655 ft)	26.57	305	8,100	405,000
Deep (2,643–2,650 ft)	71.21	90	6,400	320,000
Total sediments	-	1,379	31,800	1,590,000
Springtime water column	[4]	-	4,400	220,000
Total sediments + water column	-	-	36,200	1,810,000
Mid and deep sediments + water column	-	-	18,900	945,000

1 Estimated from approximate water depth and lake level at the time of sampling; based on 2018 bathymetry.
2 Acres are approximate values used by SePro Corporation in lanthanum-modified clay calculations.
3 Assumes 50 lbs EutroSORB G to inactivate 1 lb BAP.
4 Assumes 50 ug/L of orthophosphate and a total lake volume of 9,925 ac-ft during spring 2023.

Using mass-based stoichiometry for the SePro product EutroSORB G, approximately 1,810,000 lbs of lanthanum-modified clay would be needed to inactivate all sediment and spring water column BAP in 2023 (Table 3-1). Assuming $3.20 per lb of EutroSORB G, the estimated product cost would be approximately $5.8M, not including application costs. While typical application rates and permitting requirements would allow for a single dose of 1,810,000 lbs of lanthanum-modified clay, this amount of product is far greater than what is physically practical to apply or affordable in one treatment. Further, not all the BAP in lake sediments is released in any one

[4] Defined as approximately the top 0.04 meters of sediments.

season or year, because the hypoxic and anoxic conditions that support BAP release from sediments into the overlying water column are not persistent in the lake at all locations at all times, and diffusion of BAP from deeper layers of the surficial sediments upward to the sediment-water interface is a slow process. Although we are unaware of published reports characterizing the fraction of sediment BAP typically released within lakes each year, SePro Corporation suggests that approximately 20% of sediment BAP is likely to be released on an annual basis (S. Shuler, SePro, Pers. Comm. to M. Singer, Stillwater Sciences, March 2023).

Thus, in general, undertaking multiple smaller treatments of lanthanum-modified clay each year and over several years is a more operationally feasible and financially viable approach to phosphorus sequestration. Multiple treatments also have the potential to better distribute lanthanum-modified clay at the sediment-water interface, because any given treatment may be somewhat uneven due to lake currents, mixing, and ongoing bioturbation and re-distribution by sediment-dwelling biota. The deep and mid depth areas exhibiting the highest BAP levels in sediments correspond to approximately 400 surface acres total within Lake Henshaw, or approximately one third of the total sediment surface acres in the lake at elevation 2,670 ft and 14,580 ac-ft (Figure 3-1).

Figure 3-1. Lake Henshaw treatment areas according to overlying water depth sediment categories, deep (dark blue), mid (blue), and shallow (light blue). Acres reported here are estimated based on lake bathymetry (2018) and assume lake elevation at 2,670 ft, storage at 14,580 ac-ft.

Consistent with results of the BAP study, the District undertook three lanthanum-modified clay treatments in 2023 (i.e., 90,000 lbs applied May 2–3; 92,000 lbs applied July 10–13; 92,000 lbs applied August 7–10), targeting sediments in the approximately 400 surface acres corresponding to deep and mid overlying water depth sediments (Figure 3-1). Weekly monitoring of orthophosphate (PO_4^{3-}) concentrations overlying deep water sediments located near Henshaw Dam at the buoy line in bottom waters (H-BL) and surface waters (H-BLS), as well as at the end of the fishing dock along the western shoreline in surface waters (H-FD), allows for estimates of internal phosphorus loading before and after each of the three lanthanum-modified clay treatments. Estimated rates of internal loading are represented by calculated orthophosphate flux[5] values (top tiles in Figure 3-2 through Figure 3-4).

Results indicate that most orthophosphate fluxes ranged from approximately -50 $mg/m^2/d$ to +50 $mg/m^2/d$ as characterized by surface waters at H-BLS (Figure 3-3) and H-FD (Figure 3-4), where a negative flux indicates that water column orthophosphate concentrations decreased and a positive flux indicates that water column orthophosphate concentrations increased. Negative flux suggests phosphorus sequestration in sediments by lanthanum under 2023 lake conditions, although negative flux could also mean uptake by phytoplankton blooms and/or dilution by water column mixing. Conversely, positive flux suggests phosphorus release from hypoxic (DO < 2 mg/L) and/or anoxic (DO = 0 mg/L) sediment pore waters (internal loading) but could also be due to release by senescing (dying) phytoplankton, particularly following one of the 2023 algaecide application events (see also Section 2). While most orthophosphate fluxes calculated using bottom water concentrations at H-BL also fell within the +/- 50 $mg/m^2/d$ range, this deep water site exhibited much greater variability, ranging from approximately -450 $mg/m^2/d$ to 650 $mg/m^2/d$ (Figure 3-2), which could be due to periods of water column mixing and dilution near the sediment-water interface (large negative fluxes) and other periods of no mixing when concentrations built up in bottom waters (large positive fluxes).

Notably, while orthophosphate fluxes decreased following the May 2023 lanthanum-modified clay treatment, they did not do so following the July and August 2023 treatments (Figure 3-2 through Figure 3-4), indicating that the first 275,000 lbs of lanthanum-modified clay applied to deep and mid lake sediments were not sufficient to result in measurable decreases in internal phosphorus loading from lake bottom sediments during the four- to five-month period when bottom waters in Lake Henshaw were consistently hypoxic (bottom tiles in Figure 3-2 through Figure 3-4). Despite this, several instances of negative orthophosphate fluxes in deep bottom waters and in surface waters, and several instances of positive fluxes less than values measured in the Phase I experimental chambers under oxic, suboxic, and anoxic DO conditions, suggest that average *net* internal loading of phosphorus to Lake Henshaw in 2023 was similar to or less than the particularly high rates measured in the chambers (Beutel and Defeo 2021). Further, given that only roughly 15% of the total estimated amount of EutroSORB G necessary for treating sediment BAP was applied in 2023, it is likely too soon to be able to discern an effect on internal phosphorus loading, particularly in a lake like Henshaw that does not experience strong seasonal water column stratification and thus can readily mix orthophosphate horizontally and vertically throughout the lake.

Lastly, while internal loading of nitrogen via ammonium fluxes from bottom sediments is not expected to be affected by lanthanum-modified clay treatments, the 2023 monitoring results also indicate a high degree of variability, with most fluxes below the high values measured in the Phase I experimental chambers (Beutel and Defeo 2021) and several instances of negative fluxes

[5] Transfer of orthophosphate from pore waters in the lake sediments to the overlying water column, in units of mass per unit area per unit time.

(middle tiles in Figure 3-2 through Figure 3-4) despite an extended period of consistently hypoxic bottom waters (bottom tiles in Figure 3-2 through Figure 3-4). Like the variable orthophosphate fluxes in late spring through and early fall 2023, the ammonium flux results suggest periods of water column mixing and dilution near the sediment-water interface (large negative fluxes) and other periods of no mixing when concentrations built up in bottom waters (large positive fluxes).

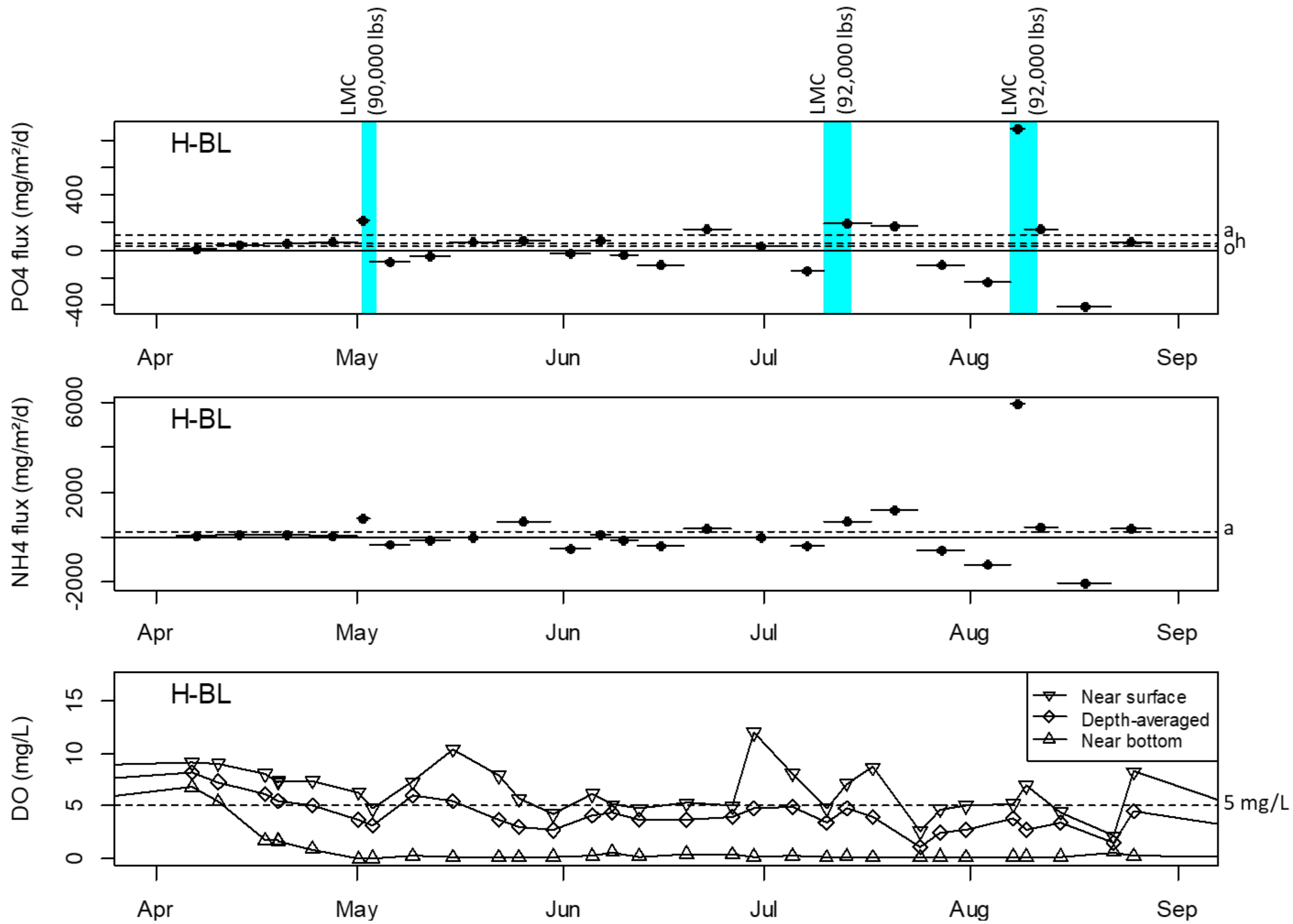

Figure 3-2. Estimated orthophosphate (PO4) and ammonium (NH4) mass fluxes from Lake Henshaw bottom sediments to the overlying water column and near surface, depth-averaged, and near-bottom dissolved oxygen (DO) concentrations at Site H-BL before, during, and after lanthanum-modified clay (LMC) applications in 2023. Horizontal dashed lines in PO4 and NH4 plots correspond to flux values calculated in Phase I sediment chamber studies under "a" anoxic (DO = 0 mg/L), "h" hypoxic (DO<2 mg/L), and "o" oxic (DO>2 mg/L) conditions (Beutel and Defeo 2021).

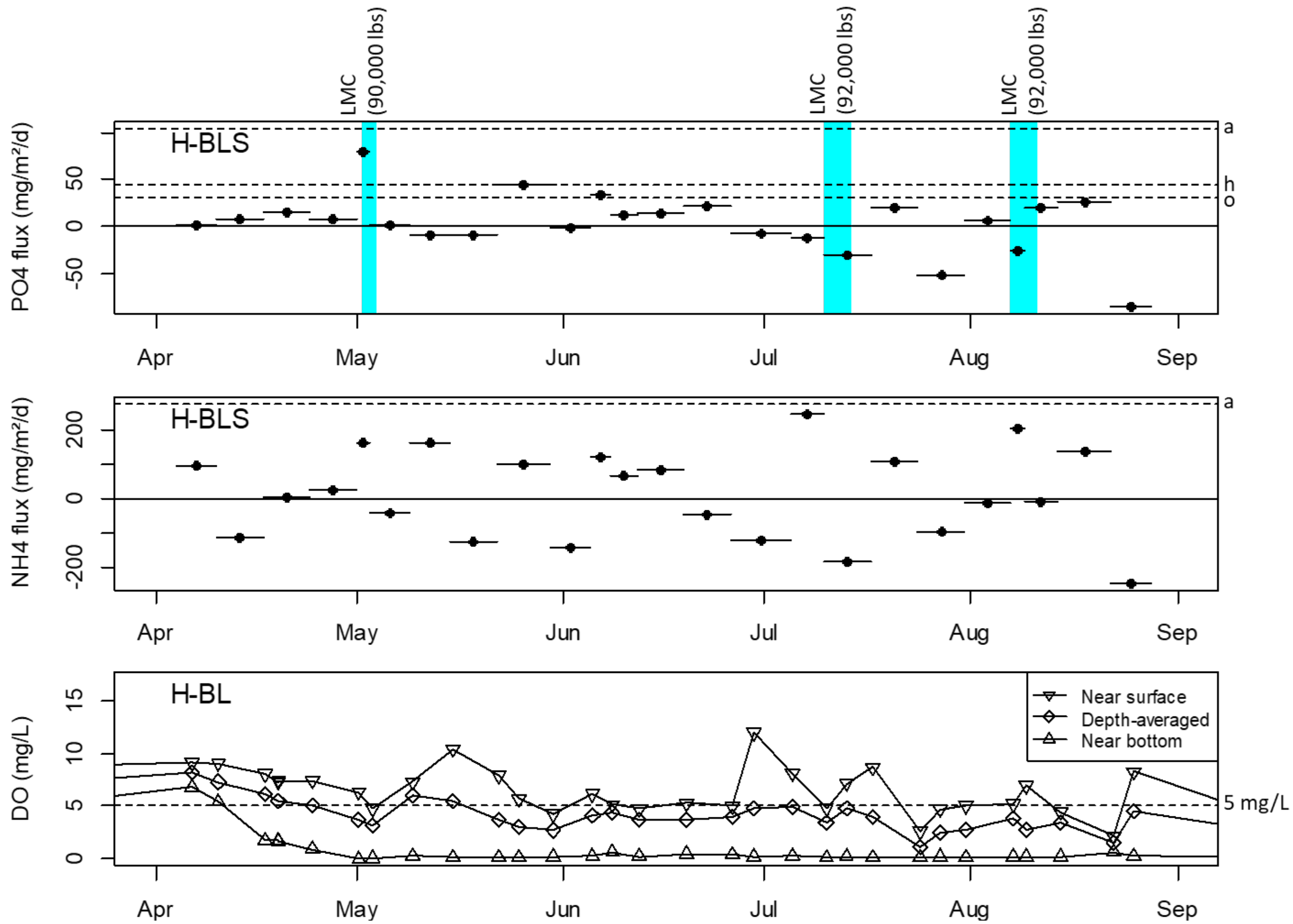

Figure 3-3. Estimated orthophosphate (PO4) and ammonium (NH4) mass fluxes from Lake Henshaw bottom sediments to the overlying water column and near surface, depth-averaged, and near-bottom dissolved oxygen (DO) concentrations at Site H-BLS before, during, and after lanthanum-modified clay (LMC) applications in 2023. Horizontal dashed lines in PO4 and NH4 plots correspond to flux values calculated in Phase I sediment chamber studies under "a" anoxic (DO = 0 mg/L), "h" hypoxic (DO<2 mg/L), and "o" oxic (DO>2 mg/L) conditions (Beutel and Defeo 2021).

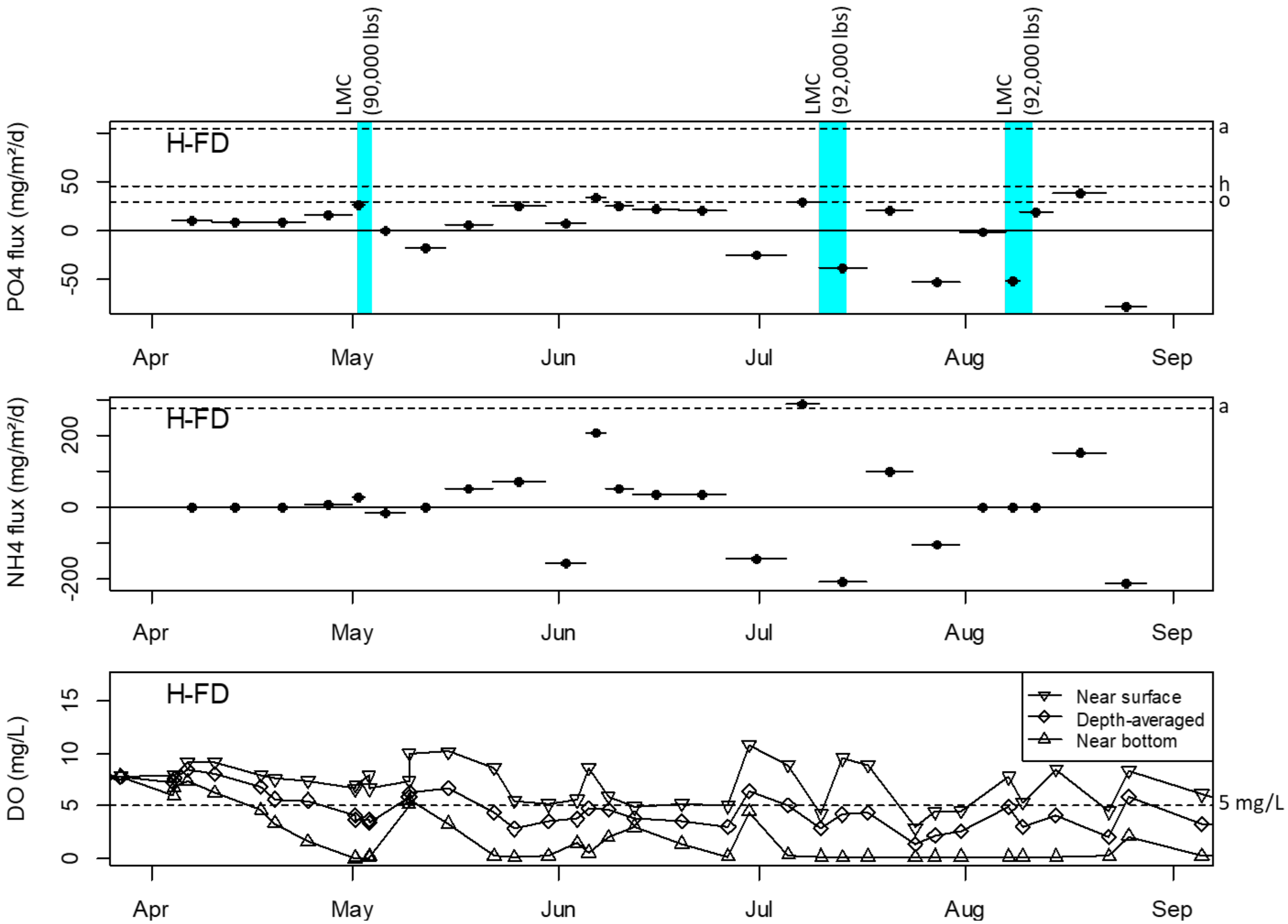

Figure 3-4. Estimated orthophosphate (PO4) and ammonium (NH4) mass fluxes from Lake Henshaw bottom sediments to the overlying water column and near surface, depth-averaged, and near-bottom dissolved oxygen (DO) concentrations before, during, and after lanthanum-modified clay (LMC) applications in 2023. Horizontal dashed lines in PO4 and NH4 plots correspond to flux values calculated in Phase I sediment chamber studies under "a" anoxic (DO = 0 mg/L), "h" hypoxic (DO<2 mg/L), and "o" oxic (DO>2 mg/L) conditions (Beutel and Defeo 2021).

3.3 Recommendations

Based on the results of the Phase II BAP study and additional orthophosphate, ammonium, and DO monitoring results, the following are recommendations related to continued lanthanum-modified clay treatments in Lake Henshaw in both the short and long term.

- Lanthanum-modified clay treatments should continue to target sediments in deep and mid overlying water depth areas because these areas possess the largest BAP amounts (18,900 lbs; Table 3-1) and are likely to exhibit the highest effective diffusion rates. These areas correspond to approximately 400 surface acres total within Lake Henshaw (Figure 3-1).
- Multiple lanthanum-modified clay treatments should occur each year and over several years for operational and financial reasons, with heavier applications at 20% to 50% of mid and deep sediment total estimated BAP (i.e., 145,000 to 362,750 lbs EutroSORB G per year across the deepest 400 surface acres of the lake). Treatments less than 145,000 lbs EutroSORB G may also be successful in smaller areas of the lake and/or for stripping orthophosphate from the water column during periods when bottom water DO is > 2 mg/L.
- Multiple lanthanum-modified clay treatments should be undertaken each year and over several years to increase the efficacy of P-binding and reduce P-breakthrough from uneven distribution of clay material on sediments due to lake currents, mixing, and ongoing bioturbation and re-distribution by sediment-dwelling biota.
- Periodic (once every two or three years) analysis of phosphorus fractions in Lake Henshaw surficial sediments following EutroSORB G treatments (or series of treatments) to demonstrate whether and how BAP fractions change over time in response to treatments. Wet bulk density should be measured in future sediment samples (see additional details in Appendix A). Periodic sediment sampling events should be undertaken at the same time of year to develop a long-term record; however, the interpretation of data from periodic sampling should include an assessment of external phosphorus inputs (e.g., from Warner Ranch Wellfield and/or storm events) to best understand trends.

4 LAKE HENSHAW SOURCE WATER NUTRIENT CONTROL

4.1 Background

In spring 2023, the District conducted a study to investigate options for treating Warner Ranch Wellfield input to Lake Henshaw to bind and inactivate phosphorus in flowing water coming from the wellfield before it enters the lake, reducing external loading of this nutrient (see also Figure 1-2). based on the recently collected phosphorus concentration data and mean monthly wellfield production, the wellfield source water contributes an average of 70 kg P/month or 150 lb P/month to Lake Henshaw, primarily in the form of orthophosphate, which is readily available to cyanobacteria that grow in the lake.

Source water nutrient control testing focused on application of a chemical (EutroSORB WC™ or similar) that the manufacturer indicates will bind rapidly and permanently with orthophosphate in flowing water coming from the wellfield. The study involved laboratory jar testing of wellfield water samples with added EutroSORB WC™ manufactured by SePro Corporation. The following questions were addressed during this study to refine source water nutrient control dosing and cost estimates provided in the *Lake Henshaw and Lake Wohlford Harmful Algal blooms Management and Mitigation Plan* (Stillwater Sciences 2022a):

1. What are the chemical properties of the Warner Ranch Wellfield water?

2. What is the removal efficiency and binding ratios of EuroSORB WC™ when dosed to target50% and 75% removal rates of orthophosphate in the Warner Ranch Wellfield water?

4.2 Key Results

Source water nutrient control testing results indicated that Warner Ranch Wellfield water exhibits high hardness levels (> 250 mg/L as $CaCO_3$), high alkalinity levels (150–200 mg/L), and elevated pH (> 8 s.u.), each of which generally decrease the orthophosphate removal efficiency of EutroSORB WC™ through competitive binding of OH^- and CO_3^{2-} with orthophosphate, thereby reducing binding with the EutroSORB WC™ active ingredients. Resulting orthophosphate removal during the laboratory jar tests ranged 27–56% for doses targeting 50% and 75% removal, respectively. Additional details are provided in Appendix B.

Binding ratios were assessed to help refine the material costs. SePro Corporation reports binding ratios as the number of prescriptive dose units (PDU) of EutroSORB WC™ per pound phosphorus (lb-P) removed, where a higher binding ratio indicates that more chemical is needed to bind a pound of phosphorus, resulting in a lower cost efficiency of the chemical. Laboratory jar testing results indicated that binding ratios decreased in water with higher starting concentrations of orthophosphate (Table 4-1). Using extrapolated values, the highest expected binding ratio for EutroSORB WC™ in wellfield water assuming approximately 70 µg/L as the starting orthophosphate concentration is 15:1 PDU/lb-P, which is anticipated to achieve 75% removal of orthophosphate. Additional details regarding binding ratio results are provided in Appendix B.

Based on a 15:1 binding ratio and a 70 µg/L starting orthophosphate concentration, EutroSORB WC™ chemical costs will range \$19,000–\$29,000 per month when the wellfield is pumping. If the Warner Wellfield were to run all year, the material costs for EutroSORB WC™ will range \$236,000–\$353,000 per year. Additionally, an onsite injection system will need to be installed at an estimated one-time cost of \$20,000–\$50,000/unit, including injection pump, power, and pad and containment for tote. The higher end of the injection system cost range would include telemetry.

Table 4-1. Laboratory jar testing results for Warner Ranch Wellfield terminus sample.

Dosing Group	Starting Orthophosphate Concentration (PO_4^{3-}) [ug/L]	Applied Dosing Ratio [PDU/lb-P]	Resulting binding Ratio [PDU/lb-P]	Orthophosphate (PO_4^{3-}) Removal [%]
1	33	4.4	16.6	27%
	51	4.7	14.8	32%
	72	4.6	14.0	33%
	90	4.8	12.5	38%
2	33	6.6	18.4	36%
	51	7.1	15.7	45%
	72	6.9	14.4	48%
	90	7.2	12.9	56%

4.3 Recommendations

An operational trial for treatment of the wellfield terminus may help elucidate whether phosphorus binding efficiency would be any higher at scale (versus jar test results), and to what degree insoluble particles of the EutroSORB WC™ (or similar) active ingredients bound to orthophosphate remain in suspension until the water reaches Lake Henshaw. However, ongoing discussions with the San Diego Regional Water Quality Control board (Regional Board) regarding permitting suggest that a chemical agent used within the Warner Wellfield to bind and inactivate phosphorus in water flowing into Lake Henshaw must be an 'allowable additive' under the District's existing water supply permit. At present EutroSORB WC™ is not considered to be an allowable additive. Thus, the following are recommendations related to source water nutrient control in the long term.

- Continue to coordinate with SePro Corporation, other product manufacturers, and the Regional Board to determine whether there is a phosphorus binding agent that would be considered an allowable additive under the District's existing water supply permit, and if so, proceed with an operational trial, as described in Appendix B.
- Prior to permit issuance for a source-water control trial (or more permanent) installation, additional lanthanum-modified clay treatments should be undertaken in Lake Henshaw during periods when the wellfield is pumping. The additional treatment dose should be calculated to inactivate an average of 70 kg P/month or 150 lb P/month adjusted for the amount of time the wellfield has been pumping.

5 LAKE HENSHAW OXYGENATION

5.1 Background

Phase II of the Project includes development of a work plan that outlines the requirements for a temporary lake oxygenation field trial for Lake Henshaw focused on the containerized SDOX system that is readily available for lease. As discussed in the *Lake Henshaw and Lake Wohlford Harmful Algal Blooms Management and Mitigation Plan* (Stillwater Sciences 2022a), lake oxygenation has the potential to prevent HAB events by controlling the oxidation-reduction potential in the water and bottom sediments and the associated release of orthophosphate and ammonium, but also dissolved manganese, dissolved iron, sulfate, and if present, methylmercury, from the reservoir sediments during hypoxic (DO < 2 mg/L) and anoxic (DO = 0 mg/L) conditions. Limiting release of nitrogen and phosphorus reduces the potential for HABs because these nutrients are required for algae and cyanobacteria growth (see also Figure 1-2).

While oxygenation systems have been successfully used to minimize internal nutrient loading in a variety of lakes and reservoirs throughout North America, to our knowledge cyanobacteria and cyanotoxin reduction (or elimination) has not been demonstrated through oxygenation, particularly in a broad, shallow lake such as Henshaw. Although some site improvements are needed to accommodate oxygenation rental equipment, the field trial is designed to allow site-specific evaluation of the oxygenation concept without the substantial capital investment required for a permanent installation. The field trial will also provide information needed to inform the sizing of a permanent oxygenation system for Lake Henshaw.

The work plan includes the following components to outline the required equipment, needed site improvements, experimental approach, and estimated costs for the temporary field trial:

1. *Basis of Design:* Outlines how the oxygen demand of Lake Henshaw was estimated and used to inform sizing of the temporary field trial oxygenation system.

2. *Equipment and Installation:* Includes general site layout and improvements needed to place equipment on site and conduct the field trial. Includes discussion of two main types of equipment considered (SDOX or Speece cone).
3. *Experimental Plan:* Describes objectives and goals, planned test scenarios, trial duration, water quality analysis and frequency, and staffing needs.
4. *Budgetary Cost Estimate:* Includes cost tables for site improvements and monthly charges for the field trial oxygenation system.

5.2 Key Results

5.2.1 Basis of Design

To successfully maintain DO levels above 5 mg/L in lake bottom waters, oxygen added to Lake Henshaw must meet the lake oxygen demand, which varies based on season, temperature, water depth, natural organic matter, ecology, and time of day. The lake's oxygen demand can be separated into *water column oxygen demand* (WCOD) from the organic material and biota (e.g., bacteria, phytoplankton) living within the water column, and *sediment oxygen demand* (SOD) from the organic material and biota (e.g., bacteria, benthic algae and/or cyanobacteria) living in the lake sediments.

To estimate WCOD, we first reviewed DO vertical profiles collected by the District at five sites during early morning and mid- to late afternoon monitoring events during March, May, and August 2022. We used the difference between afternoon and morning DO concentrations at a given site and depth as a rough estimate of net WCOD since during nighttime hours respiration (decreases DO concentrations) should dominate over photosynthesis (increases DO concentrations). Since the 2022 data exhibited widely varying WCOD from -8 to +3.5 mg/L DO per day across sites and depths, the rough estimates of WCOD were judged to be insufficient input for sizing the Lake Henshaw field trial oxygenation system. Additional details regarding the use of DO vertical profiles to estimate net WCOD in Lake Henshaw are presented in Appendix C.

Instead, a literature-based WCOD value of 0.2 mg/L/day was used based on a 2003 study of nine California lakes where the hypolimnetic oxygen demand (HOD) ranged from 0.034 to 0.147 mg/L/day (Beutel 2003). The highest value was measured in Lafayette Reservoir, located in the San Francisco bay Area, and which is also a hypereutrophic waterbody. Note that HOD represents an *in situ* net oxygen demand that inherently includes both WCOD and SOD; therefore, using an HOD value of 0.2 mg/L/day for WCOD alone is likely to provide a conservative design approach for the Lake Henshaw field trial oxygenation system.

SOD rates used for the field trial work plan are based on laboratory SOD chamber studies conducted by the University of California at Merced (UC Merced) as part of Phase II of the Project. Using sediment samples collected from six locations within the lake, UC Merced measured the decline in DO over time to determine DO uptake from lake sediments. Three different mixing conditions (no mixing, low mixing, and high mixing) were tested to simulate a range of water velocities at the sediment-water interface. The results indicate that SOD values increase with mixing and as a function of DO concentration in water above the sediments. The mean SOD ranged from 1.01 $g/m^2/d$ (no mixing) to 1.84 $g/m^2/d$ (high mixing). For field trial oxygenation system sizing, the SOD study average high-mix value of 1.8 $g/m^2/day$ was selected as a conservative value. Additional details regarding SOD chamber results are presented in Appendix D.

Lake water volume and lake sediment area change with water surface elevation. To evaluate the size of the oxygenation system needed, the total lake oxygen demand was calculated using lake bathymetry and hypsographic data relating Lake Henshaw water surface elevation with lake water volume and surface area at 1-foot intervals between 2,643 and 2,700 ft mean sea level (MSL). For the field trial oxygen demand design, the lake bottom sediment area is approximated as equal to the lake surface area.

For the typical low-level water surface elevation of 2,657 ft, the lake volume is approximately 2,193 acre-ft (2.7 x 10^9 liters) and the lake area surface area is approximately 527 acres (2,133,447 m^2). Assuming WCOD of 0.2 mg/L/day and SOD of 1.8 $g/m^2/day$, the lake oxygen demand is estimated to be 4.8 tons/day. Based on these calculations, the field trial oxygenation system should add a maximum 10,000 pounds of oxygen per day, or 5 tons/day. This size is based on meeting 100 percent of the water volume and sediment area oxygen demand at the typical low water elevation of 2,657 ft MSL (Figure 5-1). At a higher lake elevation of 2,660 ft, the 5 ton/day system would meet approximately 72 percent of the combined oxygen demand (WCOD 1.1 tons/day and SOD 5.9 tons/day). At elevation 2,670 ft, this system would meet about 33 percent of the combined oxygen demand (WCOD 4.1 tons/day and SOD 11.2 tons/day) (Figure 5-1).

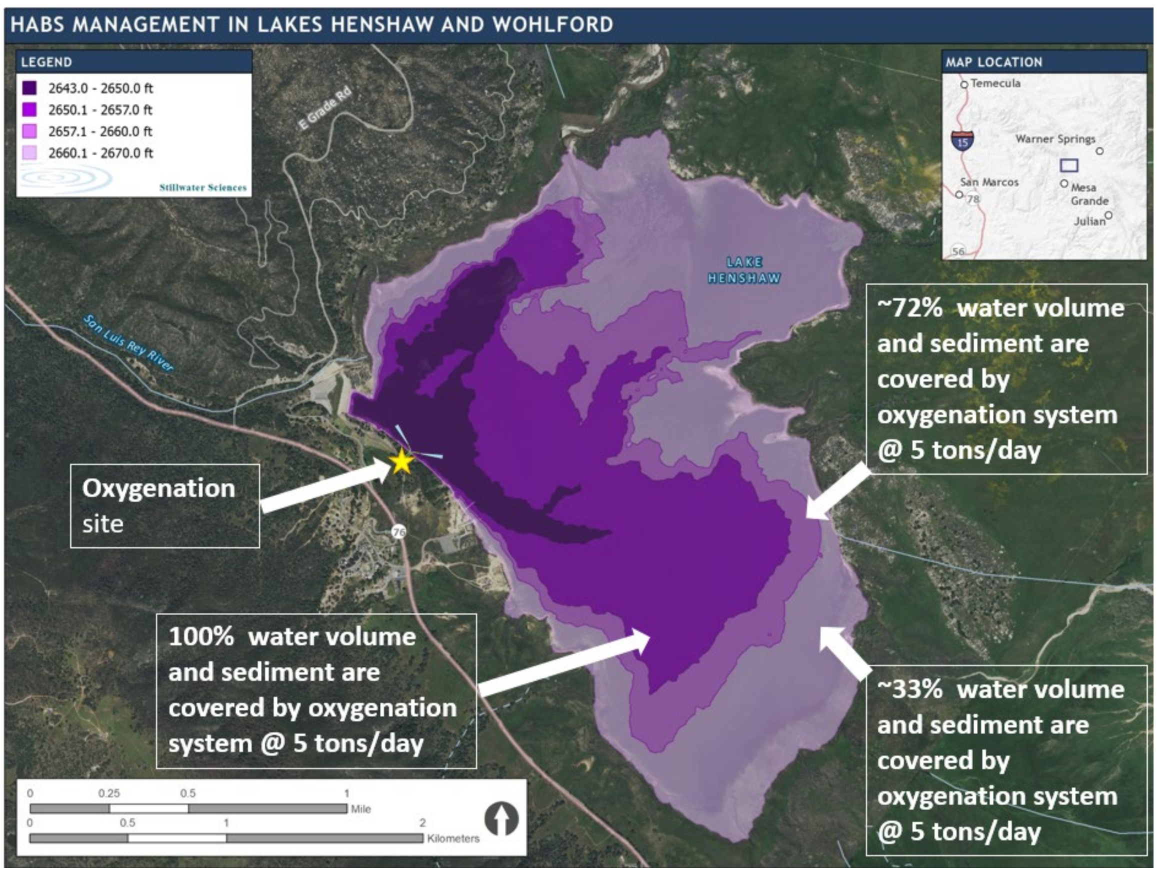

Figure 5-1. Aerial view of Lake Henshaw.

5.2.2 Equipment and Installation

Of the two types of the oxygenation saturation systems commonly implemented in lakes and reservoirs, the Lake Henshaw field trial work plan focuses on the pressurized SDOX system

(Figure 5-2) as its manufacturers have developed a containerized unit that is readily available for lease. The Speece cone systems are individually designed and constructed for each project and require a longer lead time prior to deployment with additional nuances for temporary installations (i.e., barge). Additional detail regarding the SDOX and Speece cone systems is presented in Appendix E which includes the complete work plan.

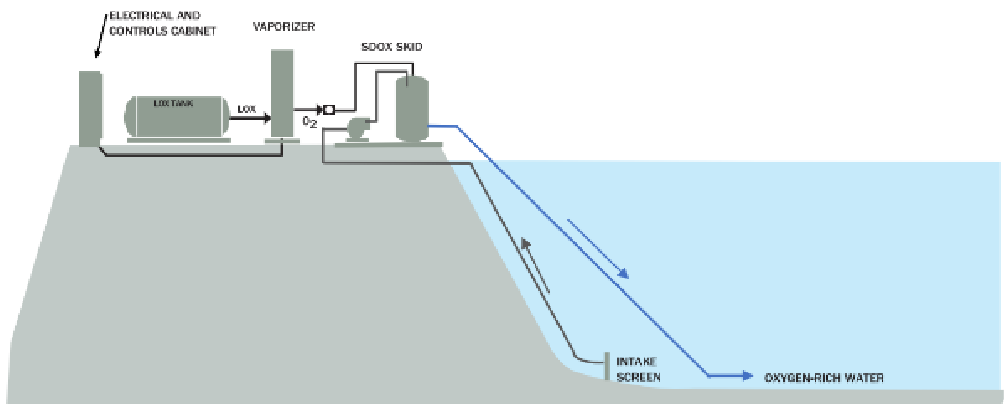

Figure 5-2. SDOX schematic.

5.2.3 Experimental Plan

The purpose of the Lake Henshaw oxygenation field trial as detailed in Appendix E is to evaluate the performance and effectiveness of oxygenation to improve water quality and mitigate HABs. This objective will be evaluated based on the following metrics:

- Increase in DO to target levels (5 mg/L or above in bottom waters)
- Decrease in concentrations of phosphorous and nitrogen
- Decrease in algal cell counts, chlorophyll-a, and phycocyanin
- Decrease in concentrations of cyanotoxins (microcystin, anatoxin-a)
- Improvement in water quality to allow water releases from Lake Henshaw to the San Luis Rey River

Based on the results of targeted effectiveness monitoring over five test scenarios, the aforementioned parameters will be compared to the baseline condition just prior to starting the oxygenation field trial and to values obtained from previous years (since 2020) that are representative of seasonal conditions observed during the trial period. Further, given that shallow lakes such as Henshaw mix vertically and horizontally frequently throughout the year (even under 2023 conditions when water column depth was relatively greater; see Section 2.2.1), it would also be prudent to include hydrodynamic modeling as part of the field trial to help interpret the targeted effectiveness monitoring results as well as to size and configure a permanent oxygenation system, should the latter eventually be recommended. Hydrodynamic modeling would involve 3-dimensional modeling of Lake Henshaw water temperature, DO, and chlorophyll-a concentrations, among other parameters, to be validated using baseline conditions and the five test scenarios included in the field trial experimental plan. Additional details regarding the effectiveness monitoring program associated with the field trial are presented in Appendix E.

5.2.4 Budgetary Cost Estimate

Estimated fixed costs for site improvements along with installation/start-up of the temporary oxygenation equipment and systems, data analysis, and permitting are $996,000. Additionally, monthly rental fees and chemical/electrical purchase costs are estimated at $125,280/month. The total costs of the oxygenation field trial for a 9-month to 12-month range are summarized in Table 5-1 including the Association for the Advancement of Cost Engineering International (AACEI) Class 5 estimate ranges for the site improvement costs. Additional detail regarding the cost estimate for the field trial are presented in Appendix E.

Table 5-1. Total cost estimate for Lake Henshaw oxygenation field trial (monthly plus fixed costs).

Parameter	Lower Range (-50%)[a]	Estimated Cost	Upper Range (+100%)[a]
9-month Project Duration	$1,625,000	$2,123,000	$3,119,000
12-month Project Duration	$2,001,000	$2,499,000	$3,495,000

[a] Range is calculated using AACEI Class 5 criteria with a cost estimate accuracy for the site improvements ranging from -50 to +100 percent.

The Lake Henshaw oxygenation field trial is based on 6 months of testing with costs for leasing based on 9 to 12 months to account for start-up and transition time while allowing operation for a full year if desired. Once the field trial is complete, the rental equipment will be returned with the following purchased items remaining:

- Gravel roadway
- Break tank
- High Density Polyethylene (HDPE) Piping and articulated concrete block mattress (ACBM)
- Electrical upgrades
- Permits

If the field trial proves to be successful and a permanent installation is desired, some of these purchased components from the field trial can be reused. It may also be possible to purchase the rental SDOX unit if a containerized configuration is acceptable for the permanent facility. However, note that a new permanent oxygen storage and feed system would need to be constructed for a permanent facility. Also note that if a different site is selected for the permanent facility, there will be additional costs associated with the new location for roadway access, electrical, and other utilities. Finally, there may be increased opportunities for grant funding if the use of hydrogen fuel were integrated into the Lake Henshaw oxygenation project. Depending on timing and engineering considerations, this may be more feasible for a permanent installation once the field trial demonstrates the efficacy of oxygenation as a HABs control measure.

5.3 Recommendations

A Lake Henshaw oxygenation full-scale field trial will help evaluate the performance and effectiveness of oxygenation to improve water quality and mitigate HABs. The following are recommendations related to lake oxygenation control in both the short and long term.

- Implement a full-scale field trial SDOX system in Lake Henshaw sized to add a maximum 10,000 pounds of oxygen per day (5 tons/day) using the recommended site layout (in Appendix E).
- During the full-scale field trial, three different test scenarios (5, 3, and 1.5 tons/day) should be implemented to compare the effectiveness of each dose and how the lake is affected.
- During the full-scale field trial, water quality conditions within the lake should be monitored through a combination of continuous data sondes and manual data collection with handheld instruments and grab samples analyses. A synoptic survey including DO and water temperature in vertical profiles at multiple locations should also be conducted at the end of each test scenario to determine the geospatial impacts of oxygen addition at each rate.
- Prior to implementation of the full-scale field trial, consider whether to undertake hydrodynamic modeling as part of the trial to help interpret the targeted effectiveness monitoring results as well as to size and configure a permanent oxygenation system, should the latter eventually be recommended. Development of the model in the months leading up to the field trial would allow the model to be up and running as data are collected during field trial monitoring.

6 SUMMARY RECOMMENDATIONS

Table 6-1 presents summary recommendations from Phase II of the Lake Henshaw and Lake Wohlford HABs Management and Mitigation Project.

Table 6-1. Phase II summary recommendations.

Type of Control	Method	Out-of-lake	In-lake	Implemented during Phase II (2023)	Potential to Implement or Continue in Short term (2024-2025)	Summary Recommendations (see Sections 2.3, 3.3, 4.3, and 5.3 for details)	Estimated Costs
HABs Prevention							
Chemical	Phosphorus inactivation/ chemical sediment sealing		X	Yes	Yes	• Continue lanthanum-modified clay treatments targeting deep and mid overlying water depth areas. • Conduct multiple lanthanum-modified clay treatments each year and continue over several years. • Conduct analysis of phosphorus fractions in Lake Henshaw surficial sediments every two or three years to demonstrate whether and how BAP fractions change over time in response to treatments.	Approximately $3M, over 4 to 5 years, not including application costs
	Source water nutrient control	X		No	No	• Coordinate with SePro Corporation, other product manufacturers, and the Regional Board to determine whether there is a phosphorus binding agent that would be considered an allowable additive under the District's existing water supply permit. • After permit issuance, conduct operational trial for treatment of the wellfield terminus.	$19K–$29K per month when wellfield is pumping; $236K–$353K per year if wellfield is pumping year round; $40K–$100K application equipment for two application sites (one time cost).
	Oxygenation via Speece Cone or SDOX		X	No	Yes	• Implement a full-scale field trial SDOX system in Lake Henshaw. • During the field trial, test three different oxygen addition rates to compare effectiveness of each dose. • During the field trial, monitor water quality conditions within the lake. • Use field trial results to refine estimated costs for a permanent oxygenation system.	$1.6M–$3.5M field trial (monthly plus fixed costs, for a 9- to 12-month project)
HABs Mitigation							
Physical	Bypass pipeline	X		No	No	• Not investigated as part of Phase II of the Project given the relatively high capital costs and extended implementation timeline associated with this out-of-lake long-term method.	Capital cost: $22M–$43M O&M: $220K per year
Chemical	Algaecide treatment		X	Yes	Yes	• Refine routine and effectiveness HABs monitoring to reduce number of sites for conducting weekly cyanobacteria identification and enumeration and number of weeks for conducting full algal community identification and enumeration. • Undertake frequent low doses of peroxide-based algaecide treatments during spring, summer, and early fall when chlorophyll-a and cyanobacteria are relatively low. • If chlorophyll-a and/or cyanobacteria are relatively high and dominated by certain genus types, consider use of a copper-based algaecide at low to moderate doses (see also below). • Conduct weekly hardness, alkalinity, pH, DOC, calcium, magnesium, sodium, potassium, sulfate, chloride, and sulfide monitoring at least three weeks prior to, during, and following copper-based algaecide treatments at specific sites. • Run BLM calculations for copper speciation to better inform conversations with the State Water Board regarding a BLM-based residual criterion. • Analyze whether there is an effect of DOC concentration on copper residual. • If possible, assess whether DOC is likely to affect the residual period before treatment occurs. • Include at least one field blank every four weeks for future dissolved copper sampling events.	$300K–$1.5M per year

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Appendices

Appendix A

Phosphorus Fractionation in Lake Henshaw Sediments to Inform Phosphorus Sequestration as a Management Strategy for Harmful Algal Blooms

Stillwater Sciences

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phone 510.848.8098

TECHNICAL MEMORANDUM

DATE:	September 12, 2023
TO:	Don Smith, Vista Irrigation District
FROM:	Maia Singer, Karin Emanuelson, Stillwater Sciences
SUBJECT:	Phosphorus Fractionation in Lake Henshaw Sediments to Inform Phosphorus Sequestration as a Management Strategy for Harmful Algal Blooms

1 INTRODUCTION

In February 2023, the Vista Irrigation District (District) conducted a study to better understand the amount and distribution of bioavailable phosphorus (BAP; i.e., orthophosphate [PO_4^{3-}] plus chemical forms of phosphorus that are readily converted to orthophosphate) within Lake Henshaw sediments. The sediment monitoring event was conducted as part of Phase II of the Lake Henshaw and Lake Wohlford Harmful Algal Blooms (HABs) Management and Mitigation Project. Phase I involved development of the *Lake Henshaw and Lake Wohlford Harmful Algal Blooms Management and Mitigation Plan* (Stillwater Sciences 2022), which included a long-term recommendation to prevent HABs by chemically removing orthophosphate from the water column and minimizing or eliminating orthophosphate release from lake sediments through application of a chemical (e.g., alum, lanthanum[1]) to the lake. Sequestering phosphorus (P) present in lake sediments (sometimes referred to as "sediment sealing") is intended to reduce internal loading of orthophosphate during hypoxic (dissolved oxygen [DO] < 2 milligrams per liter [mg/L]) and/or anoxic (DO = 0 mg/L) lake conditions, where internal loading is an important source of nutrients fueling HAB development (Stillwater Sciences 2022). The magnitude of orthophosphate release measured in Lake Henshaw sediment chambers in 2021 was the largest ever measured in similar studies of California reservoirs (Beutel 2021). In the case of lanthanum-based P-sequestration, minimizing or eliminating such a high flux occurs through chemical binding of orthophosphate to lanthanum, where the latter is present in a bentonite clay matrix, to form an insoluble and biologically inert mineral called rhabdophane ($La(PO_4)\cdot H_2O$). The applied clay and rhabdophane settles out in a fine layer on lake sediments, usually fractions of a millimeter thick, and is not easily disturbed. Targeting the dose of lanthanum-modified clay to closely align with the amount of orthophosphate available to flux out of lake sediments helps to control costs and ensure that permitting requirements are met.

[1] While the *Lake Henshaw and Lake Wohlford Harmful Algal Blooms Management and Mitigation Plan* (Stillwater Sciences 2022) provided estimated costs for heavy and moderate doses of alum and/or lanthanum-modified clay (in the Phoslock™ formulation), subsequent discussions and permitting investigations determined that alum treatment would require a lengthy permitting process. In contrast, lanthanum-modified clay application could occur via a streamlined permit. Thus, this study was focused on informing appropriate dosing levels of lanthanum-modified clay.

Phosphorus (P) in lake sediments is present in a variety of chemical forms that have been operationally defined as the following P fractions based on sequential laboratory extraction procedures (Meis et al. 2011):

- *Labile* – directly available P as orthophosphate in lake and sediment pore waters, where some labile P may be loosely bound or adsorbed to surfaces. Desorption and diffusion are the primary drivers of sediment P release for this fraction;
- *Reductant soluble* – P bound to iron (Fe)-hydroxides and manganese (Mn)-compounds that are released during sediment anoxia;
- *Metal oxide* – P adsorbed to aluminum (Al) and Fe metal oxides that is released when pH is high (i.e., greater than approximately 9 s.u.) in surface waters and surficial or disturbed sediments, which can rapidly occur during periods of high photosynthesis in poorly buffered conditions;
- *Labile organic* – P in organic matter (OM) that is broken down relatively easily/quickly during microbial decomposition, which then releases this form of P;
- *Apatite bound* – P bound within a mineral matrix including calcium of the form $Ca_{10}(PO_4)_6(X)_2$, with X = OH, Cl, or F, where P is released when pH is low (e.g., 2 to 6 s.u. [Guidry and Mackenzie 2003]); and
- *Residual* – P bound in refractory organic compounds that are not easily or quickly broken down during microbial decomposition.

The likelihood of release for labile and reductant-soluble P fractions from lake sediments into the overlying water column is high during all seasons, but particularly in summer and fall when DO can be low in sediments and deeper waters. The likelihood of release for metal-oxide and labile organic P fractions is medium to high, since pH can readily increase in eutrophic waters and typical rates of microbial activity in lake sediments are more than sufficient to break down labile carbon compounds. Apatite-bound P is generally not released given that most lake sediments do not maintain low pH. Release of residual P is also unlikely given that this P fraction is bound within a complex matrix of organic carbon that is difficult to break down and persists for years and decades buried in lake sediments. Thus, the labile, reductant-soluble, metal-oxide, and labile organic P sediment fractions are the target of lanthanum-modified clay treatment in Lake Henshaw.

The following questions were addressed during this study:

1. How much P, and what chemical form is the P, in Lake Henshaw surficial sediments?
2. What are the physical properties of surficial lake sediments in which P is found?

These questions were posed to inform the dose and location of upcoming lanthanum-modified clay treatments in Lake Henshaw. The goal is to target these treatments in areas within Lake Henshaw that have the greatest amount of P in a form that is highly likely to be released as orthophosphate when lake sediments become depleted in DO. The working assumption is that lake sediments with low bulk density and high porosity will exhibit a high effective diffusion rate of orthophosphate through pore waters such that greater amounts of orthophosphate will be released from sediments with these characteristics.

2 METHODS

2.1 Sample collection and laboratory analysis

The District re-occupied fifteen sites used for previous sediment and water sampling in Lake Henshaw, where the sites are representative of three overlying water depth categories based on lake bathymetry (shallow, mid, deep; Figure 1). The District shipped sediment samples overnight to the SePRO Research & Technology Campus (SRTC; Whitakers, NC). Percent solids and P-fractions were determined in sediments at all fifteen sites (SRTC Level 2 analyses) and additional physical and chemical analyses were performed at a subset of five sites (STRC Level 3 analyses; Table 1). Constituents and analytical methods included in SRTC levels 2 and 3 sediment analyses are presented in Table 2.

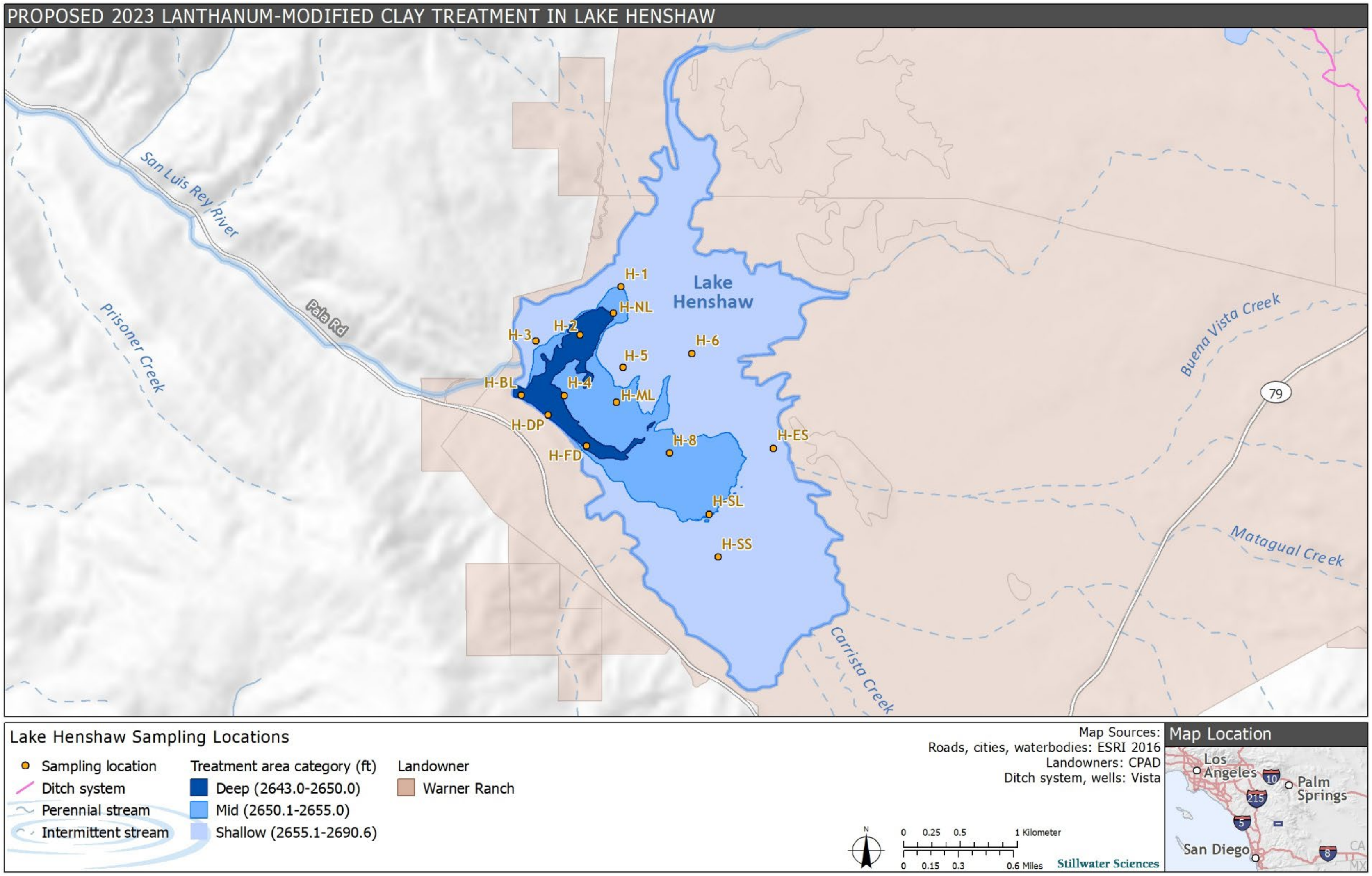

Figure 1. Lake Henshaw sediment sampling sites for SRTC Level 2 and Level 3 analysis. Lake area at 2,650.0-ft (dark blue), 2,655.0-ft (blue) and 2,690.6-ft (light blue) water surface elevations corresponds to deep, mid, and shallow overlying water depth sampling locations.

Table 1. Lake Henshaw sediment sampling sites with overlying water depth category, SRTC level of analysis, and latitude and longitude.

Site ID	Site Elevation (feet)[1]	Depth Category	SRTC Analysis Level	Latitude	Longitude
H-1	2,659	Shallow	Level 2	33.24806	-116.75226
H-2	2,651	Deep[2]	Level 3	33.24427	-116.75616
H-3	2,659	Shallow	Level 2	33.24377	-116.76035
H-4	2,651	Deep	Level 2	33.23944	-116.75768
H-5	2,660	Shallow	Level 2	33.24167	-116.75209
H-6	2,660	Shallow	Level 2	33.24277	-116.74557
H-8	2,654	Mid	Level 3	33.23486	-116.74772
H-BL	2,643	Deep	Level 3	33.23947	-116.76171
H-DP	2,644	Deep	Level 3	33.23791	-116.75922
H-ES	2,662	Shallow	Level 2	33.23522	-116.73787
H-FD	2,649	Mid[3]	Level 2	33.23545	-116.75556
H-ML	2,656	Mid	Level 2	33.23890	-116.75275
H-NL	2,656	Mid	Level 2	33.24600	-116.75300
H-SL	2,658	Mid	Level 2	33.23000	-116.74400
H-SS	2,662	Shallow	Level 3	33.22659	-116.74316

[1] Estimated from approximate water depth and lake level at the time of sampling; based on 2018 bathymetry.
[2] Originally categorized as Mid and recategorized based on analysis described in Section 2.2.
[3] Originally categorized as Deep but recategorized based on analysis described in Section 2.2.

Table 2. Sediment constituents by SRTC analysis level with corresponding analytical methods, method detection limits, and units.

Analysis		Constituent	Method	MDL	Units
Level 2	% Solids	% Solids	EPA Method 1684	1%	Percent
	Phosphorus Fractionation	Total P	EPA Method 365.3	1 mg/kg for 50% solids 10 mg/kg for 5% solids	mg/kg, dry weight
		Labile P	Based on Boström et al. (1988), Hupfer et al. (1995), Spears et al. (2007)		mg/kg, dry weight
		Reductant Soluble P	Based on Psenner et al. (1984, 1988), Boström et al. (1988), Hupfer et al. (1995), Lukkari et al. (2007), Spears et al. (2007)		mg/kg, dry weight
		Metal-oxide P	Based on Psenner et al. (1984, 1988), Boström et al. (1988), Hupfer et al. (1995), Spears et al. (2007)		mg/kg, dry weight
		Organic P	Calculated		mg/kg, dry weight
		Apatite and Residual P	Based on Psenner et al. (1984, 1988), Boström et al. (1988), Hupfer et al. (1995)		mg/kg, dry weight
Level 3	Physical Properties	Porosity	Hao et al. (2005)	5%	Percent
		Dry Bulk Density	Hao et al. (2005)	0.01	g/cm^3
		% Sand, Silt and Clay	ASTM D421	1.70%	Percent
	Organic Matter (OM) Properties	% Labile OM	Loss on ignition at 250 ºC	0.5%	Percent
		% Total OM	Loss on ignition at 550 ºC	0.5%	Percent
	Metals	Metals (Fe, Mn, Al)	Lukkari et al. (2007)	5	mg/kg, dry weight
	Redox Properties	% Reduced Mn	Calculated	0.10%	Percent
		% Reduced Fe	Calculated	0.10%	Percent
		Reducible Fe-oxide/hydroxides	Calculated	5	mg/kg, dry weight

Analysis		Constituent	Method	MDL	Units
		Total Recovered Sediment Fe	Lukkari et al. (2007)	5	mg/kg, dry weight
		Reductant Soluble Fe:P Ratio	Calculated	–	Ratio
	Metal Oxide Fractions	pH	Al-Busaidi et al. (2005)	0.1	s.u.
		Metal-oxide Al:P Ratio	Calculated	–	Ratio
		Metal-oxide Al:Fe Ratio	Calculated	–	Ratio

ASTM = American Society for Testing and Materials
EPA = US Environmental Protection Agency
MDL = method detection limit
mg/kg = milligram per kilogram

2.2 Data analysis

To inform dosing and distribution decisions related to proposed lanthanum-modified clay application in Lake Henshaw, SRTC completed the following analysis to characterize the sediment samples. Sediment sites were initially grouped into the three overlying water depth categories assigned for sampling (i.e., shallow, mid, deep; Figure 1). Results for P fractionation and percent solids (% solids) were then analyzed as a function of sampling site elevation to ensure that sediments in each water depth category exhibited reasonably similar physical and chemical characteristics. Sites H-2 (elevation 2,648 ft) and H-FD (elevation 2,646 ft) were both located close to the elevation cutoff between mid and deep (elevation 2,650 ft), and these two sites were re-binned as deep and mid respectively because their sediment characteristics most closely aligned with characteristics from those overlying water depth categories (Figure 2).

SRTC estimated percent labile OM by dividing % total OM to calculate a ratio of labile to total OM. Reported organic P fraction was split into labile organic P and ‘other organic’ P. Labile organic P was calculated by multiplying the organic P fraction by the labile to total OM ratio. Other organic P fraction was calculated as the difference between organic P and labile organic P fractions.

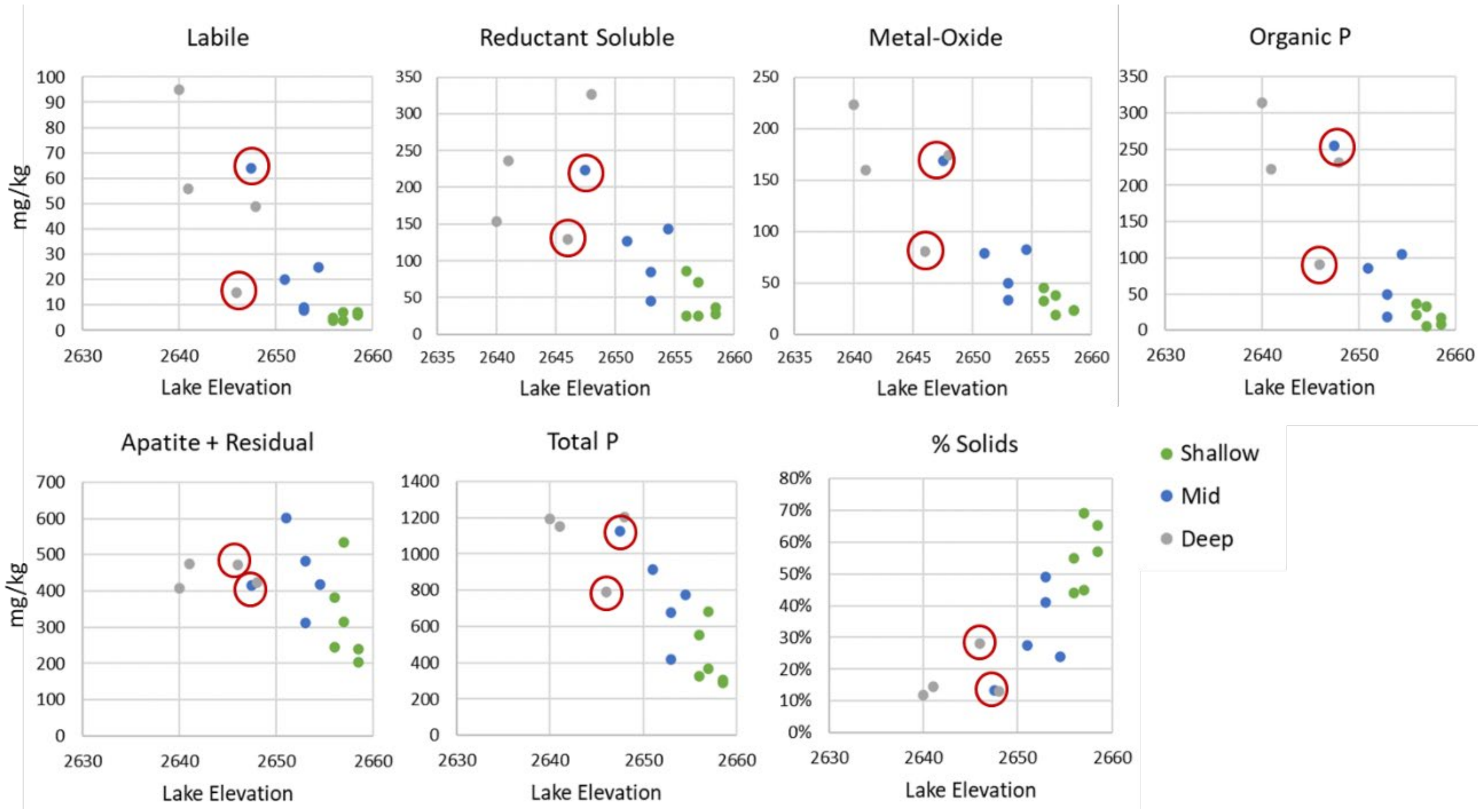

Figure 2. Lake Henshaw sediment sampling results for phosphorus fractionation and percent solids as a function of sampling site elevation binned by overlying water depth category: shallow (green), mid (blue) and deep (gray). Results from sites circled in red repeatedly clustered with the properties of a different water depth category.

Data were then summarized by overlying water depth category by averaging all sites within that category for each analyte. Results were converted from milligrams phosphorus per kilograms (mg P/kg) to pounds phosphorus per acre (lbs P/ac) according to Equation 1 using an assumed wet bulk density[2] at 1 g/cm^3, percent solids, and assumed sediment depth of 0.04 m for shallow and mid depth categories and 0.1 m for the deep category.

$$P\ Fraction\ \frac{lbs\ P}{acre} = P\ Fraction\ \frac{mg\ P}{kg} * sediment\ depth\ m * \%\ solids * wet\ bulk\ density\ \frac{g}{cm^3} * 8.9198\ (converstion\ from\ \frac{mg\ P}{L}\ to\ \frac{lbs\ P}{acre}) \quad \textbf{(Eq. 1)}$$

The BAP fraction was then calculated by summing the labile, reductant soluble, metal-oxide and labile organic P fractions (Equation 2).

$$BAP\ Fraction\ \frac{lbs\ P}{acre} = Labile\ \frac{lbs\ P}{acre} + Reductant\ Soluble\ \frac{lbs\ P}{acre} + Metal\ Oxide\ \frac{lbs\ P}{acre} + Labile\ Organic\ \frac{lbs\ P}{acre} \quad \textbf{(Eq. 2)}$$

3 RESULTS AND DISCUSSION

P fractionation results at each sampling site were evaluated to address Question 1 (Figure 3, Table 3). The shallow sites (H-1, H-3, H-5, H-6, H-ES, and H-SS) exhibited the lowest total P concentrations (288 to 682 mg P/kg), mid sites (H-FD, H-ML, H-NL, H-SL, H-8) exhibited moderate total P concentrations (418 to 913 mg P/kg), and deep sites (H-4, H-BL, H-DP, H-2) exhibited the highest total P concentrations (1,127 to 1,205 mg P/kg). The majority of P in Lake Henshaw sediments is present as apatite-bound and residual P, and other organic P, which are P forms that are not readily released as BAP, with 75–86% of total sediment P in shallow water depth sediments and 61–77% of total sediment P in mid water depth sediments present as non-BAP forms (Figure 3). In contrast, in deep sediments, only 45–51% of total sediment P is present as non-BAP forms (Figure 3).

Data summarized by overlying water depth category and converted to lbs P/ac (Table 3) show that the deep sediments exhibit the highest BAP at 71.2 lbs P/ac, followed by the mid sediments at 26.6 lbs P/ac. The shallow depth sites exhibit the lowest BAP at 17.6 lbs P/ac. Together these total P and BAP results indicate that targeting lanthanum-modified clay treatment at the mid and deep sediments provides the best opportunity for reduction of internal P loading due to the relatively high concentration of BAP at these locations.

[2] Wet bulk density was not measured. As sediments from the mid-depth and deep locations exhibit high water content (e.g., > 90%), the wet bulk density estimate was assumed to be close to that of water under ambient conditions (i.e., 1 g/cm^3). A wet bulk density estimate of 1 g/cm^3 is greater than the SRTC-measured dry density for mid-depth and deep locations (Table 4), which is expected due to the relatively high water content of these samples. However, a wet bulk density estimate of 1 g/cm^3 is lower than the SRTC-measured dry density for shallow locations, which exhibited higher sand content and are more likely to have a wet bulk density slightly greater than 1 g/cm^3 (Table 4). Overall, the use of an estimated wet bulk density value of 1 g/cm^3 is likely to be conservative by resulting in slightly greater estimated mass of P per unit area sediment (Table 3).

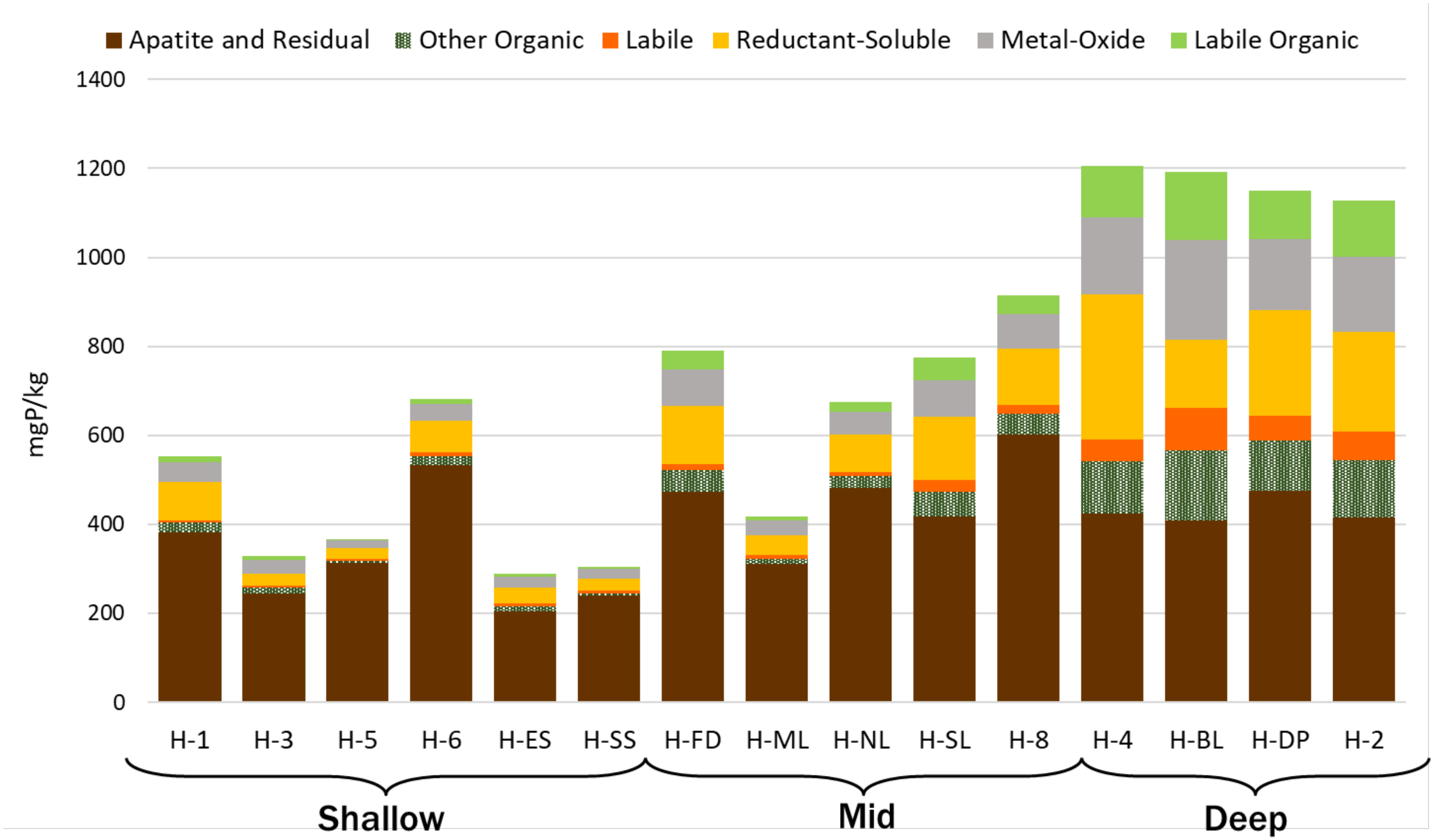

Figure 3. Lake Henshaw sediment P fractionation. Sample sites are grouped with shallow sites (H-1 through H-SS) on the left, mid depth sites (H-FD through H-8) in the middle and deep sites (H-4 through H-2) on the right. Apatite and residual P (dark brown) and other organic (dark green) are the non-BAP fractions. Labile P (orange), reductant-soluble P (yellow), metal-oxide P (gray) and labile organic P (lime green) combine to make up the BAP fraction.

Table 3. Lake Henshaw sediment P fractionation summarized by overlying water depth category.

Overlying Water Depth Category	Lake Elevation Range[1]	Labile (lbs/ac)	Reductant - Soluble (lbs/ac)	Metal-Oxide (lbs/ac)	Labile Organic (lbs/ac)	Other Organic (lbs/ac)	Apatite and Residual (lbs/ac)	Total (lbs/ac)	BAP[2] estimate (lbs/ac)
Shallow	2,655.1-2,670	1.10	8.97	5.98	1.52	2.47	63.80	83.84	17.57
Mid	2,650.1-2,655	1.86	12.87	7.86	3.98	4.49	55.32	86.38	26.57
Deep	2,643-2,650	7.73	27.48	21.25	14.76	15.16	50.46	136.83	71.21

[1] Estimated from approximate water depth and lake level at the time of sampling; based on 2018 bathymetry.
[2] See Equation 2.

To address Question 2, physical and OM properties of the sediments were assessed at each overlying water depth category (Table 4). Results indicate that shallow sediments, compared to the mid and deep sediment categories, exhibit the lowest porosity, highest bulk density, highest sand content, and lowest OM content. Mid sediments can be classified as silty clay (77% silt and 17% clay) with moderate OM content. The deep sediments also have a high porosity, the lowest bulk density, and the highest percent of total and labile OM (Table 4). Thus, the deep sediments followed by mid sediments possess physical properties most likely to support high effective diffusion rates for BAP and thus are targeted for treatment with lanthanum-modified clay.

Table 4. Physical and organic matter (OM) properties averaged by overlying water depth category.

Overlying Water Depth Category	Lake Elevation Range[1]	Avg. % Solids[2]	% Porosity[3]	Avg. Dry Bulk Density[3] (g/cm^3)	Avg. % Sand	Avg. % Silt	Avg. % Clay	Avg. % Labile OM	Avg. % Total OM	Labile to Total OM Ratio
Shallow	2,655.1-2,670	56%	50%	1.11	60%	36%	4%	1%	2%	0.38
Mid	2,650.1-2,655	34%	70%	0.77	6%	77%	17%	5%	12%	0.47
Deep	2,643-2,650	13%	70%	0.58	31%	42%	27%	11%	21%	0.49

[1] Estimated from approximate water depth and lake level at the time of sampling; based on 2018 bathymetry.
[2] Measured for each sample and reported as average value.
[3] Measured for one shallow and one mid-depth sample using dry sediment. Measured for four deep samples using dry sediment and reported as average value. Dry bulk density reported here but note that wet bulk density is required for Equation 1. See also footnote 2 on page 9.

Based on the aforementioned results, approximately 31,800 lbs of BAP are present in the surficial sediments of Lake Henshaw. Including an estimated 4,400 lbs of BAP in the springtime water column, the total BAP estimate is 36,200 lbs (Table 5).

While the *Lake Henshaw and Lake Wohlford Harmful Algal Blooms Management and Mitigation Plan* (Stillwater Sciences 2022) provided estimated costs for heavy and moderate doses of lanthanum-modified clay using the Phoslock™ formulation, further investigations determined that the product EutroSORB G, manufactured by SePro Corporation, would require lower doses of clay product to deliver the same amount of lanthanum. Using mass-based stoichiometry for the product EutroSORB G, approximately 1,810,000 lbs of lanthanum-modified clay would be needed to inactivate all sediment and spring water column BAP in 2023 (Table 5). Assuming $3.20 per lb of EutroSORB G, the estimated product cost would be approximately $5.8M, not including application costs.

From a permitting standpoint, 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 # CAG999003) does not set a limit on water column concentrations of lanthanum-modified clay, instead referencing a typical application rate of less than 150 mg/L. While in Lake Henshaw, at a surface area of 1,379 ac and approximately 14,580 ac-ft, a dose of 1,810,000 lbs of lanthanum-modified clay using the EutroSORB G product would correspond to only approximately 46 mg/L, this amount of product is far greater than what is physically practical to apply or affordable in one treatment. Further, not all the BAP in lake sediments is released in any one season or year, because the hypoxic and anoxic conditions that support BAP release from sediments into the overlying water column are not persistent in the lake at all locations at all times, and diffusion of BAP from deeper layers of the surficial sediments upward to the sediment-water interface is a slow process. Although we are unaware of published reports characterizing the fraction of sediment BAP typically released within lakes each year, SePro suggests that approximately 20% of sediment BAP is likely to be released on an annual basis (S. Shuler, SePro, Pers. Comm. to M. Singer, Stillwater Sciences, March 2023).

Thus, in general, undertaking multiple smaller treatments of lanthanum-modified clay each year and over several years is a more operationally feasible and financially viable approach to P sequestration. Multiple treatments also have the potential to better distribute lanthanum-modified clay at the sediment-water interface, because any given treatment may be somewhat uneven due to lake currents, mixing, and ongoing bioturbation and re-distribution by sediment-dwelling biota. The deep and mid depth areas exhibiting the highest BAP levels in sediments correspond to approximately 400 surface acres total within Lake Henshaw, or approximately one third of the total sediment surface acres in the lake at elevation 2,670 ft and 14,580 ac-ft (Figure 4).

Table 5. Total BAP for Lake Henshaw sediment and water column and estimates for lanthanum-modified clay product EutroSORB G needed to inactivate BAP.

Area (Lake Elevation Range[1])	Estimated BAP (lbs/ac)	Approximate Acres [2]	Estimated BAP (lbs)	EutroSORB G (lbs) [3]
Shallow (2,655.1-2,670 ft)	17.57	984	17,300	865,000
Mid (2,650.1-2,655 ft)	26.57	305	8,100	405,000
Deep (2,643–2,650 ft)	71.21	90	6,400	320,000
Total sediments	**-**	**1,379**	**31,800**	**1,590,000**
Springtime water column	[4]	**-**	4,400	220,000
Total sediments + water column	**-**	**-**	**36,200**	**1,810,000**

[1] Estimated from approximate water depth and lake level at the time of sampling; based on 2018 bathymetry.
[2] Acres are approximate values used by SePro in lanthanum-modified clay calculations.
[3] Assumes 50 lbs EutroSORB G to inactivate 1 lb BAP.
[4] Assumes 50 ug/L of orthophosphate and a total lake volume of 9,925 ac-ft during spring 2023.

Figure 4. Lake Henshaw treatment areas according to overlying water depth sediment categories, deep (dark blue), mid (blue) and shallow (light blue). Acres reported here are estimated based on lake bathymetry (2018) and assume lake elevation at 2,670 ft, storage at 14,580 ac-ft.

4 CONCLUSIONS AND RECOMMENDATIONS

While the majority of P in Lake Henshaw surficial sediments is present in mineral and organic forms that are not bioavailable, there are approximately 31,800 lbs of BAP that have the potential to be released to the overlying water column during hypoxic (DO < 2 mg/L) and/or anoxic (DO = 0 mg/L) conditions in summer and fall months. On average, sediments in the deepest portions of the lake exhibit roughly 3 times the amount of BAP (in lbs P/ac) relative to mid and shallow water depth sediments. Deep lake sediments also possess characteristics that support high effective diffusion rates for BAP from sediment pore waters into the overlying water column (i.e., high porosity, low bulk density, high percent of total and labile OM), increasing the potential for internal loading of P in deeper portions of the reservoir. Sediments at mid water depths, while possessing BAP levels only moderately higher than sediments at shallow water depths, exhibit high porosity and moderate bulk density/percent of total and labile OM, indicating that these sediments also have potential to support moderate to high internal loading of BAP.

Based on the above results, we offer the following recommendations related to lanthanum-modified clay treatments in Lake Henshaw in both the near and long term:

- While all surficial sediments in Lake Henshaw have the potential to release BAP and support HAB formation, initial lanthanum-modified clay treatments should target sediments in deep and mid overlying water depth areas because these areas possess the largest BAP amounts and are likely to exhibit the highest effective diffusion rates. These areas correspond to approximately 400 surface acres total within Lake Henshaw.

- Multiple lanthanum-modified clay treatments each year and over several years are recommended for operational and financial reasons, with heavier applications at 20% to 50% of mid and deep sediment total estimated BAP (i.e., 145,000 to 362,750 lbs EutroSORB G per year across the deepest 400 surface acres of the lake). Treatments less than 145,000 lbs EutroSORB G may also be successful in smaller areas of the lake and/or for stripping orthophosphate from the water column during periods when bottom water DO is > 2 mg/L.

- Multiple lanthanum-modified clay treatments each year and over several years are recommended to increase the efficacy of P-binding and reduce P-breakthrough from uneven distribution of clay material on sediments due to lake currents, mixing, and ongoing bioturbation and re-distribution by sediment-dwelling biota.

- Periodic (once every one or two years) analysis of P fractions in Lake Henshaw surficial sediments following EutroSORB G treatments (or series of treatments) is recommended to demonstrate whether and how BAP fractions change over time in response to treatments. Wet bulk density should be measured in future sediment samples. Periodic sediment sampling events should be undertaken at the same time of year to develop a long-term record; however, the interpretation of data from periodic sampling should include an assessment of external P inputs (e.g., from Warner Ranch Wellfield and/or storm events) to best understand trends.

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Appendix B

Warner Ranch Wellfield EutroSORB WC™ Jar Testing to Inform Source Water Nutrient Control as a Management Strategy for Harmful Algal Blooms in Lake Henshaw

Stillwater Sciences
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TECHNICAL MEMORANDUM

DATE:	October 27, 2023
TO:	Don Smith, Vista Irrigation District
FROM:	Maia Singer, Karin Emanuelson, Stillwater Sciences
SUBJECT:	Warner Ranch Wellfield EutroSORB WC™ Jar Testing to Inform Source Water Nutrient Control as a Management Strategy for Harmful Algal Blooms in Lake Henshaw

1 INTRODUCTION

In spring 2023, the Vista Irrigation District (District) conducted a study to investigate options for treating Warner Ranch Wellfield input to Lake Henshaw to bind and inactivate phosphorus (P) in flowing water coming from the wellfield before it enters the lake. There are two inputs from the Warner Ranch Wellfield into Lake Henshaw; the wellfield terminus (also referred to as the "end of ditch" [EOD]) flowing from the Warner Ranch and an outflow point associated with the 70's Wells (Figure 1). When the wellfield is pumping, wellfield terminus water flows through an unlined ditch to the West Fork San Luis Rey River and into Lake Henshaw. Pumped water from the 70's Wells flows through an unlined ditch and into Lake Henshaw (Figure 1).

This source water treatment investigation was conducted as part of Phase II of the Lake Henshaw and Lake Wohlford Harmful Algal Blooms (HABs) Management and Mitigation Project. Phase I involved development of the *Lake Henshaw and Lake Wohlford Harmful Algal Blooms Management and Mitigation Plan* (Stillwater Sciences 2022), which included a long-term recommendation to prevent HABs by chemically removing P in the form of orthophosphate (PO_4^{3-}) from the Warner Ranch Wellfield inflows to Lake Henshaw to reduce external loading of this nutrient to the lake. While there are limited historical data characterizing P in Warner Ranch Wellfield inputs, the District collected 18 samples at the wellfield terminus in 2022, which exhibited an average of 0.07±0.01 mg/L total phosphorus (TP) and 0.06±0.01 mg/L orthophosphate. During dry months, when the wellfield is pumping, the mean monthly wellfield production is fairly steady at 12–14 cfs. Based on the recently collected phosphorus concentration data and mean monthly wellfield production, the wellfield source water contributes an average of 70 kg P/month or 150 lb P/month to Lake Henshaw, primarily in the form of orthophosphate, which is readily available to cyanobacteria that grow in the lake. Although internal loading is currently understood to be a much larger source of P fueling cyanobacteria blooms in Lake Henshaw, the long-term success of the District's ongoing HABs management efforts depends upon reducing or eliminating external sources of P to the lake as well.

Source water nutrient control focused on the Warner Ranch Wellfield inputs would occur through application of a chemical (EutroSORB WC™ or similar) that the manufacturer indicates binds rapidly and permanently with orthophosphate in flowing water coming from the wellfield. The product manufacturer states that EutroSORB WC™ is a proprietary blend of aqueous phosphate binding elements that are naturally occurring and relatively common in terrestrial soils and aquatic sediments. These water-soluble components remove phosphate from the water column by binding the phosphate to form a water-insoluble salt, which then settles to the sediment, and eventually undergoes burial in the sediment (Habig et al. 2023). Application equipment would be installed at or near the wellfield terminus to treat pumped groundwater as it leaves the ditch system and moves towards the lake. Application equipment location would need to be vehicle-accessible to allow regular chemical delivery and include a level site for installation of one or more chemical storage totes. Chemical dosing depends on the characteristics of the water to be treated, the desired orthophosphate removal rate, and the removal efficiency of the chemical, in this case EuroSORB WC™, added to wellfield water.

The following questions were addressed during this study to refine source water nutrient control dosing and cost estimates provided in the *Lake Henshaw and Lake Wohlford Harmful Algal Blooms Management and Mitigation Plan* (Stillwater Sciences 2022):

1. What are the chemical properties of the Warner Ranch Wellfield water?
2. What is the removal efficiency of EuroSORB WC™ at 50% and 75% removal of orthophosphate in the Warner Ranch Wellfield water?

2 METHODS

2.1 Sample collection and laboratory analysis

On March 6, 2023, the District re-occupied the wellfield terminus sampling site (Figure 1). Since the majority of source water production from the Warner Ranch Wellfield flows through the wellfield terminus, study samples focused on this location. The District collected 4 liters of water at the wellfield terminus and shipped the sample bottles overnight to the SePRO Research & Technology Campus (SRTC; Whitakers, NC) where they were refrigerated until laboratory jar analyses could be completed.

Figure 1. Wellfield sampling sites (blue symbols).

SRTC measured alkalinity and hardness of the wellfield terminus sample using commercially available test strips (Table 1) and undertook jar testing according to the following procedure:

- Approximately 1 L of the original sample water was homogenized for analysis of orthophosphate concentration (Table 1).
- The homogenized sample was split into three subsamples to achieve different starting orthophosphate concentrations for the tests. Two containers were spiked with potassium phosphate (KPO_4) to achieve orthophosphate concentrations of 72 µg/L and 90 µg/L, respectively. One container was diluted with tap water to achieve an orthophosphate concentration of 51 µg/L.
- The subsamples with known orthophosphate starting concentrations were further split to test two dosing levels for the chemical binding agent, EutroSORB WC™. Dose 1 targeted a 50% orthophosphate removal under ideal conditions and Dose 2 targeted a 75% orthophosphate removal under ideal conditions.
- All orthophosphate removal tests were run in triplicate for each starting orthophosphate concentration and percent removal target.
- Subsamples dosed with EutroSORB WC™ were placed on an orbital shaker for 3 hours to allow for orthophosphate binding. Afterward the samples were filtered through a 0.45 micron (um) filter and analyzed for orthophosphate concentrations (Table 1).
- Some of the treated water was saved and used to test orthophosphate removal efficiency at an orthophosphate starting concentration of 33 µg/L, following the same orbital shaker and filtration steps detailed above. Diluting the original wellfield sample with tap water to obtain a relatively low orthophosphate concentration would have significantly changed the water chemistry of the sample and affected jar testing results.

Table 1. Analytical methods, method detection limits, and units.

Constituent	Method	MDL	Units
Alkalinity	Varify Pool and Spa Test Strip	40	mg/L as CaCO3
Hardness	JNW Direct Water Hardness Test Strip	25	mg/L as CaCO3
pH	SM 4500-H	0.1	s.u.
Orthophosphate	EPA Method 365.3	3.65 (limit of detection)	ug/L

SM = Standard Methods
EPA = US Environmental Protection Agency
MDL = method detection limit
mg/L = milligram per liter
ug/L = microgram per liter
s.u. = standard unit of pH

3 RESULTS AND DISCUSSION

Warner Ranch Wellfield water exhibited hardness greater than 250 mg/L as $CaCO_3$, alkalinity ranging 150-200 mg/L, and pH greater than 8 s.u. The orthophosphate concentration in the original sample water was 63 µg/L (see Section 2 for discussion of SRTC adjustments to this concentration for jar testing).

EutroSORB WC™ orthophosphate removal (i.e., binding) efficiency is influenced by general water chemistry (i.e., hardness, alkalinity, pH, turbidity, humic and fulvic acids, suspended organics, suspended particulate matter), starting orthophosphate concentration, and dosing ratio. As Warner Ranch Wellfield groundwater is naturally low in turbidity and dissolved and particulate organic matter, only hardness, alkalinity, and pH would be expected to influence phosphorus-binding performance. Jar testing results show that removal efficiencies increased with higher orthophosphate starting concentrations (Table 1, Figure 2). Dose 1 and Dose 2 targeting 50% and 75% removal respectively, provided partial orthophosphate removal, ranging 27–56%. The lower-than-targeted removal efficiencies were likely caused by the high alkalinity and high pH of the Warner Ranch Wellfield sample water. Increased concentrations of OH^- and CO_3^{2-} may compete for binding sites with the EutroSORB WC™ active ingredients, thereby reducing orthophosphate binding efficiency in solution. Binding of EutroSORB WC™ active ingredients to orthophosphate is favored over longer time periods than tested.

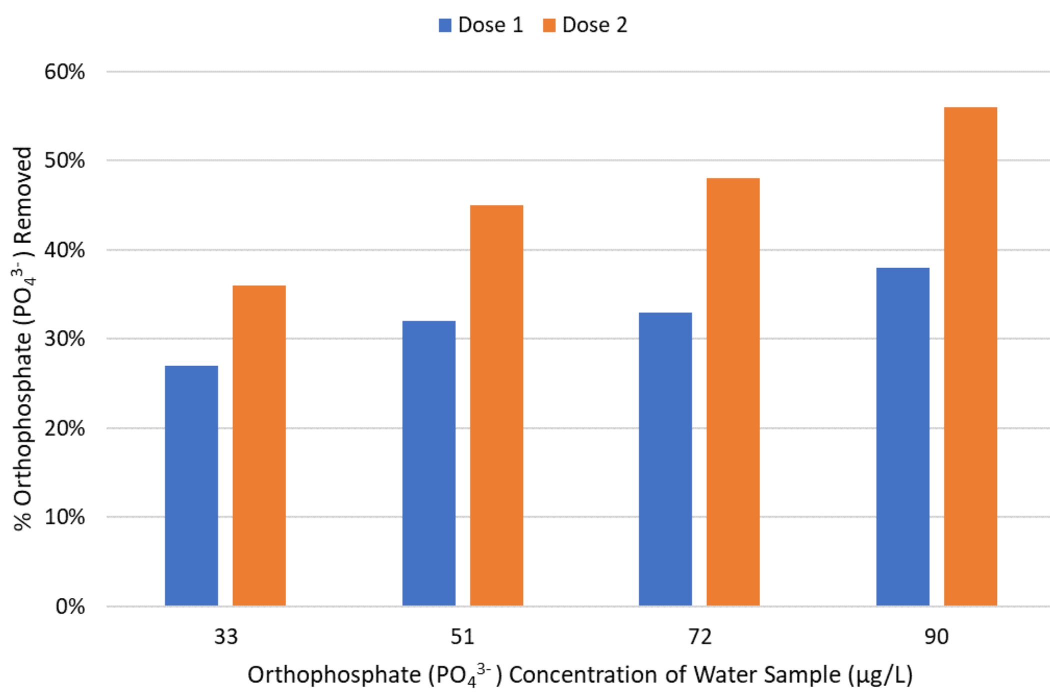

Figure 2. Jar testing orthophosphate (PO_4^{3-}) removal efficiency. Dose 1 (shown in blue) targeted a 50% removal under ideal conditions and Dose 2 (shown in orange) targeted a 75% removal under ideal conditions.

SePRO reports binding ratios as the number of prescriptive dose units (PDU) of EutroSORB WC™ per pounds phosphorus (lb-P) removed, where a higher binding ratio indicates that more chemical is needed to bind a pound of phosphorus, resulting in a lower cost efficiency of the chemical. Laboratory jar testing results indicated that binding ratios decreased in water with higher starting concentrations of orthophosphate (Table 1).

Table 2. Laboratory jar testing results for Warner Ranch Wellfield terminus sample.

Dosing Group	Starting Orthophosphate Concentration (PO_4^{3-}) [ug/L]	Applied Dosing Ratio [PDU/lb-P]	Resulting Binding Ratio [PDU/lb-P]	Orthophosphate (PO_4^{3-}) Removal [%]
1	33	4.4	16.6	27%
	51	4.7	14.8	32%
	72	4.6	14	33%
	90	4.8	12.5	38%
2	33	6.6	18.4	36%
	51	7.1	15.7	45%
	72	6.9	14.4	48%
	90	7.2	12.9	56%

Expected binding ratios for targeted orthophosphate removal (%) were extrapolated from the data for the two orthophosphate concentrations (51 and 72 µg/L) closest to the wellfield terminus sample water concentration of 63 µg/L (Figure 2). Using the extrapolation binding ratios for the 72 µg/L starting concentration, binding ratios for 50% and 75% targeted orthophosphate removal (75 lb P/month and 112 lb P/month respectively) were determined to be 14.5 PDU/lb-P and 15.1 PDU/lb-P.

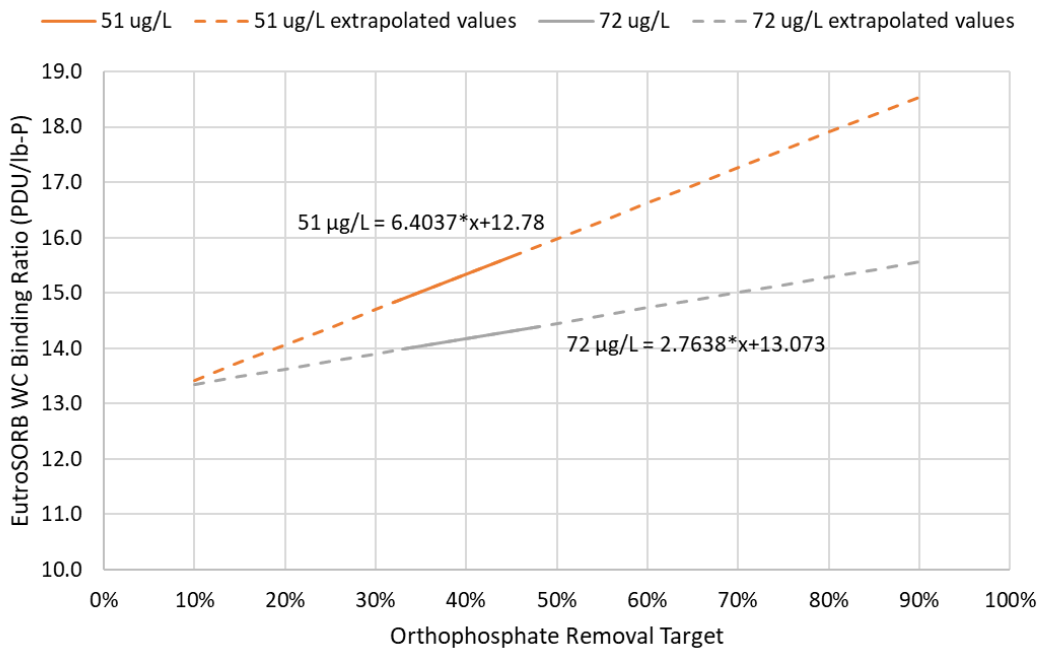

Figure 3. EutroSORB WC™ expected binding ratios for 51 µg/L (shown in orange) and 72 µg/L (shown in gray). Jar laboratory testing measured 30–50% removal (shown with solid line). Data outside of that range have been extrapolated (shown with dashed line) according to the trendline equation shown.

4 CONCLUSIONS AND RECOMMENDATIONS

Source water from the Warner Ranch Wellfield contributes an average of 150 lbs P/month to Lake Henshaw when the wellfield is pumping. The highest expected binding ratio for EutroSORB WC™ in wellfield water assuming approximately 70 µg/L as the starting orthophosphate concentration is 15:1 PDU/lb-P, which is anticipated to achieve 75% removal of orthophosphate at approximately $30K per month in chemical costs when the wellfield is pumping (Table 2). Estimated phosphorus removal, costs, and EutroSORB WC™ amounts needed for 50% removal are also presented in Table 2. If the wellfield was running all year, the material costs for EutroSORB WC™ are estimated to range $236,000–$353,000 per year. Additionally, an onsite injection system will need to be installed at an estimated one-time cost of $30,000–$50,000/unit, including injection pump, power, and pad and containment for tote. The higher end of the injection system cost range would include telemetry.

Table 3. EutroSORB WC™ dosage per month for corresponding targeted orthophosphate (PO_4^{3-}) removal.

Target PO_4^{3-} Removal (%)	P removal (kg P/month)	P removal (lb-P/month)	Binding Ratio (PDU/lb-P)	EutroSORB WC ™ (PDU/month)	EutroSORB WC ™ (gal/month)*	Unit Cost ($/lb-P removed)	Total Cost ($/month)	EutroSORB WC ™ (totes/month)
50	35	75	14.5	1087.5	135.9	$262.50	$19,687.50	1/2
75	56	112	15.1	1691.2	211.4	$262.50	$29,400.00	3/4

* 8 PDU is equal to 1 gallon of EutroSORB WC™

The San Diego Regional Water Quality Control Board (Regional Board) recently indicated that applications to Warner Wellfield to control orthophosphate loading to Lake Henshaw could be covered under the District's domestic water supply permit. The District is currently exploring whether EutroSORB WC™ in particular could potentially be considered an allowable additive under the permit. Based on the jar testing results described above, implementation of an operational trial for treatment of the wellfield terminus using approximately 50 gallons of EutroSORB WC™ may help elucidate whether binding efficiency would be any higher at scale (versus jar test results) and whether insoluble particles of the EutroSORB WC™ active ingredients bound to orthophosphate are likely to settle out in the unlined channel and/or San Luis Rey River downstream of the wellfield terminus or largely remain in suspension until the water reaches Lake Henshaw. Prior to any trial, we recommend that the District assess baseline conditions in the unlined channels downstream of the wellfield terminus and the 70's Wells, including *in situ* water quality (e.g., water temperature, conductivity, dissolved oxygen, pH), as well as hardness, alkalinity, orthophosphate, and potentially other constituents consistent with the District's existing water supply permit. During and following the operational trial, the District would re-assess water quality at representative sites to determine the efficacy of EutroSORB WC™ at binding orthophosphate prior to entry of pumped wellfield water into Lake Henshaw and potential effects on bioindicators. If an operational trial is successful, then the District could move forward with full implementation of a chemical application system to treat Lake Henshaw source water when wellfield pumping is occurring.

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Appendix C

Calculations for Estimating Water Column Oxygen Demand in Lake Henshaw

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DRAFT TECHNICAL MEMORANDUM

DATE:	November 26, 2023
TO:	Don Smith and Lesley Dobalian, Vista Irrigation District
FROM:	Maia Singer and Peter Baker, Stillwater Sciences
SUBJECT:	Calculations for Estimating Water Column Oxygen Demand in Lake Henshaw

1 INTRODUCTION

In 2022, as part of Phase I of the Lake Henshaw and Lake Wohlford Harmful Algal Blooms (HABs) Management and Mitigation Project (Project), the Vista Irrigation District (District) monitored *in situ* water quality parameters along vertical profiles at five sites in Lake Henshaw before, during, and after March, May, and August algaecide treatments. In 2023, consistent with the *Water Quality Monitoring Plan* included in the *Lake Henshaw and Lake Wohlford Harmful Algal Blooms Management and Mitigation Plan* (Stillwater Sciences 2022a), the District began routine (i.e., weekly) monitoring of *in situ* parameters at multiple locations to better characterize lake conditions, and they continued monitoring these parameters (i.e., water temperature, dissolved oxygen (DO), pH, phycocyanin) as part of an ongoing algaecide effectiveness assessment.

Phase II of the Project includes development of a work plan that outlines the requirements for a temporary lake oxygenation field trial for Lake Henshaw. As discussed in the *Lake Henshaw and Lake Wohlford Harmful Algal Blooms Management and Mitigation Plan* (Stillwater Sciences 2022a), lake oxygenation has the potential to prevent HAB events by controlling the oxidation-reduction potential in the water and bottom sediments and the associated release of orthophosphate and ammonium, but also dissolved manganese, dissolved iron, sulfate, and if present, methylmercury, from the reservoir sediments during hypoxic (DO < 2 mg/L) and anoxic (DO = 0 mg/L) conditions. Limiting release of nitrogen and phosphorus reduces the potential for HABs because these nutrients are required for algae and cyanobacteria growth.

To successfully maintain DO levels above 5 mg/L in lake bottom waters, oxygen added to Lake Henshaw must meet the lake oxygen demand, which varies based on season, temperature, water depth, natural organic matter, ecology, and time of day. The lake's oxygen demand can be separated into *water column oxygen demand* (WCOD) from the organic material and biota (e.g., bacteria, phytoplankton) living within the water column, and *sediment oxygen demand* (SOD) from the organic material and biota (e.g., bacteria, benthic algae and/or cyanobacteria) living in the lake sediments. SOD rates used for the Lake Henshaw field trial work plan are based on laboratory SOD chamber studies conducted by the University of California at Merced (UC Merced) as part of Phase II of the Project (Beutel 2023).

WCOD can be estimated by comparing DO concentrations at a given water column depth over periods where respiration is the dominant mechanism for DO change. Respiring organisms remove DO from waters below the photic zone[1] during daytime and nighttime hours and from all depths during nighttime hours. During daytime hours, photosynthesizing organisms add DO to waters within the photic zone such that the net DO signal includes both WCOD and photosynthetic production of DO. While DO diffuses from the atmosphere across the air-water interface of a lake to maintain equilibrium conditions, and thus DO is constantly being added to surface waters, the rate of oxygen diffusion is orders of magnitude slower than rates of photosynthesis and respiration in a productive lake such as Henshaw. Thus, DO diffusion is not considered further for WCOD estimates in Lake Henshaw.

2 METHODS

The District measured *in situ* DO vertical profiles at two routine monitoring sites (H-FD, H-BL) and three additional open water sites (H-NL, H-ML, H-SL; Table 1) before, during, and after algaecide treatments on March 14–15, May 16–19, and August 17–18, 2022. DO measurements were taken in the morning (between approximately 8:00 am and noon) and the afternoon (between approximately 12:00 pm and 2:00 pm) at 1-foot depth intervals using a calibrated YSI DSS Pro multiprobe. Additional details regarding Lake Henshaw *in situ* measurements associated with the 2022 algaecide treatments are provided in Stillwater Sciences (2022b,c,d).

Since 24-hour (diurnal) DO measurements are not available for Lake Henshaw, we used the difference between paired afternoon and morning DO concentrations at a given monitoring site and depth to provide a rough estimate of WCOD, based on the assumption that during nighttime hours respiration (which decreases DO concentrations) should dominate over photosynthesis (which increases DO concentrations). For comparison, the difference between paired morning and afternoon DO concentrations was also calculated to provide a rough estimate of net daytime DO production plus respiration. Given the timing of the DO measurements relative to the algaecide treatments, all WCOD estimates occurred during or after algaecide application, while daytime DO production plus respiration estimates on one date (i.e., March 14) represent conditions independent of algaecide application.

Although *in situ* DO vertical profiles were also collected at the monitoring sites in Table 1 before, during, and after nine algaecide treatments in 2023, generally only morning measurements were taken, such that DO change between afternoon and morning hours could not be estimated for the 2023 monitoring dates.

Table 1. Lake Henshaw water quality monitoring sites for routine and algaecide effectiveness monitoring associated with the March, May, and August 2022 treatment events.

Site ID	Location	Latitude	Longitude
H-BL	Buoy line at dam in bottom waters	33.23963°N	116.76174°W
H-FD	Southwestern shoreline at the in-water end of the fishing dock in surface waters	33.23544°N	116.75568°W
H-NL	Northern portion of lake in surface waters	33.24600°N	116.75300°W
H-ML	Mid-lake in surface waters	33.23890°N	116.75275°W
H-SL	Southern portion of lake in surface waters	33.23000°N	116.74400°W

[1] The upper layer of a waterbody that receives sunlight, allowing phytoplankton and aquatic macrophytes to photosynthesize.

Figure 1. Lake Henshaw water quality monitoring sites for algaecide effectiveness monitoring associated with the August 2022 treatment event.

3 RESULTS

Across all monitoring dates, 2022 DO readings were variable ranging 4–13 mg/L (40 to 135% saturation) in March, 0.3–10.9 mg/L (3–125% saturation) in May, and 1.5–13.7 mg/L (11–170% saturation) in August. The highest values were measured in surface waters, while the lowest values were measured in bottom waters, particularly at the deepest sites H-BL and H-FD and following algaecide treatment (Figure 2).

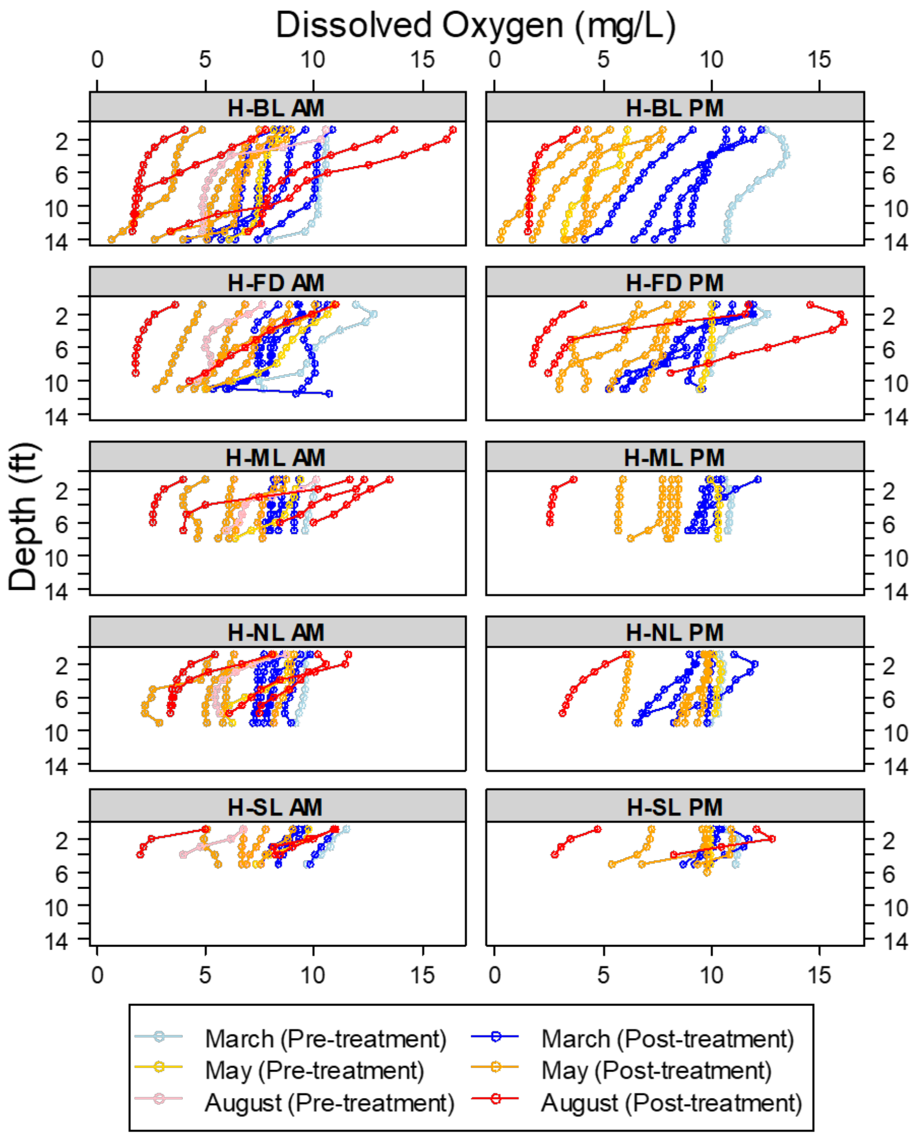

Figure 2. Lake Henshaw dissolved oxygen (milligrams per liter [mg/l]) during algaecide effectiveness monitoring associated with the March, May, and August 2022 treatment events.

The 2022 data exhibited widely varying estimated WCOD from -8 milligrams per liter per day (mg/L/d) at Site H-NL (9-foot depth, May 23) to +3.5 mg/L/d at Site H-BL (13-foot depth, May 16; Figure 3 through Figure 7). Multiple positive WCOD values were calculated despite all WCOD estimates occurring during or after algaecide treatment when oxygen demand of senescing (dying) phytoplankton is expected to be high (i.e., a large negative number). This result suggests that the net WCOD signal due to senescing (dying) phytoplankton was in several cases overcome by oxygen production due to photosynthesis earlier in the day, although in general the WCOD estimates are likely affected by horizontal and vertical water column mixing between measurement periods, such that the paired samples are not likely to represent the same parcel of water.

In contrast, the range in estimates of daytime DO production plus respiration was even larger, from -16 mg/L/d at Site H-BL (4-foot depth, May 23) to +27 mg/L/d at Site H-NL (8-foot depth, May 23; Figure 3 through Figure 7). Daytime DO production plus respiration estimates on the one date (March 14) representing conditions independent of algaecide application were not systematically higher than estimates on the other dates, suggesting that the oxygen demand due to senescing (dying) phytoplankton from algaecide application was not overcome by oxygen production due to photosynthesis on this day. However, as noted above, in general the daytime DO production plus respiration estimates also are likely affected by horizontal and vertical water column mixing between measurement periods.

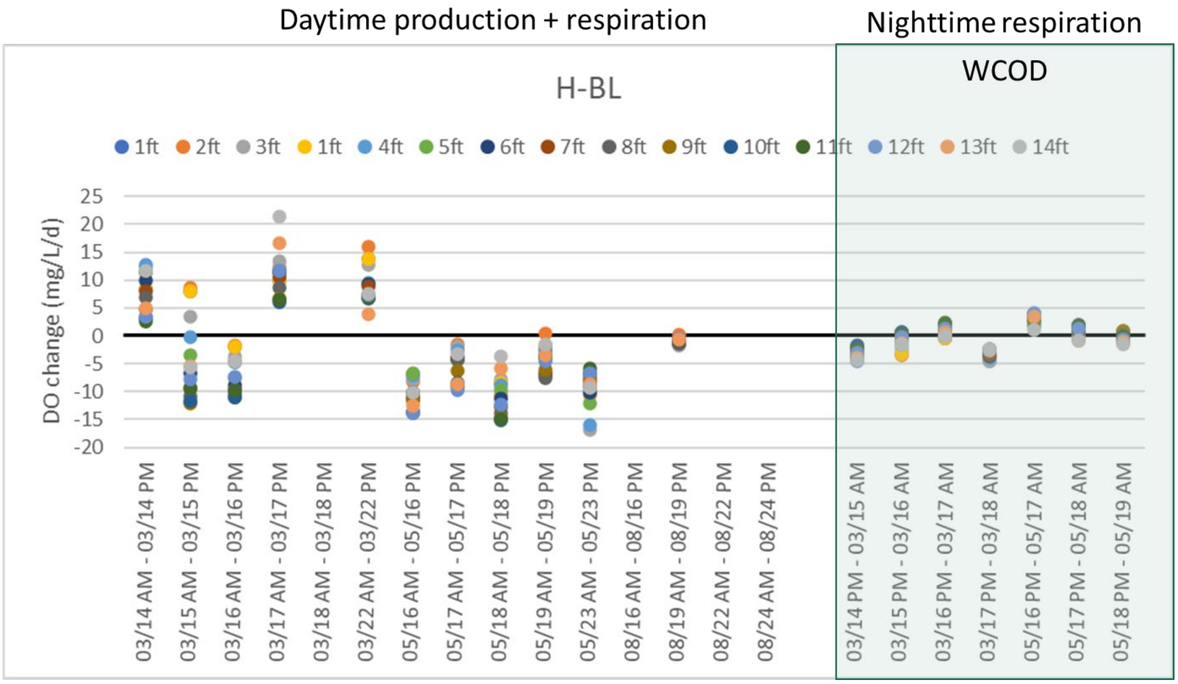

Figure 3. Lake Henshaw net change in dissolved oxygen (DO; milligrams per liter per day [mg/L/d]) at Site H-BL before, during, and after algaecide treatments March 14–15, May 16–19, and August 17–18, 2022.

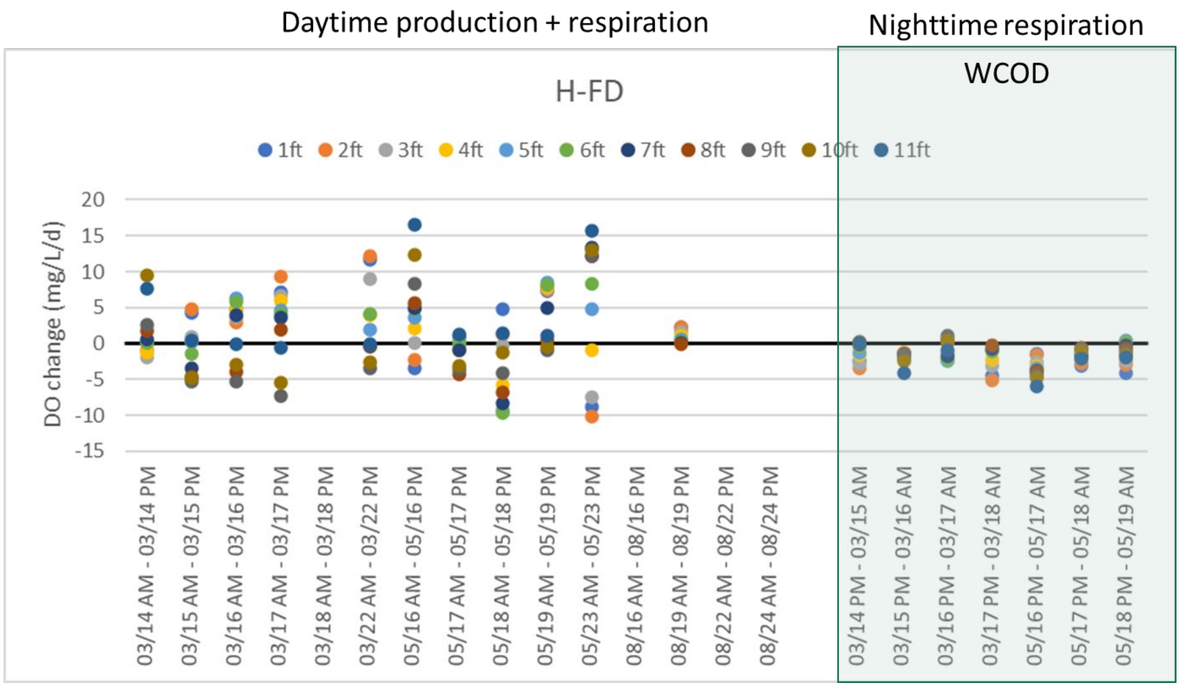

Figure 4. Lake Henshaw net change in dissolved oxygen (DO; milligrams per liter per day [mg/L/d]) at Site H-FD before, during, and after algaecide treatments March 14–15, May 16–19, and August 17–18, 2022.

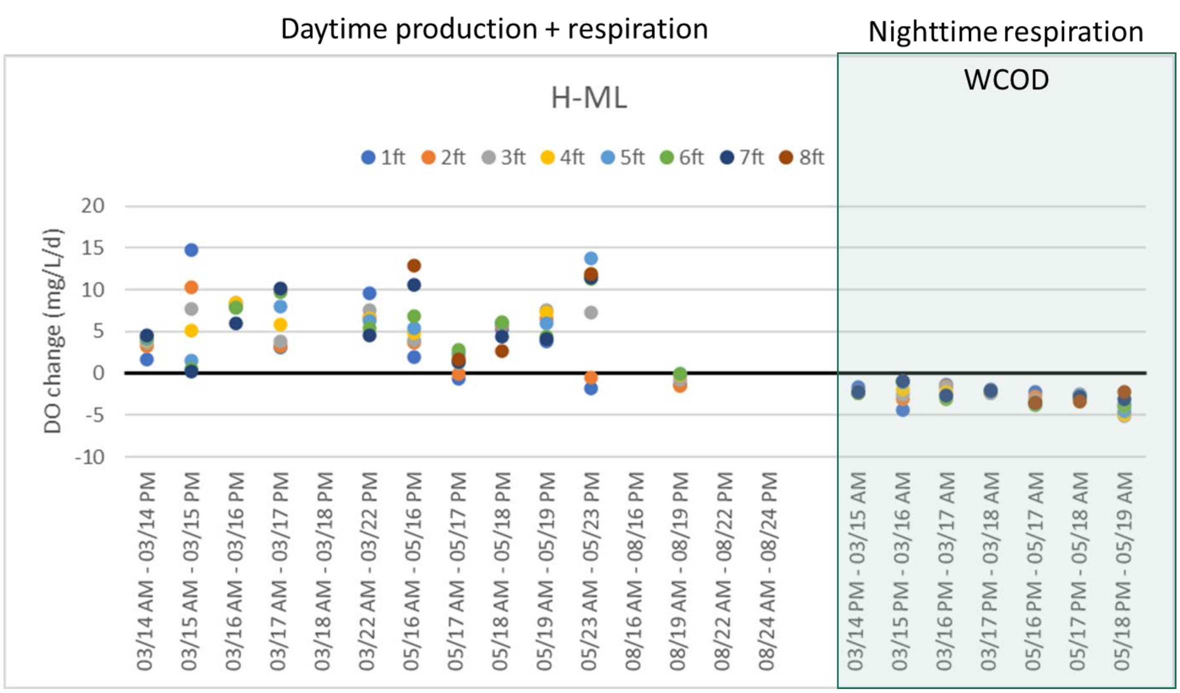

Figure 5. Lake Henshaw net change in dissolved oxygen (DO; milligrams per liter per day [mg/L/d]) at Site H-ML before, during, and after algaecide treatments March 14–15, May 16–19, and August 17–18, 2022.

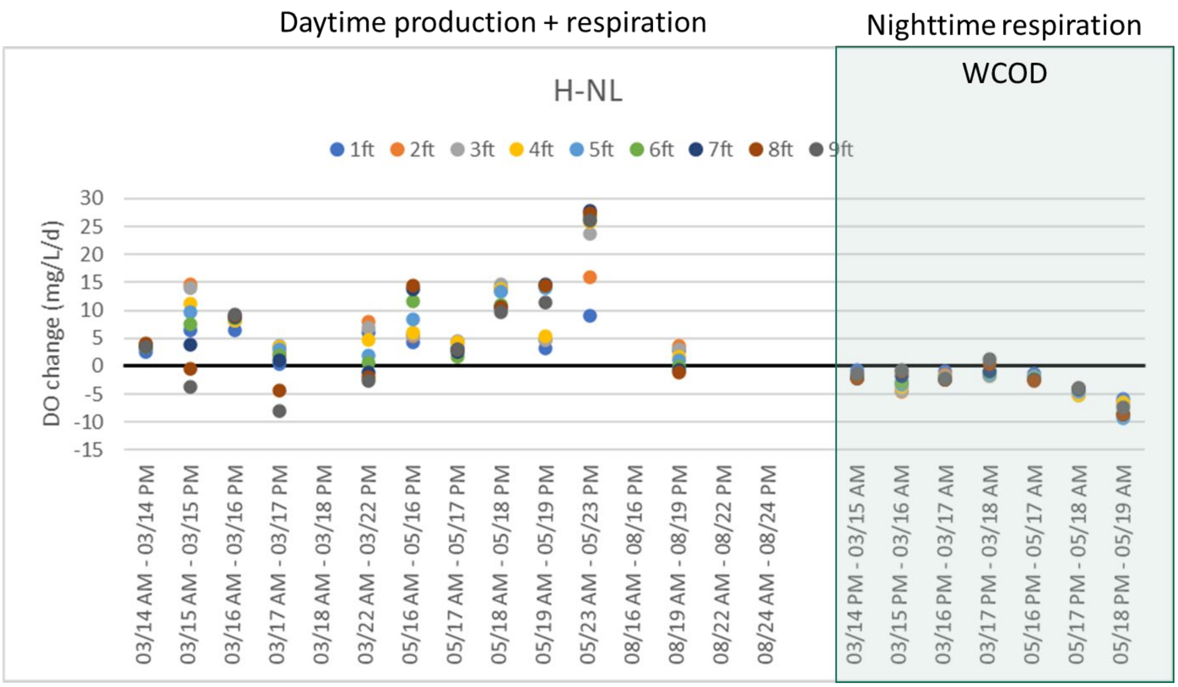

Figure 6. Lake Henshaw net change in dissolved oxygen (DO; milligrams per liter per day [mg/L/d]) at Site H-NL before, during, and after algaecide treatments March 14–15, May 16–19, and August 17–18, 2022.

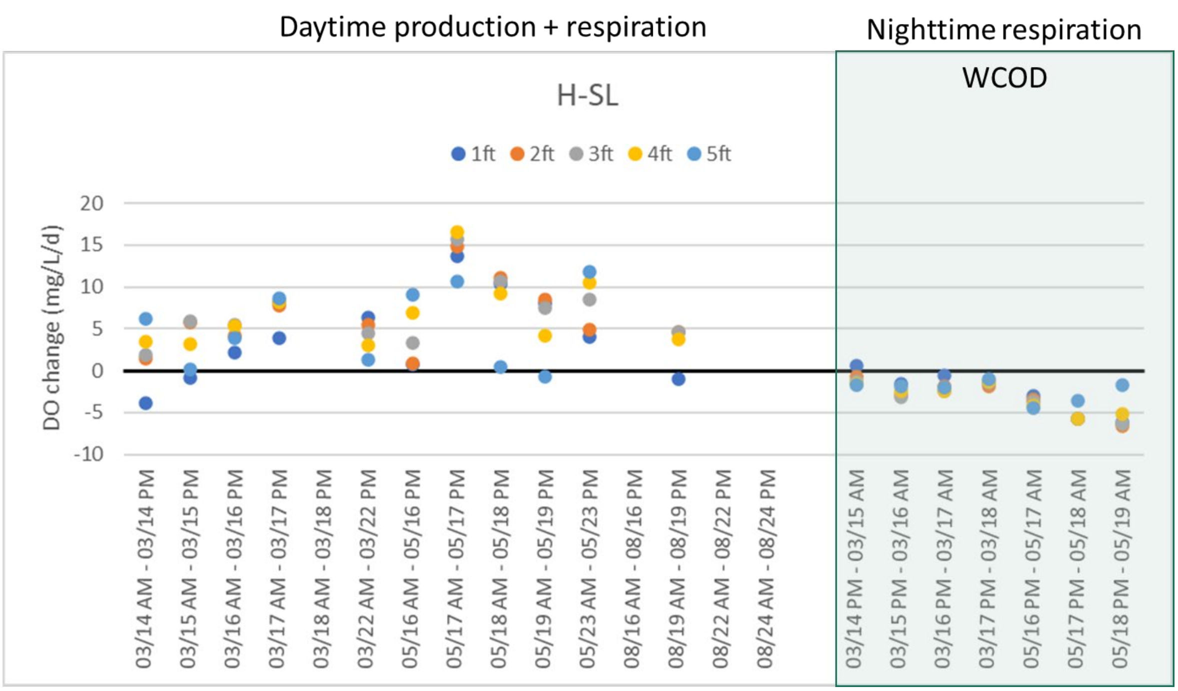

Figure 7. Lake Henshaw net change in dissolved oxygen (DO; milligrams per liter per day [mg/L/d]) at Site H-SL before, during, and after algaecide treatments March 14–15, May 16–19, and August 17–18, 2022.

4 CONCLUSIONS

Overall, given the high variability across sites and water depths, the rough estimates of WCOD calculated using 2022 *in situ* vertical profiles are insufficient for sizing the Lake Henshaw field trial oxygenation system. Consistent with the *Water Quality Monitoring Plan* included in the *Lake Henshaw and Lake Wohlford Harmful Algal Blooms Management and Mitigation Plan* (Stillwater Sciences 2022a), the use of simultaneously deployed sondes and/or DO loggers to collect continuous data (i.e., every 15 minutes) for a minimum of a 48-hour monitoring period at multiple sites is recommended. For mid- and deep-water sites, one logging instrument should be placed in the surface waters and one should be placed in bottom waters to elucidate WCOD differences by location in the water column. Application of literature-based WCOD values may also be used to support design specifications for the Lake Henshaw field trial oxygenation system.

5 REFERENCES

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Stillwater Sciences. 2022b. Assessment of March 2022 Algaecide Treatment Effectiveness for Lake Henshaw. Prepared by Stillwater Sciences, Berkeley, California for Vista Irrigation District, Vista, California.

Stillwater Sciences. 2022c. Assessment of May 2022 Algaecide Treatment Effectiveness for Lake Henshaw. Prepared by Stillwater Sciences, Berkeley, California for Vista Irrigation District, Vista, California.

Stillwater Sciences. 2022d. Assessment of August 2022 Algaecide Treatment Effectiveness for Lake Henshaw. Prepared by Stillwater Sciences, Berkeley, California for Vista Irrigation District, Vista, California.

Appendix D

Lake Henshaw Sediment Oxygen Demand Study

Lake Henshaw Sediment Oxygen Demand Study -

Dr. Marc Beutel

Draft May 25, 2023
Revised Draft June 29, 2023
Final August 11, 2023

1. Summary

Under the guidance of Stillwater Sciences and with field support from Vista Irrigation District, in March and April of 2023 I implemented experimental laboratory sediment-water incubations to assess sediment oxygen demand (SOD) in Lake Henshaw. This data will inform the sizing of a potential pilot oxygenation system for the reservoir. I measured SOD in experimental chambers with sediment collected from six sampling stations in the reservoir representing deep, moderately deep and moderately shallow regions of the reservoir. SOD experiments were conducted in the dark at 21-22 ^oC. The incubations assessed SOD under three mixing regimes: quiescent conditions (no mix), low water velocity (low mix), and high water velocity (high mix). In a few chambers elevated gas production in sediment led to sediment resuspension, thus negating the SOD testing results in the affected chambers.

I calculated $SOD_{>5}$ in $g/m^2{\cdot}d$ for all viable incubations based on the slope of the linear regression of dissolved oxygen (DO) concentration in chamber water versus time when DO concentration was above 5 mg/L. $SOD_{>5}$ values ranged from 0.5 to 3.0 $g/m^2{\cdot}d$. The lowest SOD values were measured in chambers from shallow stations with lower organic content, while the highest SOD values were measured in chambers from deep stations with higher organic content. Overall mean $SOD_{>5}$ values for all sites were 1.01, 1.50 and 1.85 $g/m^2{\cdot}d$ for no mix, low mix and high mix conditions, respectively. These SOD values were similar to values measured in analogous shallow, eutrophic to hypereutrophic waterbodies in Southern California including Lake Hodges and Lake Elsinore.

As expected, SOD increased with increasing DO in overlying water and increasing water temperature. An increase in DO in overlaying water from 2 mg/L to 8 mg/L led to an approximate doubling of SOD. Based on experimental data, SOD in Lake Henshaw had a "theta" value of 1.048, which is equivalent to a 1.6-fold increase in SOD with a 10 ^oC increase in water temperature.

The SOD assumption of 2 $g/m^2{\cdot}d$ used by the team for preliminary oxygenation calculations (Stillwater Sciences 2022) appears on target. Based on results of the sediment incubations, the project team can use metrics presented in this report to further refine SOD estimates in Lake Henshaw for hypolimnetic oxygenation system sizing, including the effects of water currents, water temperature, and overlaying DO conditions on SOD.

2. Background on Sediment Oxygen Demand

SOD is an important oxygen sink in aquatic ecosystems and is driven by the decay and biodegradation of organic matter (e.g., dead algae) that settles to the sediment-water interface. Based on my applied research, SOD in lakes and reservoirs typically ranges from around 0.1 to 2 $g/m^2 \cdot d$ and is dependent on the trophic status of the water body. Other key parameters that effect SOD include water temperature, which tends to speed up biological and chemical reactions that consume DO, and water depth, with deeper systems exhibiting lower SOD since settling organic matter has more time to undergo degradation in the water column.

In the context of my SOD experimental incubations, I evaluate two key parameters in water overlaying sediment that affect SOD: mixing and DO concentration. Elevated mixing and DO concentration both enhance SOD. DO flux into sediment is governed by Fick's Law of diffusion across a sediment-water boundary:

$$SOD = D\,\frac{\Delta DO}{DBL}$$

where *SOD* ($g/m^2 \cdot d$) is the flux of oxygen from overlaying water into the sediment; *D* (m^2/d) is the diffusion coefficient of dissolved oxygen in water; Δ*DO* (mg/L) is the difference between the DO concentration in overlaying water and at the sediment-water interface and is the diffusional "driving force" that promotes the downward flux of DO; and *DBL* (m) is the thickness of a stagnant film of water hugging the sediment called the diffusive boundary layer that acts as a "barrier" to the downward diffusion of DO. Increasing the DO in the bulk water increases ΔDO, thereby increasing SOD. Mixing tends to thin or disrupt the DBL, thereby increasing SOD. These observations yield two important conclusions: first, we cannot rely on unmixed laboratory experiments to predict in situ SOD since lake water is not still; and second, rates of DO uptake measured in situ under low oxygen conditions may be lower than those during hypolimnetic oxygenation when DO levels at or near the sediment-water interface will be elevated.

Another practical model characterizes SOD as having biological and chemical components (Walker and Snodgrass 1987, Beutel 2003). The biological component encompasses respiring microbes consuming organic matter in surficial sediment. The chemical component accounts for the abiotic oxidation of reduced compounds such as iron and sulfide diffusing upwards from decaying anaerobic sediments. As detailed in the equation below, the biological component follows saturation kinetics, and the chemical component follows first order kinetics, relative to DO oxygen concentration in overlaying water:

$$SOD = \mu\,\frac{DO}{DO + k} + K \cdot DO$$

where μ ($g/m^2 \cdot d$) is the maximum oxygen utilization rate by microbes, *DO* (mg/L) is the dissolved oxygen concentration in overlaying water, *k* (mg/L) is the half-saturation coefficient for microbial oxidation, and *K* (m/d) is the first-order chemical oxidation coefficient. This equation is shown schematically in Figure 1. The biological component of SOD (first term in equation) approaches a maximum level as other environmental factors (e.g., available carbon) become limiting. The chemical component of SOD (second term in equation) increases linearly as DO in overlaying water increases. This model was applied to some of the experimental results from this study, which allows for a prediction of how SOD varies with DO concentration in overlaying water.

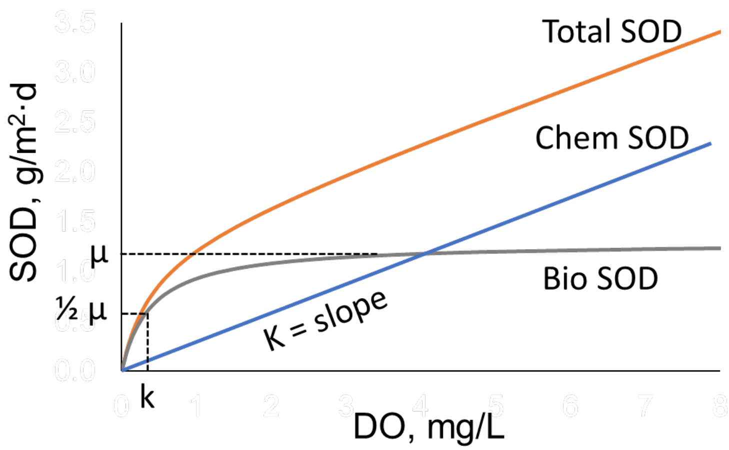

Figure 1. Schematic of biological and chemical SOD model, where μ ($g/m^2 \cdot d$) is the maximum oxygen utilization rate by microbes, k (mg/L) is the half-saturation coefficient for microbial oxidation, and K (m/d) is the first-order chemical oxidation coefficient.

Another simple SOD metric I have developed as part of my applied research with lake sediment is termed $SOD_{>5}$. This is an estimate of the SOD when DO in overlaying water is greater than 5 mg/L. This estimate excludes the low rates of oxygen uptake typically observed at lower DO concentrations. As noted above, I performed more sophisticated SOD modeling, but $SOD_{>5}$ is a practical metric to assess SOD under oxygenated conditions.

3. Methods

3.1. Field Sampling

With field support from Vista Irrigation District, on March 28, 2023, I collected duplicate SOD samples at six sampling stations at the reservoir (Figure 2). Designated stations 1-6, they represent deep (stations 1 and 2), moderately deep (stations 4 and 5) and moderately shallow (stations 3 and 6) regions of the reservoir moving away from the dam. Stations 1, 3 and 6 overlapped with existing sampling stations at the reservoir. While the sampling plan originally targeted two each of deep, moderately deep, and shallow sites, rapidly increasing water levels in Lake Henshaw in winter and spring 2023 meant that sites 3 and 6 were only moderately shallow at the time of sampling. However, sites 3 and 6 represent locations in the lake that have experienced relatively shallow water columns over the past several years when lake level has been lower. Sediment with overlaying water was initially collected into an Ekman dredge and pulled gently to the surface. Once in the boat, a subsample of the sediment-water interface was collected into specialized cylindrical Polycarbonate chambers (Figure 3). Chambers were gently topped up with lake water and transported to the laboratory for testing in the dark at 21-22 °C (Figure 3. This temperature was selected since it was easy to implement experimentally (i.e., room temperature) and close to summertime water temperatures in the lake when water quality challenges and DO demand are greatest, and when oxygen addition could be implemented to improve water quality.

Stations ranged from 8-10 m in depth, which was relatively deep compared to past sampling events, and was the result of the recent wet weather and elevated inflow to the lake in winter and spring 2023. At the time of sampling (around 8 am to noon) water temperature was around 12.5 °C, DO was around 9 mg/L, and Secchi depth was around 50-60 cm (Table 1). I also measured water content (dry at 105 °C) and loss on ignition (LOI) (bake at 550 °C) in sediment samples from each chamber in duplicate after the SOD incubation. Note LOI is an analog to organic carbon, with organic carbon levels roughly equal to half of LOI values since organic matter typically has a carbon content of around 50%. Sediment at station 1, the deepest site near the dam, had high water and organic matter content (LOI of 59%); other deep stations moving away from the dam (stations 2, 4 and 5) also had elevated water content but lower organic matter content (LOI of 10-16%); two of the shallower stations (stations 3 and 6) had lower water content and LOI (3-8%). These values were similar to those reported from the earlier comprehensive assessment of Lake Henshaw sediment quality by the project team (Stillwater Sciences 2023). That assessment categorized sediments as deep, mid and shallow, and showed a gradient of decreasing water and organic content from deep to shallow. Since oxygen demand in sediment is partly driven by organic matter degradation and decay, elevated organic matter content in sediments may correlate with elevated SOD.

Table 1. SOD sampling stations & sediment quality.

				Sediment		Water Column		
SOD Station	**Name**	**Coordinates**	**Depth, m**	**Water Content, %**	**Loss on Ignition, %**	**Secchi depth, cm**	**DO, mg/L**	**Temp, °C**
1	Dam (H-BLS/BL)	33.2395, -116.76615	10	94.2	58.9	49.5	8.84	12.4
2	Pier	33.2358, -116.7558	9.2	84.1	13.1	58.5	9.17	12.5
3	H-ML/MLD	33.2389, -116.7526	7.8	41.1	3.0	61.0	8.54	12.1
4	Between Dam & HNL	33.2423, -116.7579	8.8	85.7	15.6	53.0	8.59	12.6
5	Between H-ML & HNL	33.2405, -116.7556	8.8	80.6	10.1	63.0	8.54	12.6
6	H8	33.2347, -116.7480	8.3	72.9	8.0	54.0	-	-

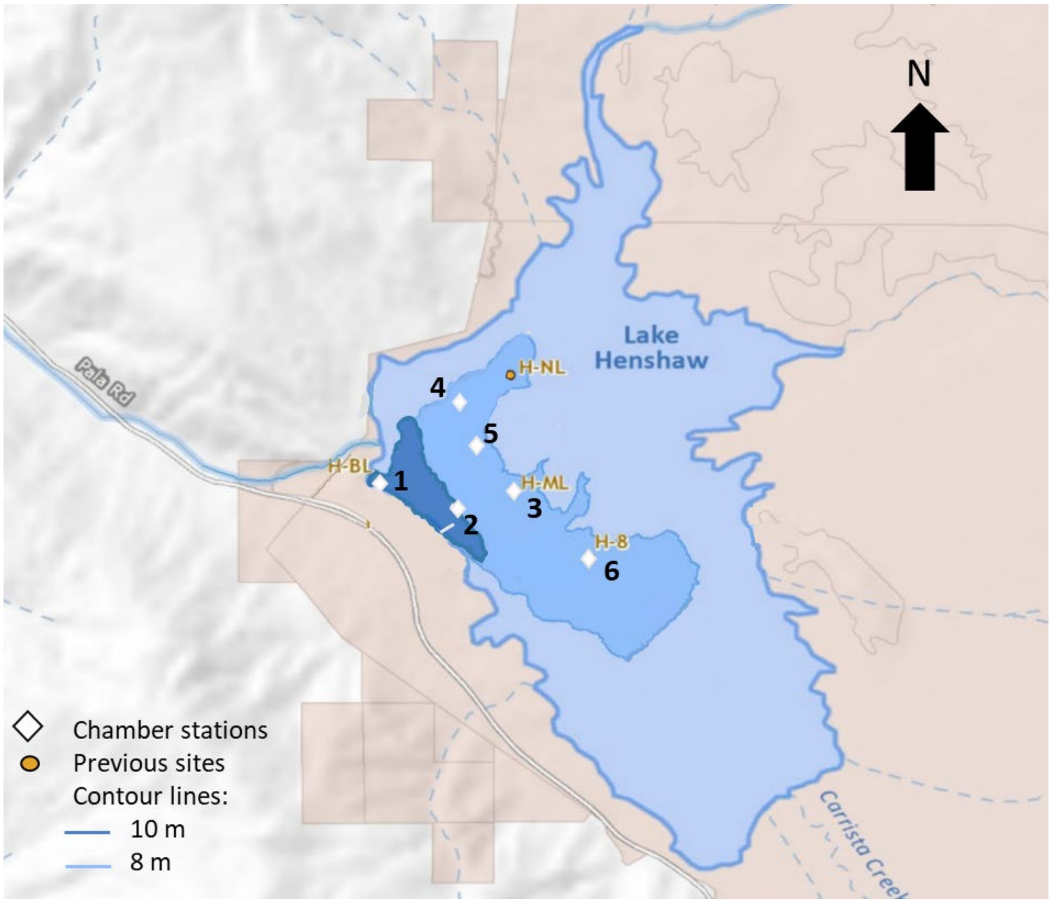

Figure 2. SOD sampling stations.

Figure 3. Left: SOD chamber collection in the field. Middle: No mix SOD chamber incubations in the lab. Right: SOD chambers on mixing apparatus in lab.

3.2. Laboratory Incubations

Sediment chambers were stored in the dark at 6 °C. Before SOD testing, chambers were bubbled with air and acclimated to an incubation temperature of 22 °C for at least 12 hours. Between testing of different mixing regimes, chambers were kept at 21-22 °C and re-aerated by bubbling with air for at least 6 hours before testing.

SOD testing in the laboratory consisted of three mixing regimes: no mix, low mix and high mix. Chambers were first incubated under quiescent conditions (no mix). Next, chambers were installed onto a mixing apparatus and mixed at a mean water velocity of 1.3 cm/s (low mix) (Figure 3). For the final mixing regime, chambers were mixed at a mean water velocity of 4 cm/s (high mix). These velocities mimic typical water velocities in lake waters, which range from around 0.5 to 10 cm/s and are typically around 0.5-1 cm/s in the profundal zone of deep lakes (Horne and Goldman 1994, Lemmin and Imboden 1987). Sediment was not resuspended due to mixing during the testing. DO concentration was measured every 15 minutes using a calibrated HACH LDO oxygen probe and HD40Q data logger.

I also performed additional SOD incubations on ten chambers to assess how SOD changed with holding time. My concern was that by holding chambers for longer periods of time, the organic matter pool in the sediment could be depleted, since fresh organic matter was no longer depositing onto the sediment from the overlying water column. To see how temperature affected SOD, I also performed additional SOD incubations on ten chambers at a lower temperature of 12-13 °C. Based on experimental data I derived a "theta" value based on the commonly used temperature rate model:

$$K_2 = K_1\,\theta^{(T_2-T_1)}$$

Where K is the rate of interest (SOD), T (°C) is temperature, and theta is the temperature coefficient.

3.3. Data Analysis

I calculated $SOD_{>5}$ in g/m^2·d for all incubations as the slope of the linear regression of DO concentration in chamber water versus time when DO concentration was above 5 mg/L. This was converted to a flux by multiplying by chamber water height (m), which is equivalent to the volume of chamber water divided by sediment surface area. Under mixed conditions, chambers exhibit a pattern in which SOD decreases with decreasing DO concentration in overlaying water. This pattern can be fit to the biological/chemical SOD model discussed above. I calculated SOD at a given DO concentration as the change in DO per 15-minute time step, multiplied by the chamber water height. SOD values were plotted against DO concentration and fit to the biological/chemical SOD model in Excel using the Solver function with μ (maximum oxygen utilization rate by microbes), k (half-saturation coefficient for microbial oxidation), and K (first-order chemical oxidation coefficient) as fitting variables. Project stakeholders with proper permission can access SOD run data for this study on Google Drive at https://drive.google.com/drive/folders/1YUOnVWuwXBwBO8x701fAUpgg9J7yWSzG?usp=drive_link.

4. Results and Discussion

4.1. Magnitude of SOD

$SOD_{>5}$ values ranged from 0.5 to 3.0 g/m^2·d (Table 2). As was anticipated, mixing led to an increase in SOD in all chambers (Figure 4). Overall mean $SOD_{>5}$ values for all sites were 1.01, 1.50 and 1.85 g/m^2·d for no mix, low mix and high mix conditions. Some spatial patterns of SOD were evident. The lowest SOD was measured at shallower station 3 and 6 with the lowest LOI. The highest SOD was measured at deeper stations 1, 2, 4, and 5 with higher LOI. SOD levels measured in Lake Henshaw were similar to those measured in other hypereutrophic systems in California, including Lake Elsinore and Hodges Reservoir (Figure 5).

As chambers warmed during the experiment, gas bubbles were observed in pockets of sediment in some chambers. In chambers 1A and 4B this caused sediment bloating in which sediment was resuspended in chamber water, thus negating the SOD testing results. In other cases, the warm conditions caused sediment doming, where sediment in the center expanded upwards, but sediment was not resuspended. The organic nature of sediments at stations 1 and 4, combined with elevated temperature, promoted microbial activity in sediments which generated gas production (e.g., CO_2, CH_4). I have observed this phenomenon in other chamber incubations, typically in sediments with high organic matter incubated at elevated temperatures.

Table 2. $SOD_{>5}$ in g/m^2·d by sample site and mixing regime

SOD Station	No Mix		Low Mix		High Mix	
	A	B	A	B	A	B
1	0.97	0.86	1.21	1.64	**	2.34*
2	0.94	0.93	1.33	1.48	1.33	1.41
3	0.82	0.68	1.03	1.15	1.43	1.26
4	1.99	1.88	2.63*	2.31*	2.98*	**
5	1.00	0.98	1.41	1.58	2.19	2.14
6	0.50	0.58	0.98	1.24	1.73	1.57
Overall Mean ± Stand Dev	1.01 ± 0.46		1.50 ± 0.50		1.84 ± 0.56	

A and B are duplicate chambers
**Sediment "bloating" and resuspension occurred in chamber, invalidating results
*Sediment "doming" was observed, but substantial sediment resuspension did not occur

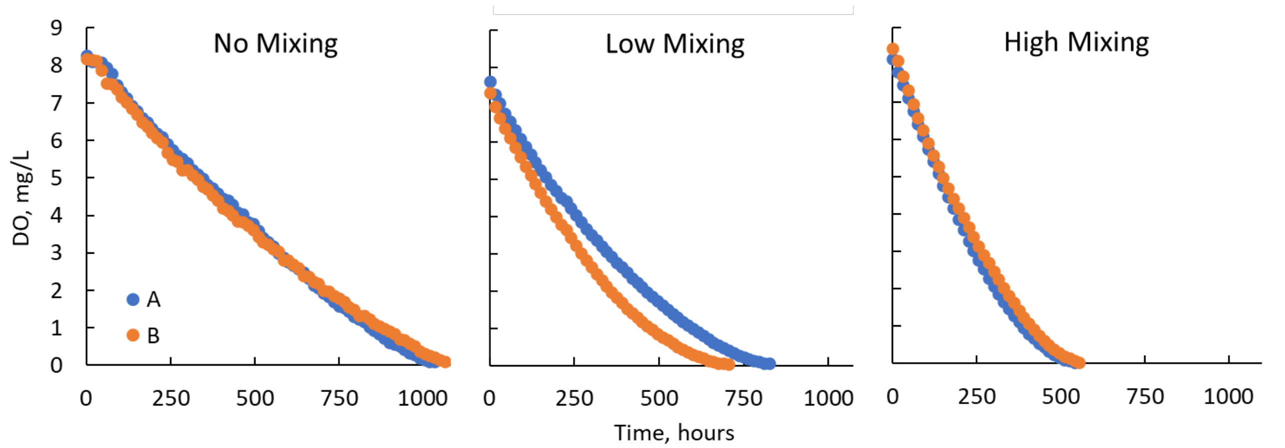

Figure 4. Example dataset for SOD incubations from station 5 for duplicate chambers A and B. Note how the rate of DO uptake increased with higher mixing. Mean $SOD_{>5}$ values for these chambers under no mix, low mix and high mix conditions were 0.99, 1.50 and 2.17 g/m²·d.

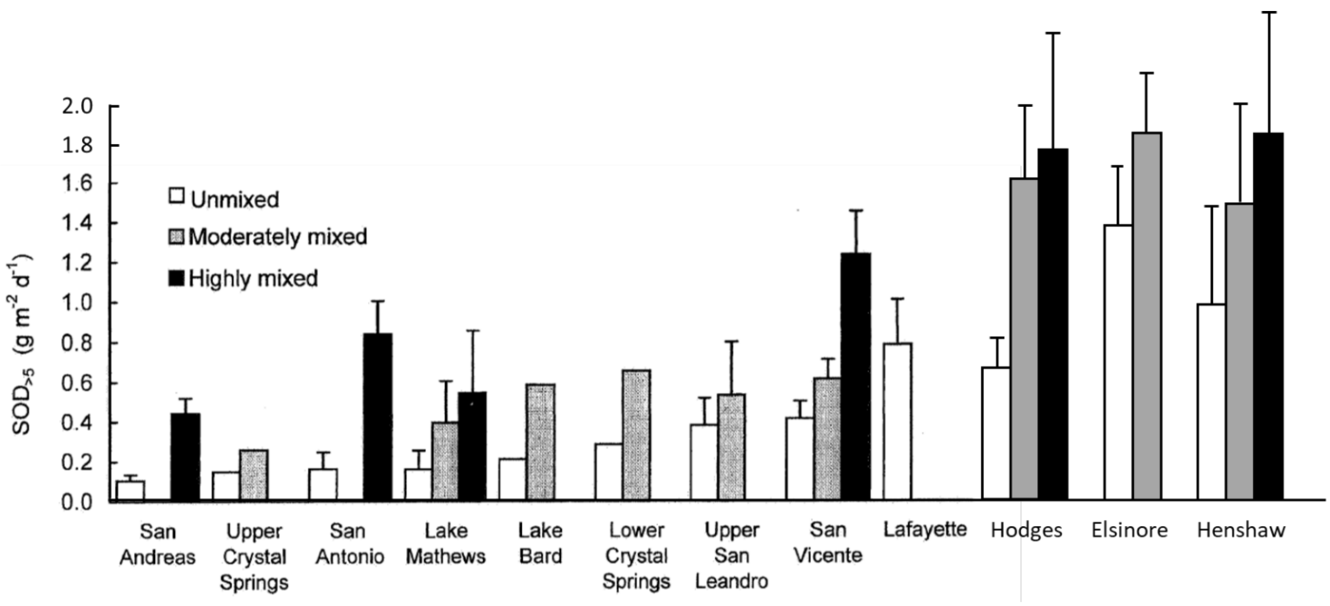

Figure 5. Summary of mixing effects on $SOD_{>5}$. Reservoirs are shown in approximate order of increasing trophic status. Error bars show one standard deviation of measurements at multiple stations. Most incubations were performed at 14-16 °C. Elsinore incubations were performed at 24-27 °C. Henshaw incubations were performed at 21-22 °C. Modified from Beutel (2003).

4.2. Effects of DO on SOD

The biological/chemical model of SOD presented earlier was fit to low mix and high mix incubations that showed clear patterns of SOD as a function of DO concentration in overlaying water (Table 3, Figure 6). Values for μ, the maximum oxygen utilization rate by microbes, typically ranged from 0.5 to 2.0 g/m²·d and were elevated under high mixing conditions and in chambers with higher $SOD_{>5}$ values (e.g., stations 4 and 5). These values were similar in magnitude to those reported for eutrophic lake sediment lakes (1-5 $g/m^2 \cdot d$) by Walker and Snodgrass (1986), and higher than values reported by Beutel et al. (2006) for mesotrophic Lake Perris (0.1-0.2 $g/m^2 \cdot d$). Values for k, the half-saturation coefficient for microbial oxidation, typically ranged from 0.1 to 0.5 mg/L. Recall k is the DO concentration at which the biological SOD is half of its maximum value. These results confirmed that biological SOD was limited by DO only at concentrations below around 1-2 mg/L (Figure 6). Walker and Snodgrass (1986) used a value of 1.4 mg/L in their SOD modeling efforts, but acknowledged that others have reported values on the order of 0.5 mg/L. Values for K, the first-order chemical oxidation coefficient, typically ranged from 0.1-0.3 m/d, and values were lowest in chambers with low $SOD_{>5}$ and low LOI (stations 3 and 6). These values are greater than those reported by Walker and Snodgrass (1986) (0.04-0.07 m/d), possibly because they did not mix water in their SOD experiments, which could have underestimated the effects of chemical oxidation relative to mixed conditions in my experiments. K values for Lake Henshaw SOD experiments were also higher than values reported by Beutel et al. (2006) for mesotrophic Lake Perris (0.03-0.06 m/d).

Table 3. Kinetic variables for biological/chemical SOD model

	Low Mix				High Mix			
Chamber	**μ, $g/m^2 \cdot d$**	**k, mg/L**	**K, m/d**	**r^2**	**μ, $g/m^2 \cdot d$**	**k, mg/L**	**K, m/d**	**r^2**
1B	0.656	1.191	0.179	1.00	0.533	0.268	0.295	1.00
2A	0.584	0.468	0.130	0.98	0.947	0.441	0.068	0.97
2B	0.456	0.110	0.177	0.98	0.417	0.197	0.158	0.96
3A					1.220	0.514	0.046	0.97
3B					1.063	0.487	0.042	0.98
4A	1.295	0.394	0.272	0.96	2.046	0.335	0.164	0.99
4B	1.408	0.171	0.134	0.95				
5A	0.575	0.226	0.133	0.94	1.456	0.658	0.142	0.99
5B	0.773	0.481	0.145	0.98	1.039	0.312	0.167	0.99
6B					0.937	0.268	0.095	0.96

The results presented here for Lake Henshaw SOD experiments highlight the fact that elevated DO results in higher SOD. For the datasets shown in Figure 6, for example, an increase in DO in overlaying water from 2 mg/L to 8 mg/L leads to an approximate doubling of SOD. The project team can use the metrics presented here to further assess anticipated SOD in Lake Henshaw at target DO levels post oxygen addition. A key take home message is that there is a key ecological feedback in lakes in which adding oxygen at the sediment-water interface will increase the consumption rate of oxygen, and this needs to be anticipated in the context of sizing lake oxygenation systems.

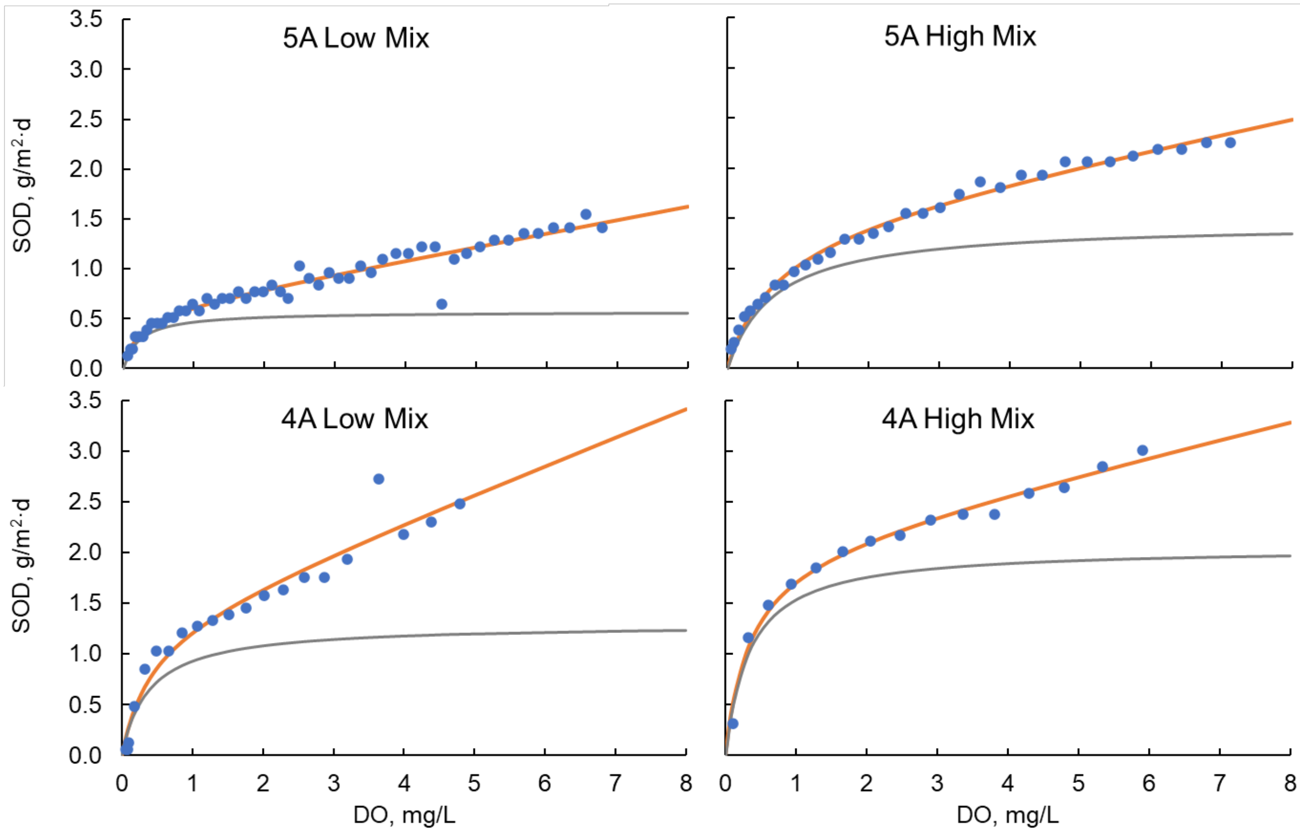

Figure 6. Example dataset of SOD as a function of DO in overlaying chamber water. Blue circles are data points, orange line is model of total SOD (biological plus chemical), and gray line is model of biological SOD. Chamber 5A exhibited relatively low SOD compared to chamber 4A. At both stations higher DO enhanced SOD.

4.3. Effects of Hold Time and Temperature on SOD

I also performed a second incubation run on a subset of chambers to assess how $SOD_{>5}$ changed with holding time (Table 4). My concern was that by holding chambers for longer periods of time, the organic matter pool in the sediment could be depleted, since fresh organic matter was no longer depositing onto the sediment from the overlying water column. In fact, there was on average a 74% increase in $SOD_{>5}$, which I attribute to enhanced biological activity in warmed organic-rich sediment. It is difficult to interpret these experimental results in the context of summertime oxygen demand in Lake Henshaw. Lake sediments will warm up slowly over the spring, in contrast to the rapid warming experienced in this benchtop experiment. In addition, actual lake sediment may not warm up to the same vertical extent that experimental chamber sediments did, since laboratory chambers were surrounded by warm conditions. The most conservative interpretation is that summertime SOD in the lake could be higher than values presented in Table 2 due to enhanced oxygen demand from warming organic sediments.

Table 4. Effects of holding time on $SOD_{>5}$ incubations in g/m^2·d

Station	Mix	Initial Run	Second Run	% Increased Between Runs
1A	No	0.97	1.66	71
	Low	1.21	2.29	89
2A	No	0.94	1.09	16
2B	No	0.93	1.27	37
3A	No	0.82	1.45	77
3B	No	0.68	1.20	76
6A	No	0.50	1.27	54
	Low	0.98	1.42	45
6B	No	0.58	1.33	29
	Low	1.24	1.81	46
Average ± St Dev				74 ± 42

To see how temperature affected $SOD_{>5}$, I also incubated a subset of chambers at a lower temperature of 12-13 °C (Table 5). Using a temperature difference in my experiment of 9 °C yields an average "theta" value of 1.048. This is equivalent to a Q_{10} value, the factor by which the rate goes up if temperature increases 10 °C, of 1.6. A few other studies have reported lake SOD theta values ranging from around 1.065 to 1.1 (Walker and Snodgrass 1986, Traux et al. 1995). The project team could use these findings to fine tune SOD values reported here to seasonal lake water temperatures.

Table 5. Effects of temperature on $SOD_{>5}$ in g/m^2·d

Station	Mix	Initial Run Cold (12-13 °C)	Initial Run Warm (21-22 °C)	Theta Value
1A	Low	0.79	1.21	1.049
3A	No	0.61	0.82	1.033
	Low	0.63	1.03	1.056
3B	No	0.39	0.68	1.064
	Low	0.70	1.15	1.057
5A	Low	0.86	1.41	1.056
6A	Low	0.61	0.98	1.054
	High	1.02	1.73	1.060
6B	Low	0.91	1.24	1.035
	High	1.33	1.57	1.019
Average ± St Dev				1.048 ± 0.015

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Appendix E

Lake Henshaw Oxygenation Field Trial Work Plan

FINAL

Lake Henshaw Oxygenation Field Trial Work Plan

Prepared for

Vista Irrigation District

Vista, California

November 27, 2023

FINAL

Lake Henshaw Oxygenation Field Trial Work Plan

Prepared for
Vista Irrigation District
Vista, California
November 27, 2023

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List of Abbreviations

ACBM	articulated concrete block mattress
CDFW	California Department of Fish and Wildlife
CEQA	California Environmental Quality Act
CNDDB	California Natural Diversity Database
CWA	Clean Water Act
DO	dissolved oxygen
ESA	Endangered Species Act
FGC	Fish and Game Code
ft	feet
gpm	gallons per minute
HABs	harmful algal blooms
HOD	hypolimnetic oxygen demand
hp	horsepower
IpaC	Information for Planning and Conservation
IS/MSND	Initial Study/Mitigated Negative Declaration
ISO	International Organization for Standardization
LOX	liquid oxygen
LSA	Lake or Streambed Alteration
NMFS	National Marine Fisheries Service
NWP	Nationwide Permit
PDS	Planning and Development Services
SDGE	San Diego Gas and Electric
SDOX	supersaturated dissolved oxygen
SHRP	Small Habitat Restoration Project
SOD	sediment oxygen demand
Qty	quantity
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
VFD	variable frequency device
VID	Vista Irrigation District
WCOD	water column oxygen demand
WQC	water quality certification

Section 1

Background

1.1 Introduction

This Work Plan outlines the requirements for a temporary, lake oxygenation field trial for Lake Henshaw. The need for a trial became apparent when evaluating oxygenation as a long-term option as described in the *Lakes Henshaw and Wohlford Harmful Algal Blooms (HABs) Management and Mitigation Plan*. Although some site improvements are needed to accommodate rental equipment, the temporary trial allows real world evaluation of the concept without the substantial capital investment required for a permanent installation. The trial will also provide information needed to inform the sizing and cost of a permanent oxygenation system for Lake Henshaw.

Lake oxygenation is needed to mitigate HAB events by controlling the oxidation-reduction potential in the water and bottom sediments and the associated release of orthophosphate, ammonia, dissolved manganese, dissolved iron, sulfate, and if present, methylmercury, from the reservoir sediments during hypoxic (dissolved oxygen [DO] < 2 mg/L) or anoxic (DO = 0 mg/L) conditions. Limiting release of nitrogen and phosphorus reduces the potential for HABs because these nutrients are required for algae and cyanobacteria growth. Although release of manganese, iron, and/or sulfate from Lake Henshaw bottom sediments has thus far not caused difficulty for the Escondido-Vista Water Treatment Plant to comply with these constituents' secondary maximum contaminant limits, continued releases could become problematic. In addition, methylmercury is a toxic metal that bioaccumulates in the aquatic food web. Oxygenation also provides benefits to general lake water quality and fish populations by reducing release of this compound.

In deep reservoirs and lakes, it is common for seasonal thermal stratification to occur, where the upper layer of the water column (called the epilimnion) warms in the spring, while the bottom layer (hypolimnion) remains cool. The epilimnion can descend through the water column and the hypolimnion can become smaller as the spring and summer progress. In shallow lakes, like Lake Henshaw, the water column may only weakly stratify or not stratify at all, instead remaining a uniform warm temperature throughout the spring and summer until cooling in the fall. Low or zero DO conditions often occur in the hypolimnion of deep reservoirs and lakes during the summer and/or fall, but they can also be present in shallow warm water columns. Oxygenation systems are designed and operated to mitigate this phenomenon by maintaining a positive dissolved oxygen concentration in the water column and at the sediment/water interface.

The surface water elevation in Lake Henshaw varies depending on several factors including rainfall, groundwater pumping from the Warner Ranch Wellfield, and releases from the dam. The deepest part of the reservoir is a relatively small area located near the dam where the water depth ranges from 14 ft at low water level (2,657 ft) to 47 ft at a full pool elevation of 2,690 ft. Historically, this maximum water level occurs infrequently, and the lake level more typically ranges from 2,660 to 2,670 ft. Beyond the deeper portion near the dam, the rest of the lake is broad and shallow, with typical depths ranging from 6 to 20 ft.

Oxygenation has been identified as a HABs prevention method that has a strong potential for success in Lake Henshaw and has focused on two options: the non-pressurized Speece Cone and the pressurized supersaturated dissolved oxygen (SDOX) system. Both methods involve creating an oxygen-rich water stream that is mixed into lake bottom waters, increasing water column and sediment DO levels without disturbing any thermal stratification that may exist. Both systems consist of two main components – a liquid oxygen (LOX) system located above grade near the lake shore, and an oxygen transfer and delivery system. Both systems involve pumping a small portion of the lake volume, called a sidestream, to create super-saturated oxygenated water that is mixed back into the water column.

This Work Plan focuses on the pressurized SDOX system as its manufacturers have developed a containerized unit that is readily available for lease. The Speece Cone systems are individually designed and constructed for each project and require a longer lead time prior to deployment with additional nuances for temporary installations (i.e., barge). Speece Cone requirements for Lake Henshaw are discussed briefly to summarize pertinent differences between systems.

1.2 Basis of Design

This process is designed and will be operated to add enough oxygen to the lake to keep DO levels above 5 mg/L in the bottom waters. The added oxygen must meet the lake oxygen demand, which varies based on season, temperature, natural organic matter, ecology, and time of day. This oxygen demand can be broken into two parts: water column oxygen demand (WCOD) from the organic material and biology living within the water column, and the sediment oxygen demand (SOD) from the organic material and biomass living in the lake sediments.

For WCOD, the team reviewed data from DO measurements collected during am/pm vertical profiles in March 2022. Unfortunately, the data showed widely varying nighttime oxygen demand, varying from -3 to +5 mg/L DO per day. To size this oxygenation system, a conservative value of 0.2 mg/L/day was used for Lake Henshaw based on a 2003 study of nine California lakes where the hypolimnetic oxygen demand (HOD) ranged from 0.034 to 0.147 mg/L/day (Beutel, 2003). The highest value was measured in Lafayette Reservoir which can be categorized as hypereutrophic like Lake Henshaw. Note that the HOD is an in-situ oxygen demand that includes both WCOD and SOD; therefore, using this HOD value for WCOD provides a very conservative design approach for the oxygenation system.

For SOD, Dr. Marc Beutel performed a laboratory SOD chamber study in 2023 as part of the Phase II Lake Henshaw HABs Management project. Using sediment samples collected from six locations within the lake, his team measured the decline in DO over time to determine the DO uptake from the sediment. Three different mixing conditions (no mixing, low mixing, and high mixing) were tested to simulate current across the sediment. The primary results showed that SOD values increase with mixing. SOD values also increase with DO concentration in water above the sediments. The mean SOD ranged from 1.01 g/m^2/d (no mixing) to 1.84 g/m^2/d (high mixing). For oxygenation system sizing, the study's average high-mix value of 1.8 g/m^2/day was selected.

The total lake oxygen demand is the sum of the WCOD multiplied by the water volume and SOD multiplied by the lake bottom area as shown in the equation below.

$$Lake\ Oxygen\ Demand\ \left(\frac{g}{day}\right) = WCOD\ \left(\frac{\frac{g}{L}}{day}\right) \times\ Water\ Volume\ (L) + SOD\ \left(\frac{\frac{g}{m^2}}{day}\right) \times\ Sed\ Area\ (m^2)$$

The lake water volume and lake sediment area change with water surface elevation. VID provided hypsographic data correlating Lake Henshaw water surface elevation with lake water volume and lake surface area at 1-foot intervals between 2,643 and 2,700 ft Mean Sea Level. For this oxygen demand analysis, the lake bottom sediment area is approximated as equal to the lake surface area.

To evaluate the size of the oxygenation system needed, the total lake oxygen demand was calculated at each elevation. For the typical low level elevation of 2,657 ft, the hypsographic data show the lake volume as 2,193.28 acre-ft (2.71 x 10^9 liters) and lake area surface area as 527.19 acres

(2,133,447 m^2). Assuming WCOD of 0.2 mg/L/day and SOD of 1.8 g/m^2/day, the lake oxygen demand is estimated to be 4.8 tons/day. Based on these calculations, the temporary oxygenation system for this trial was sized to add a maximum 10,000 pounds of oxygen per day (5 tons/day). This size was based on meeting 100 percent of the water volume and sediment area oxygen demand at the typical low water elevation of 2,657 ft MSL. At a higher lake elevation of 2,660 ft, the 5 tons/day system would meet approximately 72 percent of the combined oxygen demand (WCOD 1.1 tons/day and SOD 5.9 tons/day). At elevation 2,670 ft, this system would meet about 33 percent of the combined oxygen demand (WCOD 4.1 tons/day and SOD 11.2 tons/day). Figure 1-1 shows an aerial image with the lake levels at various elevations. The lightest purple shaded area represents a lake elevation of 2,670 ft.

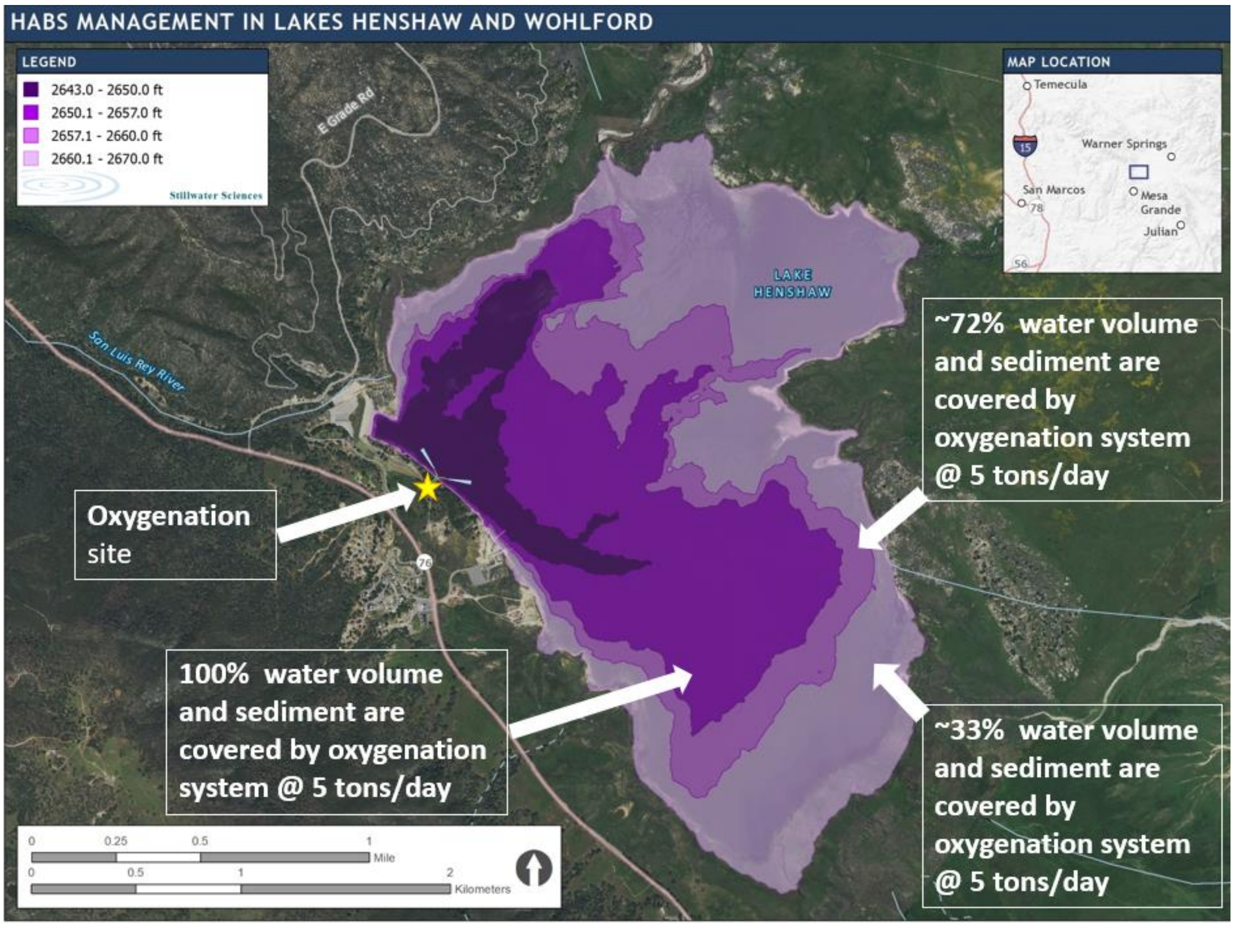


Figure 1-1. Aerial view of Lake Henshaw

Section 2

Equipment and Installation

2.1 Site Plan

The proposed site for the oxygenation equipment will be located west of the lake shoreline and northwest of the boat ramp area. This location is preferred due to the proximity of power source, shoreline, access, and preservation of the lake's viewshed. Figure 2-1 is a site map which shows the oxygenation equipment location with respect to the lake and the boat ramp areas.

Figure 2-1. Site map

Figure 2-2 is a large scale view of the proposed site location with the oxygenation equipment layout shown. The layout shows the LOX/vaporizer trailer and SDOX container. There is a power pole located approximately 200 feet north of the site that can be used to power the equipment. Further coordination with San Diego Gas and Electric (SDGE) will be needed to determine what is required to make the connection to the power source. The red rectangle shown in the figure represents the gravel pad and the minimum clearance needed around the LOX trailer. Per the 2022 California Fire Code §5504.3.1.1, the LOX storage needs a 15-foot separation from combustible materials including paper, leaves, weeds, dry grass or debris. The fencing and gravel limits shown are based on the 15-foot separation requirement. The site will be graded level and topped with landscape fabric and gravel prior to the placement of oxygenation equipment. The landscape fabric will prevent any plant growth that could serve as combustibles near the LOX tank. The refilling area for the LOX tanks will need to have steel plates laid down to prevent any spills from contacting the gravel surface. LOX is an oxidizer and could cause a fire hazard if it comes into contact with hydrocarbons in certain pavement types. Further coordination to confirm LOX storage approach with the County Fire Marshall is required before finalizing installation plans.

Figure 2-2. Oxygenation equipment layout map

It is recommended that a chain link fence and access gate be installed around the equipment for security purposes. For the filling of the LOX tank, a tanker truck can pull up parallel to the equipment and use the access gate for re-filling operations.

2.1.1 Roadway Access

Roadway access routes were reviewed during development of this work plan. A site walk was performed in July 2023 to determine which route would provide the best tanker truck access to the oxygenation equipment site. The proposed route is selected based on ease of access and amount of grading work needed to create the path. As shown in Figure 2-3, the proposed access route approaches from south of the oxygenation site and utilizes the existing entrance to the boat ramp area off State Route 76. After traveling past the gate and partway north on the asphalt road, the route would go north on an existing dirt path leading up to the proposed oxygenation site, as shown in yellow. This route would be used for both entry and exit of the site. The tanker truck would exit the site by reversing back down the route into a hammerhead turnaround to turn around and drive in a forward direction to leave the area. Coordination with LOX suppliers proved at least one supplier felt it possible to safely reverse back down the route into the hammerhead turnaround; however, it is recommended to further coordinate with LOX suppliers and have them complete a site visit prior to construction of the roadway. The hammerhead turnaround is located approximately 720 feet south of the oxygenation site. The existing dirt path is approximately 5-6 feet wide with shallow cross-slopes. Modifications to the dirt path will be needed to create a road surface that is suitable for tanker truck travel. Moderate grading would be needed to remove any unsuitable cross slopes to create a level path for the truck. The path would need to be widened to a standard lane width of 12 feet. The tanker truck dimensions are approximately 9 feet wide by 60 feet long by 14 feet tall with a minimum inner 55-foot and outer 75-foot turning radius for reference. A turning radius analysis has been performed to ensure there is enough space for the tanker truck to turn onto the gravel road and turn around at the hammerhead turnaround. The proposed gravel road length would be approximately 1,550 feet long with an average existing grade of 5.5 percent. For the gravel road, it is recommended that the top 12 inches of native subgrade be compacted to 95 percent and the surface be paved with a 4-inch-thick gravel layer. To create this site access, trimming of trees and clearing of vegetation along the gravel road, hammerhead turnaround, and around the oxygenation equipment area is required for proper access of the tanker truck to enter and leave the site. An environmental impact study might be needed to determine what mitigation measures are needed for trimming trees and removing vegetation prior to finalizing installation plans.

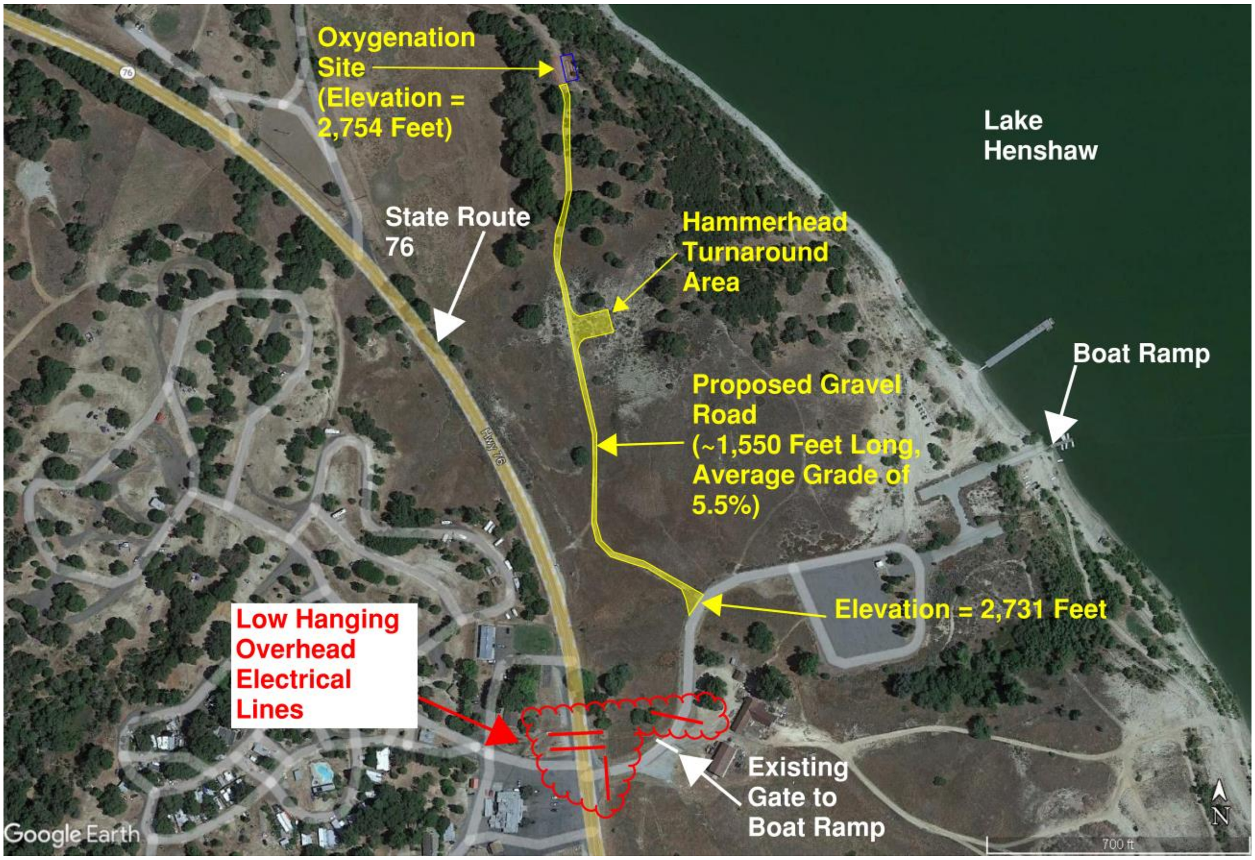


Figure 2-3. Roadway access map

It should be cautioned that there are some low hanging overhead electrical utilities which may cause vertical clearance issues for the tanker truck. Figure 2-4 shows low hanging electrical power lines crossing State Route 76 looking west. Figure 2-5 shows another low hanging electrical power line crossing the boat ramp access road looking southwest. Based on 2022 and 2023 algaecide and lanthanum modified clay deliveries to the boat dock via standard semi-trucks with trailers, the wires may be at an acceptable height; however, it is recommended to further evaluate and coordinate with SDGE and the LOX supplier to confirm there are no vertical clearance conflicts for access. Delivery truck dimensions shall also accommodate highway restrictions. Freight of equipment may require multiple deliveries and/or a smaller LOX delivery truck.

Figure 2-4. Overhead electrical utility crossing State Route 76

(Looking west standing on boat ramp access road entrance)

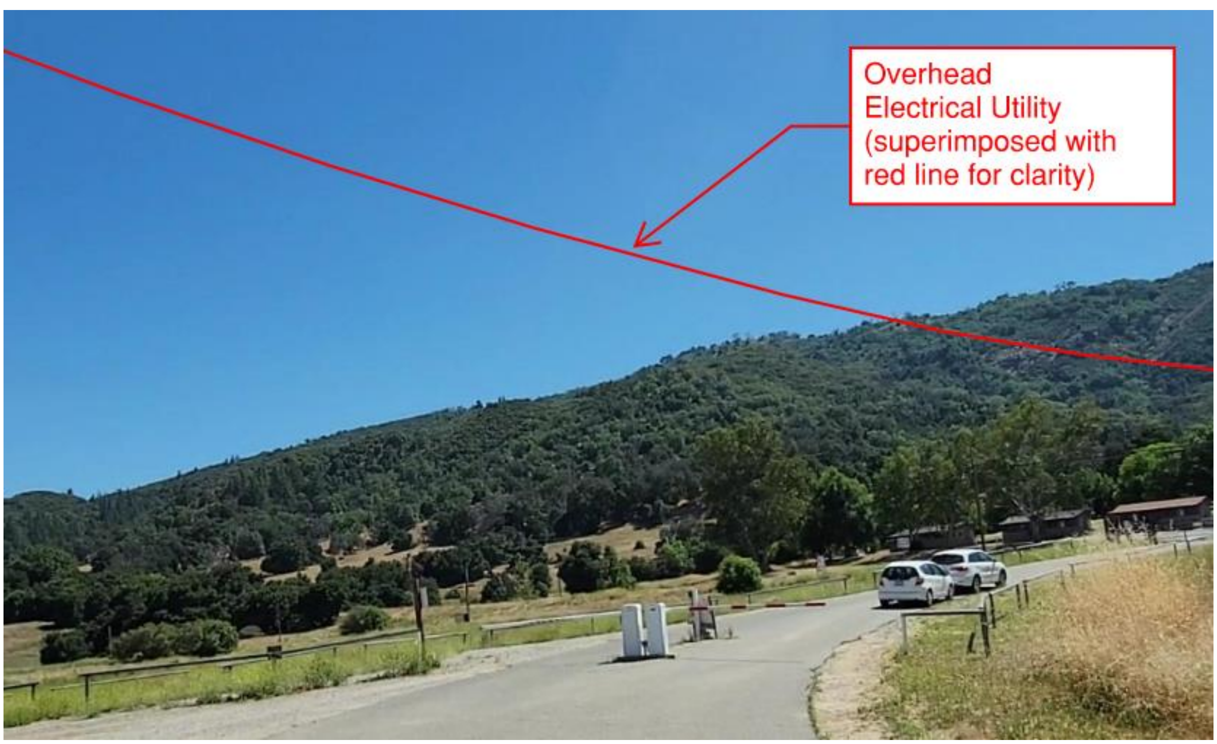


Figure 2-5. Overhead electrical utility crossing boat ramp access road

(Looking Southwest)

2.2 Equipment Options

The equipment required for the field trial are detailed in the following sections. The level of design is approximately 20 percent based on prepackaged systems and coordination with multiple equipment suppliers. As introduced in Section 1.1, the Work Plan focuses on the pressurized SDOX system as its manufacturers have developed a containerized unit that is readily available for lease. The Speece Cone systems are individually designed and constructed for each project and require a longer lead time prior to deployment with additional nuances for temporary installations (i.e., barge). Speece Cone requirements for Lake Henshaw are discussed briefly in Section 2.2.2 to summarize pertinent differences between systems.

The design considerations with respect to the SDOX system are as follows:

- Transfer pump type
- Pipe length and type (suction and discharge) based on transfer pump type.
- Oxygenated water pipeline (one versus two pipelines with a tee-approach for diffusion into lake water).
- SDGE coordination and drawings based on selected pump approach.
- SDOX system real time monitoring and controls.
- Delivery truck dimensions to accommodate highway restrictions. Freight of equipment may require multiple deliveries and/or a smaller LOX delivery truck.
- Environmental assessment for clearing and grubbing of access road and oxygenation site.

2.2.1 SDOX O2 System

The Work Plan uses the SDOX600 O2® system (SDOX System) by Chart Industries BlueInGreen. The SDOX system will provide oxygen transfer into the sidestream above grade near the LOX system. The sidestream water will flow through a pressurized enclosed vessel that is fed simultaneously with oxygen to create a super-saturated oxygen solution that is piped back into the lake as shown in Figure 2-6. While most of the oxygen will be completely dissolved within the sidestream, at higher addition rates a portion of the oxygen will be entrained in the sidestream water in gas form. This entrained gas is dissolved into the lake water when the sidestream is reintroduced to the lake through the dispersion nozzle. The velocity and pressure drop from the sidestream pipeline at an injection depth of 12-25 ft will allow for rapid mixing with minimal bubbles or gas emerging to the surface. BlueInGreen stated that each of the two trains within their SDOX system can provide complete dissolution of 3,000 pounds of oxygen per day (ppd) at 28 °C to 4,500 ppd at 7 °C at the proposed sidestream flowrate of 1,000 gpm per train. With both trains operating, the completely dissolved total ranges from 6,000 to 9,000 ppd (3 to 4.5 tons/day). To achieve 5 tons/day requires additional gas entrainment within the supersaturated sidestream where this entrained gas is transferred into the lake water at the dispersion nozzle.

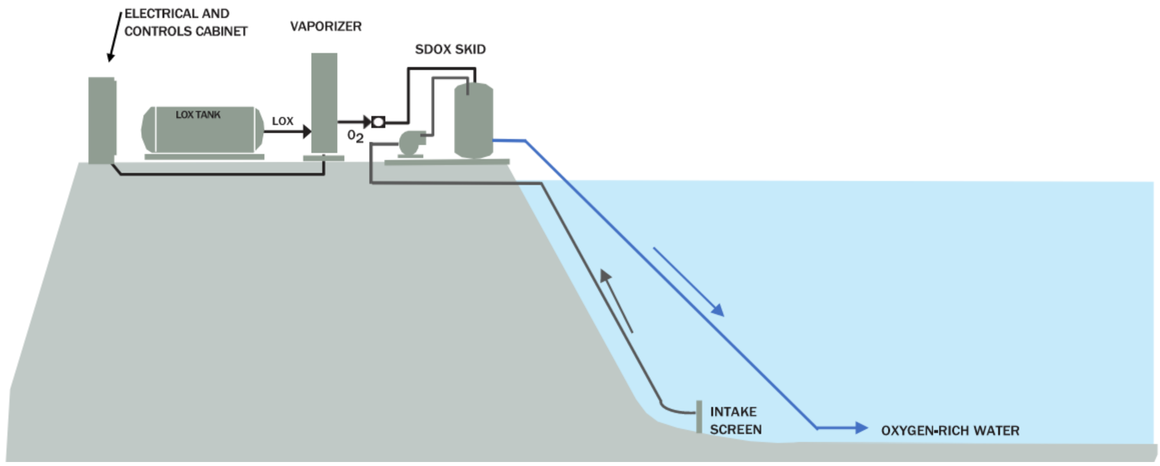


Figure 2-6. SDOX schematic

Figure 2-6 depicts a potential future permanent installation located near the lake shore. For this temporary trial at Lake Henshaw, a trailer-mounted LOX tank and vaporizer system will provide oxygen to the containerized SDOX system. Also note that the temporary system is located uphill from the lake shore such that a transfer pump will be needed to lift water from the lake to supply the SDOX pumps.

2.2.1.1 Chart Industries LOX Trailer

The oxygenation system will require a LOX storage tank and subsequent vaporizer that will be located at the oxygenation site and mounted on an open trailer as shown in Figure 2-7. This trailer system will be provided by Chart Industries and will require LOX chemical delivery by tanker truck to supply the 9,000-gallon storage tank. The trailer will be parked at the oxygenation site with steel plates located at the LOX storage tank fill connection to mitigate combustion. A 1-inch stainless steel (SS) flex hose will transfer the gas from the vaporizer to the SDOX container. The transfer hose will be provided by Chart Industries. The LOX trailer and SDOX container should be placed next to each other to limit additional piping needs.

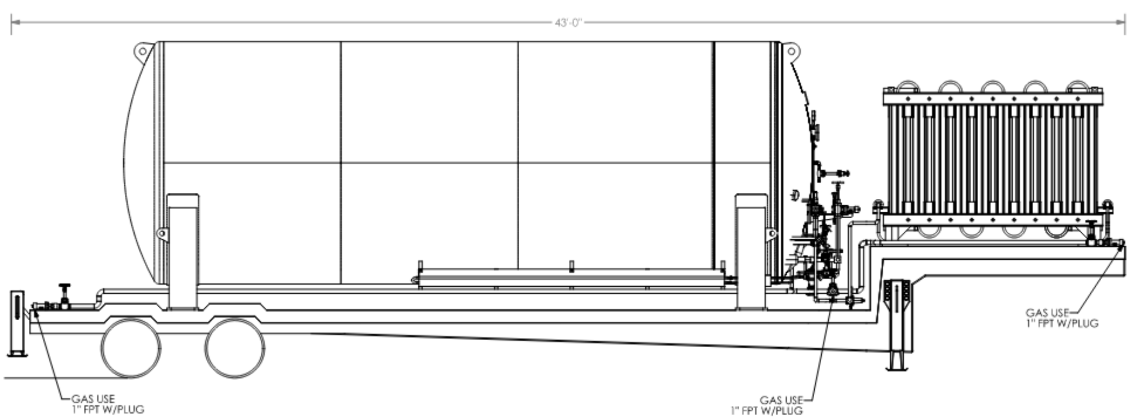


Figure 2-7. LOX trailer system

The LOX truck delivery frequency is dependent on the oxygen supply rate and the test scenarios. When the oxygenation system is operating at the maximum oxygen supply rate, more frequent deliveries will be required. Multiple truck deliveries will be needed to fill the LOX storage tank to capacity. Table 2-1 summarizes the truck delivery frequencies for the maximum and minimum oxygen supply rates.

Table 2-1. LOX Delivery Truck Frequency

Parameter	Units	Maximum Condition[a]	Minimum Condition[b]
Oxygen Supply Rate	tons/day	5	1.5
LOX Storage Tank Size	gal	9,000	9,000
LOX Storage Days	days	8.6	28.6
LOX Delivery Truck Load[c]	gal	2,400	2,400
LOX Truck Delivery Frequency	days	2.3	7.6

a. *Based on meeting 100 percent of the water volume and sediment area oxygen demand at the typical low water elevation of 2,657 ft MSL*

b. *Based on meeting approximately 60 percent of the water volume and sediment area oxygen demand at typical low water elevation of 2,657 MSL.*

c. *Based on smaller truck delivery due to state road limitations.*

2.2.1.2 SDOX Container

The SDOX600 O2® equipment and control room will be housed within a 20-ft International Organization for Standardization (ISO) container, as shown in Figure 2-8, that will be placed on the gravel pad at the oxygenation site. The SDOX system has a plug and play approach, needing to only connect power and process piping to start operation. The container includes a partition to allow for an electrical control room that houses the breaker panels, variable frequency device (VFD), junction box, transfer, and control cabinets. The electrical control room includes a heat and air conditioning unit.

Figure 2-8. SDOX O2® ISO container

The SDOX container houses two SDOX600 units, each capable of providing 5,000 pounds per day of oxygen. The SDOX600 units include pressure vessels, pumps and motors with respective guards, and the ancillary components for the systems (e.g., piping, valving, and vessel components). The SDOX system feed pumps maintain a minimum operating pressure of 40 pounds per square inch through each pressure vessel. The ISO container has three different process piping connections for water inlet, water outlet, and gas inlet as described in section 2.2.1.4. The equipment area includes a fan for ventilation. The design criteria for the oxygenation system is summarized in Table 2-2.

Table 2-2. SDOX Oxygenation System Design Criteria

Parameter	Units	Design
Container dimensions	L x W x H	20' x 8' x 9.5'
Total Connected Load[a]	Amps	350
Oxygen Supply Rate Range	tons/day	1.5 – 5.0
Controls[b]	-	Real time monitoring and control
Number of Feed Pumps	Qty	2 duty, 0 standby
Max Flow Rate, Each	gpm	1,000
Motor Size, Each	hp	100
Control Device	-	VFD

a. Full load amps is 264, 480 volt (V) 3-phase. The provided connected load is rush amps for safety factor.

b. Parameters for real time monitoring and controls to be coordinated with Chart Industries prior to rental agreement.

2.2.1.3 Transfer Pump and Break Tank

A transfer pump will be required to convey the SDOX system sidestream up to the oxygenation site, which is located at an elevation of 2,750 ft and is 60 to 90 ft above the lake level. The transfer pump will convey lake water to a 1,000-gallon break tank with a passive overflow located near the SDOX container. The SDOX feed pump inlet lines will be connected to the break tank. If the break tank empties, the SDOX control system will alarm and the SDOX system will shutdown safely. The transfer pumps may be trailer-mounted dry pumps near the shoreline or submersible wet pumps located in the deep elevations of the lake. Two duty pumps will be required to meet the oxygen delivery ranges as outlined in the oxygenation trial test scenarios described in Section 3 and will be independent with no common headers. The design criteria for the transfer pumps and break tank are summarized in Table 2-3.

Table 2-3. Transfer Pumps and Break Tank Design Criteria

Parameter	Units	Design
Transfer Pump		
Number of Pumps	Qty	2 duty, 0 standby
Pump Type	-	Trailer mounted dry pump or submersible wet pump
Flow Rate, Each	gpm	1,000
Total Dynamic Head	ft	102
Motor Size, Each	hp	50
Motor Control	-	Fixed or VFD
Break Tank		
Number of Tanks	Qty	1 duty, 0 standby
Tank Type	-	Vertical Polyethylene
Tank Capacity	gal	1,090
Tank Diameter	ft-in	5'-1"
Tank Connections	-	(1) 12" Overflow[a], (4) 8" Side wall (1) Drain

a. Overflow will be conveyed back to the reservoir and will be continuous to allow for ample supply to the feed pump.

2.2.1.4 Pipelines

There will be multiple pipelines required for the plug and play approach for the SDOX system. The pipelines are detailed in

Table 2-4. Pipe Material Schedule

. As this is a temporary site, it is recommended to not trench the pipelines and rather grub and clear an at-grade pathway down the reservoir embankment for the pipelines to travel to and from Lake Henshaw with expansion joints and anchorage. It is recommended that VID develops a plan to prevent a tripping hazard to the public, whether it is developing signage, a barrier, and/or a riser to safely cross over the piping. The pipelines should run in parallel and be tied together with heavy duty nylon zip ties for the entire length. The submerged pipelines should be anchored by standard articulated concrete block mattresses (ACBM) with cables.

Table 2-4. Pipe Material Schedule

Pipeline Service	Diameter (in)	Proposed Material	Location
Gas Line	1”	SS flex hose	Vaporizers to SDOX Container provided by Chart Industries
Raw Lake Water	8”	Black Water Suction Hose with quick disconnect (QD) fittings	Lake to Transfer Pumps (2 pipelines)
Raw Lake Water	8”	Heavy Duty Layflat Hose with QD fittings	Transfer Pumps to Break Tank (2 pipelines)
Raw Lake Water	8”	Composite hose with 150# flange fittings	Break Tank to each SDOX water inlet (2 pipelines)
Break Tank Overflow	12”	Heavy Duty Layflat Hose with QD fittings	Break Tank to Lake
Oxygenated Lake Water	8”	Heavy Duty Layflat Hose with QD fittings	SDOX water outlet to Lake shoreline (2 pipelines)
Oxygenated Lake Water	8”	HDPE SDR 17	Shoreline to Lake for diffusion (2 pipelines)

2.2.1.5 Supplying oxygenated water to the lake

The SDOX system will have two parallel trains, each equipped with a 6-inch diameter outlet. Each outlet will be connected to an increaser so that two flexible 8-inch diameter lines can be routed down the hill to the lake. Each line will be equipped with a single 4-inch diameter outlet to create a round turbulent jet to direct and disperse the oxygenated water into the lake. This approach will provide two separate oxygenated streams to be directed in two different directions within the lake. It is recommended that this portion of the lake be restricted from public use with a buoy line to prevent hazards to the system from boating. Figure 2-9 shows the general arrangement of the piping, transfer pumps, and break tank.

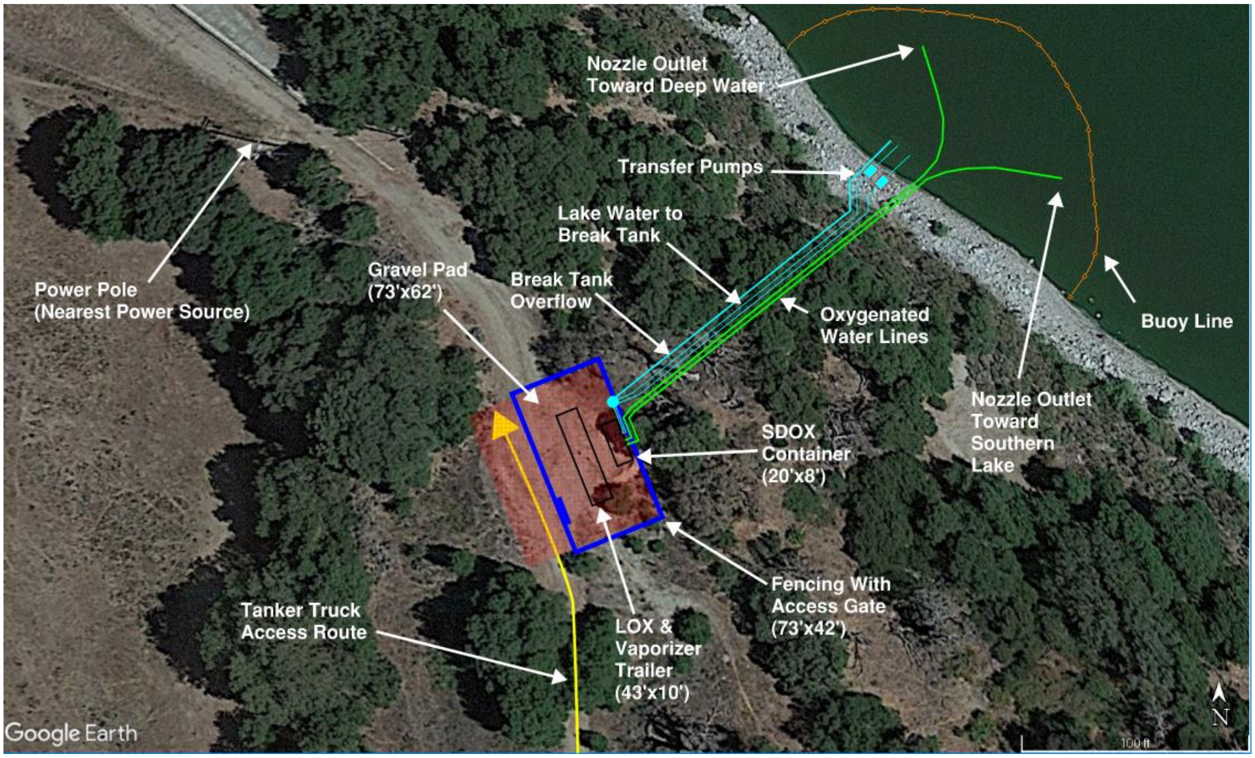


Figure 2-9. General piping layout

2.2.2 Speece Cone Considerations

For a Speece Cone, which is manufactured by ECO_2, oxygen transfer into the sidestream typically occurs underwater, where the Speece Cone assembly skid would be anchored to the lake floor. The skid would be equipped with an intake screen and submersible circulation pump that moves lake water through the Speece Cone at high velocity, where oxygen bubbles are applied. The oxygenated water would be discharged at the bottom of the Speece Cone through a pipeline with a diffuser. Figure 2-10 shows the general arrangement for a permanent Speece Cone installation. Speece cones could also be arranged above grade or on a barge in a similar sidestream approach to that used with the SDOX O2 System. For a field trial, it would be assumed the Speece Cone would have a sidestream application located on a barge on Lake Henshaw and would require the following equipment.

- 12 ft-diameter ECO_2 Speece Cone
- 10,000 gpm feed pump, 250 hp
- 18-in suction and discharge piping
- 20 ft x 30 ft barge
- LOX trailer including storage tank and vaporizer
- Supersaturated water diffusers

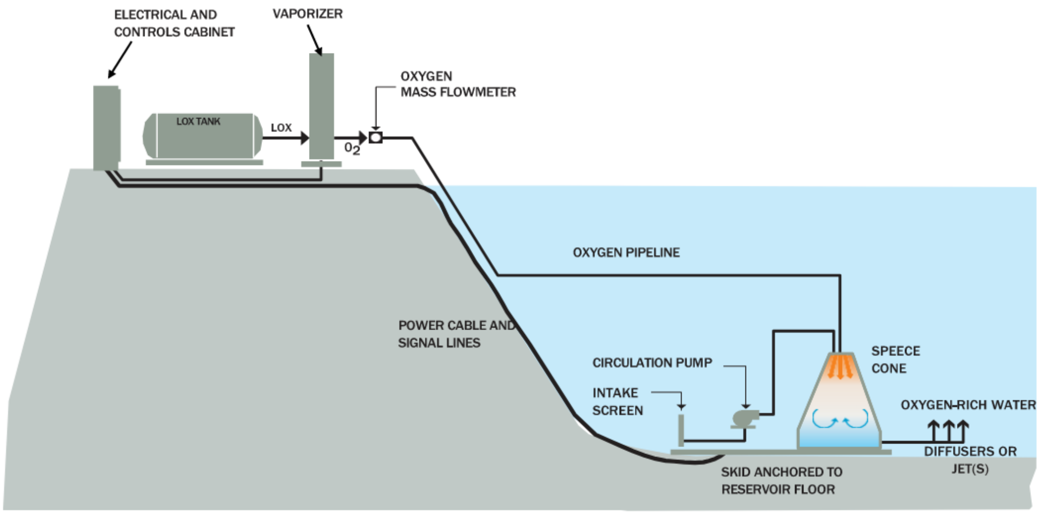


Figure 2-10. Speece cone schematic

2.3 Power and Communication

As discussed in Section 2.1, there is an existing power pole located approximately 200 feet north of the oxygenation site that may be used to power the equipment. Additional coordination with SDGE will be required to determine service requirements. Service requirements for power connections will be done through an approved SDGE service agreement. An approved SDGE service agreement will require that a developed civil and electrical site plan, electrical single line plan, and a load list be submitted for SDGE's record and review. The power pole nameplate is shown in Figure 2-11.

Figure 2-11. Power pole structure P513003

Most of the equipment will be located at the oxygenation site; however, the transfer pumps for the SDOX system will also require conduit and wiring. Since the transfer pumps will be located near the shoreline or within Lake Henshaw, it is recommended to route the conduit in PVC rigid steel down the embankment in parallel with the process piping. This approach will also be required for the Speece Cone configuration and its sidestream pumps to lift the water to the barge and subsequent Speece Cone vessels.

The service power requirements will be 480V 3-phase 450 amps via utility transformer and metering distribution panel to power four 430V pumps and a 15 kVA, 480V-208V/120V transformer with lighting panel to power the 120V PLC control panel and miscellaneous devices (i.e., lighting, instruments, etc.).

2.4 Utilities

For the field trial, there will be a minimal number of utilities required. The typical utilities will be summarized below with discussion on their necessity for the project.

- **A potable water connection** may be required for the emergency shower and eyewash station that would be near LOX chemical storage; however, this can be avoided if a portable eyewash station is used instead. These systems require water preservatives to prevent bacteria and algae growth. The cost estimate assumes a portable eyewash station will be used at the oxygenation site.
- **A sanitary sewer connection** will not be necessary as the oxygenation site will only contain the systems and LOX trailer. If desired, a portable restroom can be placed on site.
- **Utility water** will not be necessary at the oxygenation site although it would be beneficial to have access to hose down the area as needed.

2.5 Permitting Considerations

Based on recent experience with a hypolimnetic oxygenation system installation in a northern California reservoir, and preliminary queries of the California Department of Fish and Wildlife's (CDFW) California Natural Diversity Database (CNDDB) and USFWS Information for Planning and Conservation (IpaC) portal conducted for the *Lake Henshaw and Lake Wohlford Harmful Algal Blooms Management and Mitigation Plan* (Stillwater Sciences, 2022), the following are permitting considerations for the Lake Henshaw oxygenation system field trial (and potentially for a permanent installation). The below considerations should be refined following preliminary informal consultation with the resource agencies to confirm the current assumptions.

- Clean Water Act (CWA) Section 404
  - CWA Section 404 requires a permit from the U.S. Army Corps of Engineers (USACE) for construction and fill-related activities within the ordinary high-water mark of Lake Henshaw.
  - The project may qualify for a Nationwide Permit (NWP), for example NWP 27 for Aquatic Habitat Restoration, Enhancement, and Establishment Activities, which would streamline Section 404 permitting efforts. Permitting tasks should include time to determine the appropriate NWP type, or if an individual permit will instead be required.
  - The working assumption is that project "fill" activities would be confined to the installation of temporary oxygenation equipment (i.e., transfer pump, oxygenated water lines) at the bottom of the reservoir along the western shoreline near the dam, that wetlands would not be affected by the project, and that preparation of a jurisdictional wetland delineation would not be required.
  - A cultural resources evaluation is not anticipated to be required because there would be no ground disturbance, and there are no anticipated effects on historical properties or structures within the project footprint (Figure 2-1). However, a historic resources records search may be required for the NWP.
- Endangered Species Act (ESA) Section 7

  - USACE—as the federal nexus to the project via issuance of an CWA Section 404 permit—would need to coordinate with the U.S. Fish and Wildlife Service (USFWS) regarding ESA compliance though Section 7 consultation.
  - Construction activities for a field trial oxygenation system in the Lake Henshaw dam area could occur in potential habitat for state- and federally-listed species including, but not limited to: arroyo toad (*Bufo californicus*), western spadefoot (*Spea hammondii*), Stephen's kangaroo rat (*Dipodomys stephensi*), southcoast garter snake (*Thamnophis sirtalis*), tricolored blackbird (*Agelaius tricolor*), least Bell's vireo (*Vireo bellii pusillus*), and southwestern willow flycatcher (*Empidonax trailii extimus*). Additional review of wildlife permitting considerations following preliminary informal consultation with the agencies may result in the need to include other special-status species designations, such as CDFW Species of Special Concern or State Fully Protected species.
  - The District may be able to fulfill ESA Section 7 consultation requirements via technical assistance with the USFWS, if there would be no anticipated project effects on federally listed species. It may be possible to determine no effects via a coordination letter to USFWS based on the following:
    - Project effects would be confined to Lake Henshaw itself, existing access roads, and existing developed areas adjacent to the reservoir.
    - Any potential effects on water quality in the reservoir and the San Luis Rey River downstream of the project area would be beneficial.
  - If USFWS concurs with no anticipated project effects, then no Biological Assessment (BA) would be necessary. The outcome of technical assistance consultation with USFWS would also be submitted with the CWA Section 404 application.
  - Permitting tasks should include review of existing data regarding species surveys and biological evaluations in the project vicinity and coordination with USFWS.
  - No consultation with the National Marine Fisheries Service (NMFS) is expected as there are no listed anadromous salmonids that use San Luis Rey River downstream of the project area given existing unsuitable habitat conditions and barriers to fish passage.
- California Fish and Game Code (FGC) Section 1602
  - A Lake or Streambed Alteration (LSA) Agreement under California FGC Section 1602 applies to any project that will divert, obstruct, or change the natural flow of a river, stream or lake; change the bed, channel, or bank of a river, stream, or lake; use material from any river, stream, or lake; or deposit or dispose of material into any river, stream, or lake.
  - The working assumption is that the installation of temporary oxygenation equipment (i.e., transfer pump, oxygenated water lines) at the bottom of the reservoir along the western shoreline near the dam, would represent a minor change to the reservoir bed and would not substantially adversely affect existing fish or wildlife resources.
  - A biological resources evaluation would be included in the Section 1602 permit application, involving updated standard database queries for special-status wildlife (i.e., federally listed, state listed, state species of special concern, or state fully protected species) and special-status plants with the potential to occur in and around the project site. Given the planned placement of temporary oxygenation equipment in upland areas where trees are currently located, including aboveground oxygenated water lines running beneath the tree canopy toward the reservoir shoreline, a site survey is recommended to help determine whether construction activities are likely to adversely affect special status species. Coordination with

CDFW regarding avoidance measures identified in the biological resource evaluation would be needed to ensure potential impacts to state-listed species (if present) can be avoided.

  - Habitat restoration permitting pathways, such as the CDFW Habitat Restoration and Enhancement Act (HREA) for small habitat restoration projects, should be explored with CDFW to determine if the project meets the requirements for use of these permitting pathways. Under the HREA pathway, an LSA and California Endangered Species Act permit are not required.
- CWA Section 401
  - A CWA Section 401 water quality certification (WQC) would be needed from the San Diego Regional Water Quality Control Board (Regional Board) for activities that may result in a discharge to Waters of the State.
  - This requirement would be triggered by the in-water work to place the temporary oxygenation equipment (i.e., transfer pump, oxygenated water lines) at the bottom of the reservoir along the western shoreline near the dam, construction activities for temporary oxygenation equipment along the uplands adjacent to the dam, and the need for a CWA Section 404 permit.
  - Habitat restoration permitting pathways, such as the Regional Board’s Small Habitat Restoration Project (SHRP) pathway, should be explored with CDFW to determine if the project meets the requirements for use of these permitting pathways. Under the SHRP permitting pathway, an individual CWA Section 401 WQC would not be required. Rather, a notice of intent to utilize the SHRP process would be needed.
- California Environmental Quality Act (CEQA)
  - The project may be categorically exempt from CEQA under the following sections:
    - 15303 for the construction and location of a limited number of new, small facilities or structures.
    - 15304 for minor public alterations in the condition of land, water and vegetation which do not involve removal of healthy, mature, scenic trees.
  - If the project is not categorically exempt:
    - Initial Study/Mitigated Negative Declaration (IS/MSND) and detailed habitat assessments may be required for one or more of these species listed above as part of CEQA compliance.
- California Division of Safety of Dams (DSOD)
  - Coordination with DSOD is recommended due to the placement of temporary oxygenation equipment, including LOX delivery and storage facilities, proximal to the south saddle dam (Figure 2-1).
- San Diego County
  - Given the need for grading and site improvements to facilitate temporary oxygenation equipment installation and operations, it is anticipated that the project would require a San Deigo County Planning and Development Services (PDS) site grading plan or improvement plan. A prescreen (preliminary review) for land development would help determine whether these plans are necessary and what information is needed for the permit process.

Section 3

Experimental Plan

3.1 Objective and Goals

The purpose of the full-scale trial will be to evaluate the performance and effectiveness of oxygenation to improve water quality to mitigate harmful algal blooms. This objective will be evaluated based on the following metrics:

- Increase in DO to target levels (5 mg/L or above in bottom waters)
- Decrease in concentrations of phosphorous and nitrogen
- Decrease in algal cell counts, chlorophyll-A, and phycocyanin
- Decrease in concentrations of cyanotoxins (microcystin, anatoxin)
- Improvement in water quality to allow water releases from Lake Henshaw to the San Luis Rey River

These parameters will be compared to the baseline condition just prior to starting the trial and to values obtained from previous years that are representative of seasonal conditions observed during the trial period. The consulting team will use data collected since 2020 as part of the overall HABs management plan to compare values and determine the significance of trends observed during the trial.

3.2 Planned Test Scenarios and Durations

The temporary oxygenation system will have the ability to add 1.5 to 5 tons of oxygen per day to the lake. Three different oxygen addition rates will be tested to compare the effectiveness of each dose and how much of the lake is affected by each rate. Table 3-1 shows the operational details for each test scenario. The sampling parameters, location and timing of testing are outlined in the following section.

Table 3-1. Oxygenation Trial Test Scenarios

Test Number	Description	Oxygen Addition Rate (tons/day)	Duration	Goal
0	Baseline – no oxygen	0	2 weeks	Quantify pre-test conditions
1	High	5	5 weeks	Observe high-rate addition effects
2	Medium	3	5 weeks	Observe changes from lowering rate
3	Low	1.5	5 weeks	Observe changes from lowering rate
4	No Oxygen	0	3 weeks	Observe weekly changes resulting from oxygenation system being out of service. At the end of the period, compare with baseline condition.
5	Repeat Testing	Value selected from 1.5 to 5	5 weeks	Decide which oxygenation rate to retest after analyzing results from tests 1 – 3. Duplicate testing will be done to compare two different test periods.
Total Duration			25 weeks	

The initial plan outlined in Table 3-1 should be kept flexible to accommodate real world events and to allow modifications of later test conditions based on results from earlier ones. Note that the total duration of the initial plan is 25 weeks or approximately 6 months to span at least two seasons (spring and summer or summer and fall). The final schedule of all activities should include 2 to 3 months of additional time to account for potential delays or issues encountered during the test period such as runoff and/or releases affecting the lake level.

3.3 Water Quality Analysis and Frequency

Water quality conditions within the lake will be monitored through a combination of continuous data sondes and manual data collection with handheld instruments and grab sample analyses.

Figure 3-1 shows the established monitoring sites within Lake Henshaw. These sites will be used to monitor water quality during the trial to allow direct comparison with historical water quality values also collected at these locations. The three main monitoring locations will be:

- BL buoy line (deepest part of lake)
- FD fishing dock (mid lake monitoring)
- SL south lake (furthest in lake monitoring location from oxygenation point

Figure 3-1. Lake Henshaw monitoring sites

These locations have been monitored since June 2020 for a suite of water quality parameters, including cyanotoxins. The test plan includes deploying an unattended multiparameter sonde at each of these locations to measure DO, temperature, chlorophyll-A, and phycocyanin on a continuous basis.

Three other locations (ML - mid lake, NL – north lake, and ES – east shore) will not be equipped with sondes for continuous data reporting, but they are included in the experimental plan for periodic vertical profile monitoring and/or grab sampling. Data from these sites will provide insight into the geospatial impacts of the oxygenation plumes. For example, will the DO be increased at the north lake sample site for all rates tested, or only the higher ones? Is the east shore impacted at any rate?

Table 3-2 outlines the sampling plan including type of measurement, water quality parameter, sampling frequency, sampling locations, and total number of grab samples.

Table 3-2. Sampling Plan

Type	Parameters	Frequency	Locations						Number of Samples
			BL	FD	SL	ML	NL	ES	
Multiparameter Sonde	DO Temperature Chlorophyll-A Phycocyanin	Continuous	X	X	X				N/A
Vertical Profile	DO/Temp	Weekly[a]	X	X	X	X	X	X	N/A
In Situ Measurement	Secchi Depth	Weekly[a]	X	X	X	X	X	X	N/A
Grab Sample	Cyanotoxins	End of each Test Scenario	X	X	X	X	X	X	36
Grab Sample	Algal Cell Counts	Twice per Test Scenario (midpoint and end)	X	X	X	X	X	X	72
Grab Sample	Chlorophyll-A	Twice per Test Scenario (midpoint and end)	X	X	X	X	X	X	72
Grab Sample	Phycocyanin	Twice per Test Scenario (midpoint and end)	X	X	X	X	X	X	72
Grab Sample	Phosphorous (Total and ortho-P)	Twice per Test Scenario (midpoint and end)	X	X	X	X	X	X	72
Grab Sample	Nitrogen (TN, Nitrate, Ammonia)	Twice per Test Scenario (midpoint and end)	X	X	X	X	X	X	72
								Subtotal	396

a. *If possible, to be tested on the same day each week for consistency and interpretation of results*

A synoptic survey will also be conducted at the end of each test scenario to determine the geospatial impacts of oxygen addition at each rate. This work will involve measuring DO and temperature in vertical profiles at multiple locations across the area of the lake using a defined grid pattern. This work is estimated to take approximately six hours per event using a sonde and a boat equipped with GPS so that the same grid pattern sites are monitored each time.

3.4 Staffing Needs

Personnel will be needed to conduct this oxygenation trial and analyze the results. The tasks can be grouped into the following categories:

- **Site preparation –** As discussed in Section 2, the area where the temporary equipment and LOX trailer will be located needs to be graded and prepared for installation of equipment. This work can be done by a Contractor or by Vista Irrigation District (VID) staff if they have the skills and equipment available. The area also needs to be fenced and secured to keep the public away from the equipment.
- **Access road improvements –** Also discussed in Section 2, the existing dirt road needs to widened, compacted, and a gravel layer added. This work can be done by a Contractor or by VID staff if they have the skills and equipment available.
- **Equipment installation and start-up –** The equipment supplier will be responsible for placing their equipment onsite, but a Contractor or qualified VID staff are needed to install the piping between components and run the conduit and cable to provide power to the units. A diving team will be needed to install and remove the temporary diffuser piping within the lake. Representatives from the equipment manufacturer will be onsite for startup along with members of the engineering team and VID staff who will be local coordinators.
- **Physical system monitoring –** The oxygen dissolution equipment can be monitored remotely through cellular connection to the onsite system control panel. There are automatic shutdowns configured with the control system and associated alarms that can be monitored through this connection. During pre-planning meetings, the system for alerting VID staff to these alarms will need to be determined whether it be through cellular connection or notification by the supplier. Local personnel should also visit the site twice a week to do a visual inspection with a checklist to verify that the system is functioning, no apparent leaks are present, and no damage has occurred to physical components.
- **Water quality monitoring –** For the sampling events where in-situ measurements are performed and grab samples are collected and transported to the lab, this work can be done by VID staff, or outsourced to the consulting team or another private firm. For the continuously recording data sondes, there are two options available.
  - **Option 1 - outsource this monitoring** to a private company like LakeTech Consulting, who owns and deploys units with a multiparameter sonde attached to a buoy and cellular unit as shown in Figure 3-2. LakeTech also sets up a digital dashboard with live data streams and weather conditions which would be very useful for monitoring results and making decisions about the next test condition on the schedule. This service from an outside company would include rental costs for the sonde for 9 months to 1 year, an annual subscription fee for setting up the platform dashboards, and site visits to maintain the buoys and potentially collect additional samples and profiles for sampling events. LakeTech has not had issues with public accessing the buoys and a barrier is likely not required. The buoys can be disguised as vegetation mats or ducks if needed.
  - **Option 2 – purchase or rent multiparameter sondes** and perform data collection and maintenance with VID or consulting team staff.
- **Data analysis and reporting** – This work would be completed by the consulting team overseeing the study. The analysis will involve combining continuous data streams with discrete data from both field measurements and laboratory reports. It will be important to complete data analysis at the end of each test condition to make informed decisions about how the next scenario should be conducted and evaluated. Regular updates would be provided during monthly meetings and written summaries at the end of each test condition. A final report would be issued with a detailed summary of the testing, results, and recommendations.

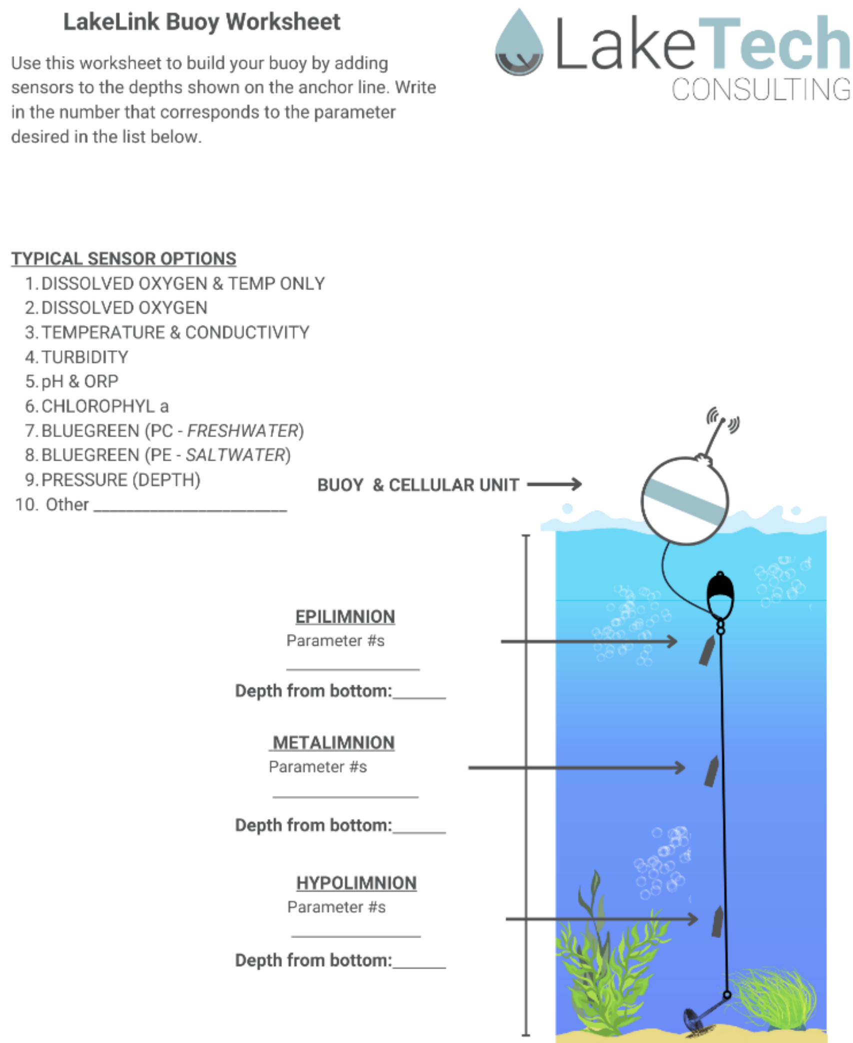


Figure 3-2. LakeTech rental buoy with multiparameter sonde and cellular unit

Section 4

Budgetary Cost Estimate

4.1 Cost Estimate

The cost estimate for this oxygenation trial is divided into two categories: 1) fixed costs for site improvements along with installation/start-up of the temporary equipment and systems; 2) monthly rental fees and chemical/electrical purchase costs.

A Class 5 cost estimate for site improvements needed to install the temporary oxygenation via SDOX was assembled in accordance with Association for the Advancement of Cost Engineering (AACE) International criteria. The accuracy of Class 5 estimates ranges from -50 to +100 percent. The capital costs were developed from unit costs, vendor supplied budgetary quotes, fixed fees, and scaled from recent projects like the San Pablo Reservoir Speece Cone oxygenation project in northern California.

The monthly costs account for chemical purchase, power costs, rental equipment, and O&M. These items were developed from unit costs and vendor-supplied budgetary proposals.

Table 4-1 and Table 4-2 summarize the site improvements cost and monthly costs, respectively. It is assumed that the field trial will last approximately 9-months for the SDOX system; however, if the Speece-Cone oxygenation system is selected, a 1-year minimum rental agreement is required. The costs for a temporary Speece Cone system were not evaluated in detail but are the same order of magnitude as the SDOX system. The total costs of the project for a 9-month to 12-month range are summarized in Table 4-3 including the Class 5 estimate ranges for the site improvement costs.

Table 4-1. Fixed Cost Estimate (Site Improvements, Install, Study)	
Parameter	**Cost**
Site Clearing and Preparation[a]	$25,200
Gravel Roadway[b]	$86,020
Gates, Fencing[c]	$8,775
Hose Piping and Pump Rental Installation[d]	$130,344
Break Tank[e]	$14,250
HDPE Piping and ACBM[f]	$56,988
Electrical[g]	$107,000
Diver Installation[h]	$15,000
Capital Cost, 7/2023	**$287,105**
Engineer Drawings for SDG&E–Fixed Cost	$100,000
Start-Up and Training – Fixed Cost	$15,000
Data Analysis and Reporting – Fixed Cost	$100,000
Permitting – Fixed Cost[i]	$107,500
Undesign/Undevelop Contingency – 30.0%	$229,823
Construction Cost, 7/2023	**$996,000**

a. *Based on $7 per square yard with an estimated clear and grub area of 3,600 square yards. Unit costs developed from 100% contractor estimate. If work is not contracted out and VID purchases materials and performs work, then there may be cost savings.*

b. *Based on $22 per square yard with a total of 3,910 square yards. If work is not contracted out and VID purchases materials and performs work, then there may be cost savings.*

c. *Based on $39 per linear feet with a total of 225 feet If work is not contracted out and VID purchases materials and performs work, then there may be cost savings.*

d. *Provided by Xylem in August 2023. Includes installation and one-time fees for pump rentals.*

e. *Provided by PolyProcessing in August 2023.*

f. *Scaled from San Pablo Reservoir July 2021 construction schedule of values and brought to current year.*

g. *Includes electrical estimate for equipment and labor, from power pole to site and site to lake with $5,000 SDG&E engineering and design fee. SDG&E will cover the utility transform and wiring from pole to metering switchboard. This is a rough order magnitude of cost based on experience with SDG&E. Further coordination is required with SDG&E to confirm level of effort and construction costs.*

h. *Based on Lake Hodges 2021 installation dives.*

i. *Based on average from range of $65,000 to $150,000. Does not include permitting fees. This estimate should be refined following preliminary informal consultation with the resource agencies.*

Table 4-2. Monthly Cost Estimate

Parameter	Cost per Month ($/month)
Equipment	
Transfer Pumps and Components[a]	$14,035
SDOX Container[b]	$29,000
LOX Tank Lease[b]	$9,000
Security Camera[c]	$250
Eye Wash Station[d]	$460
Buoy Monitoring[e]	$7,444
O&M	
Pump Power[f]	$21,820
LOX Chemicals[g]	$12,765
Laboratory Analysis[h]	$5,380
Diver Maintenance[i]	$1,333
Staff Needs[j]	$2,907
Monthly Subtotal, 8/2023	**$104,400**
Undesign/Undevelop Contingency – 20.0%	$20,880
Monthly Total, 8/2023	**$125,280**

a. Based on budgetary proposal from Xylem dated August 16, 2023.
b. Based on budgetary costs provided by Chart Industries in July 2023.
c. Based on budgetary cost provided by Silverstrand Technologies in August 2023.
d. Based on budgetary cost provided by United Rentals in August 2023.
e. Based on budgetary costs provided by LakeTech Consulting in August 2023. Monthly cost is based on installation fee, dashboard subscription, 3 buoy rentals and three maintenance visits divided by a 9-month duration.
f. Based on $0.15 per kilowatt-hour. Monthly costs is based on the entire power needs detailed in the test scenario divided by a 9-month duration.
g. Based on $7.00 per 1,000 standard cubic foot of LOX and $200 fee per drop at Lake Henshaw. Monthly costs is based on the entire LOX needs detailed in the test scenario divided by a 9-month duration.
h. Based on 2023 Lake Henshaw sampling costs. Monthly cost is based on the testing scenarios divided by a 9-month duration.
i. Based on Lake Hodges 2021 maintenance dives divided by a 9-month duration.
j. Based on Water Resource Aide salary with a site visit two times a week for 4-hours. It is assumed a sampling event will require a total of 12-hours for sampling, bottling, and preparation. Total estimated cost was divided by a 9-month duration.

Table 4-3. Total Cost Estimate (Monthly plus Fixed Costs)

Parameter	Lower Range (-50%)[a]	Estimated Cost	Upper Range(+100%)[a]
9-month Project Duration	$1,625,000	$2,123,000	$3,119,000
12-month Project Duration	$2,001,000	$2,499,000	$3,495,000

a. Range is calculated using Class 5 AACE criteria with a cost estimate accuracy for the site improvements ranging from -50 to +100 percent.

Section 5

Summary

This Work Plan outlines the requirements for a temporary, lake oxygenation field trial for Lake Henshaw focused on the containerized SDOX system that is readily available for lease. Although certain site improvements are needed to accommodate rental equipment, the temporary trial allows real world evaluation of the concept without the substantial capital investment required for a permanent installation. The trial will also provide information needed to inform the sizing and cost of a permanent oxygenation system for Lake Henshaw.

The purpose of the full-scale trial will be to evaluate the performance and effectiveness of oxygenation to improve water quality to mitigate harmful algal blooms. This objective will be evaluated based on the following metrics:

- Increase in DO to target levels (5 mg/L or above in bottom waters)
- Decrease in concentrations of phosphorous and nitrogen
- Decrease in algal cell counts, chlorophyll-A, and phycocyanin
- Decrease in concentrations of cyanotoxins (microcystin, anatoxin)
- Improvement in water quality to allow water releases from Lake Henshaw to the San Luis Rey River

These parameters will be compared to the baseline condition just prior to starting the trial and to values obtained from previous years that are representative of seasonal conditions observed during the trial period. The consulting team will use data collected since 2020 as part of the overall HABs management plan to compare values and determine the significance of trends observed during the trial period.

The field trial is based on 6-months of testing with costs for leasing based on 9 to 12-months to account for start-up and transition time while allowing operation for a full year if desired. Once the field trial is complete, the rental equipment will be returned with the following purchased items remaining:

- Gravel roadway
- Break tank
- HDPE Piping and ACBM
- Electrical upgrades
- Permits

If the field trial proves to be successful and a permanent installation is desired, some of these purchased components from the field trial can be reused. It may also be possible to purchase the rental SDOX unit if a containerized configuration is acceptable for the permanent facility. However, note that a new permanent oxygen storage and feed system would need to be constructed for a permanent facility. Also note, that if a different site is selected for the permanent facility, there will be additional costs associated with the new location for roadway access, electrical, and other utilities.

Section 6

Limitations

This document was prepared solely for Vista Irrigation District in accordance with professional standards at the time the services were performed and in accordance with the contract between Stillwater Sciences and Brown and Caldwell dated January 9, 2023. This document is governed by the specific scope of work authorized by Stillwater Sciences; it is not intended to be relied upon by any other party except for regulatory authorities contemplated by the scope of work. We have relied on information or instructions provided by Stillwater Sciences and other parties and, unless otherwise expressly indicated, have made no independent investigation as to the validity, completeness, or accuracy of such information.

Section 7

References

Beutel, M. W. (2003). Hypolimnetic Anoxia and Sediment Oxygen Demand in California Drinking Water Reservoirs. *Lake and Reservoir Management*, 208-221.

Stillwater Sciences. (2022). *Lake Henshaw and Lake Wohlford Harmful Algal Blooms Management and Mitigation Plan.* Prepared by Stillwater Sciences, Berkeley, California for Vista Irrigation District, Vista, California and City of Escondido, Escondido, California.

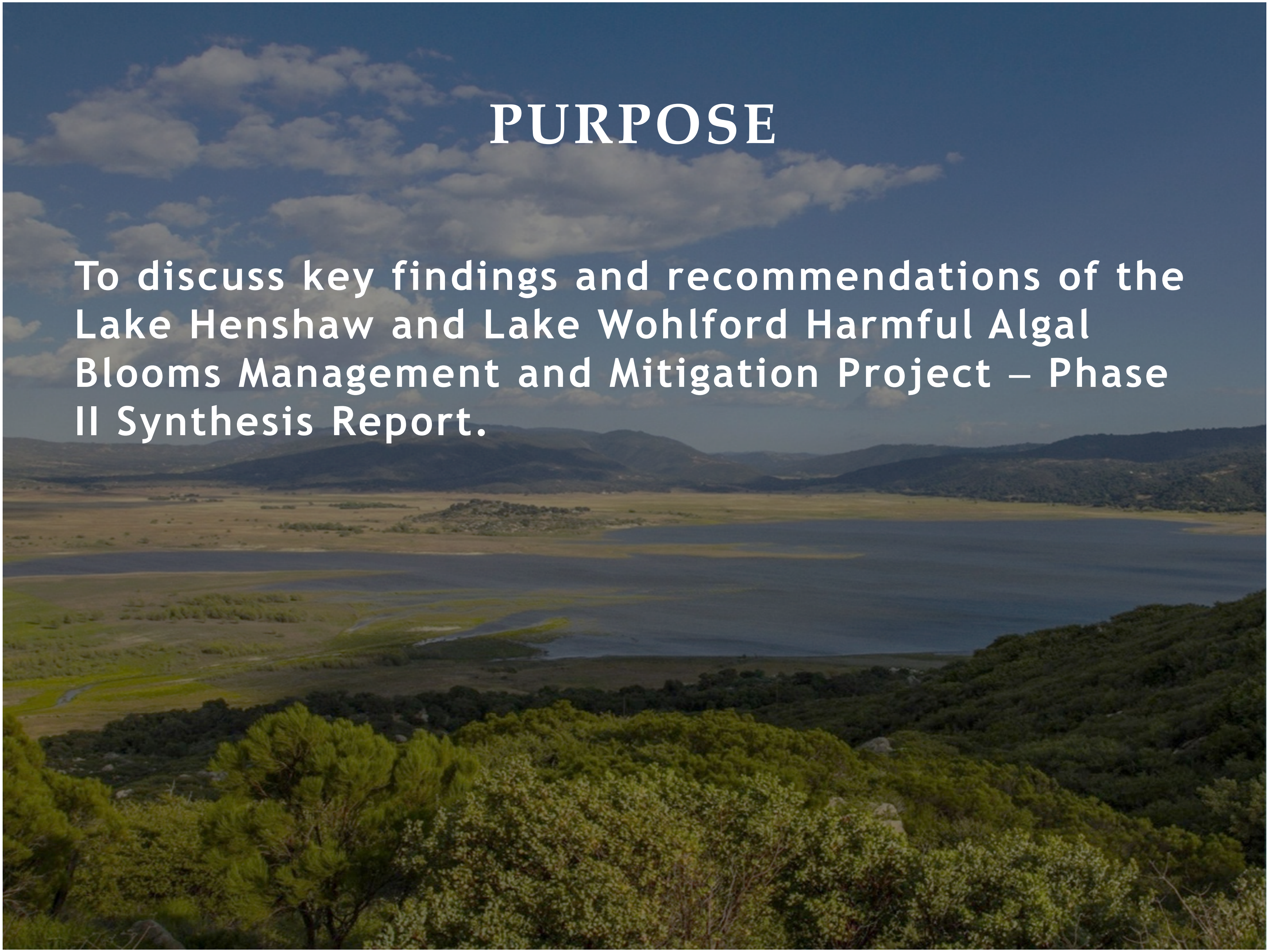
Exhibit A

Lakes Henshaw and Wohlford
Harmful Algal Blooms Management – Phase II

Presentation to the Vista Irrigation District Board of Directors
December 6, 2023

Dr. Maia Singer,
Stillwater Sciences

Stillwater Sciences
AHA
Brown AND Caldwell
Robertson - Bryan, Inc.
Solutions for Progress



PURPOSE

To discuss key findings and recommendations of the Lake Henshaw and Lake Wohlford Harmful Algal Blooms Management and Mitigation Project – Phase II Synthesis Report.

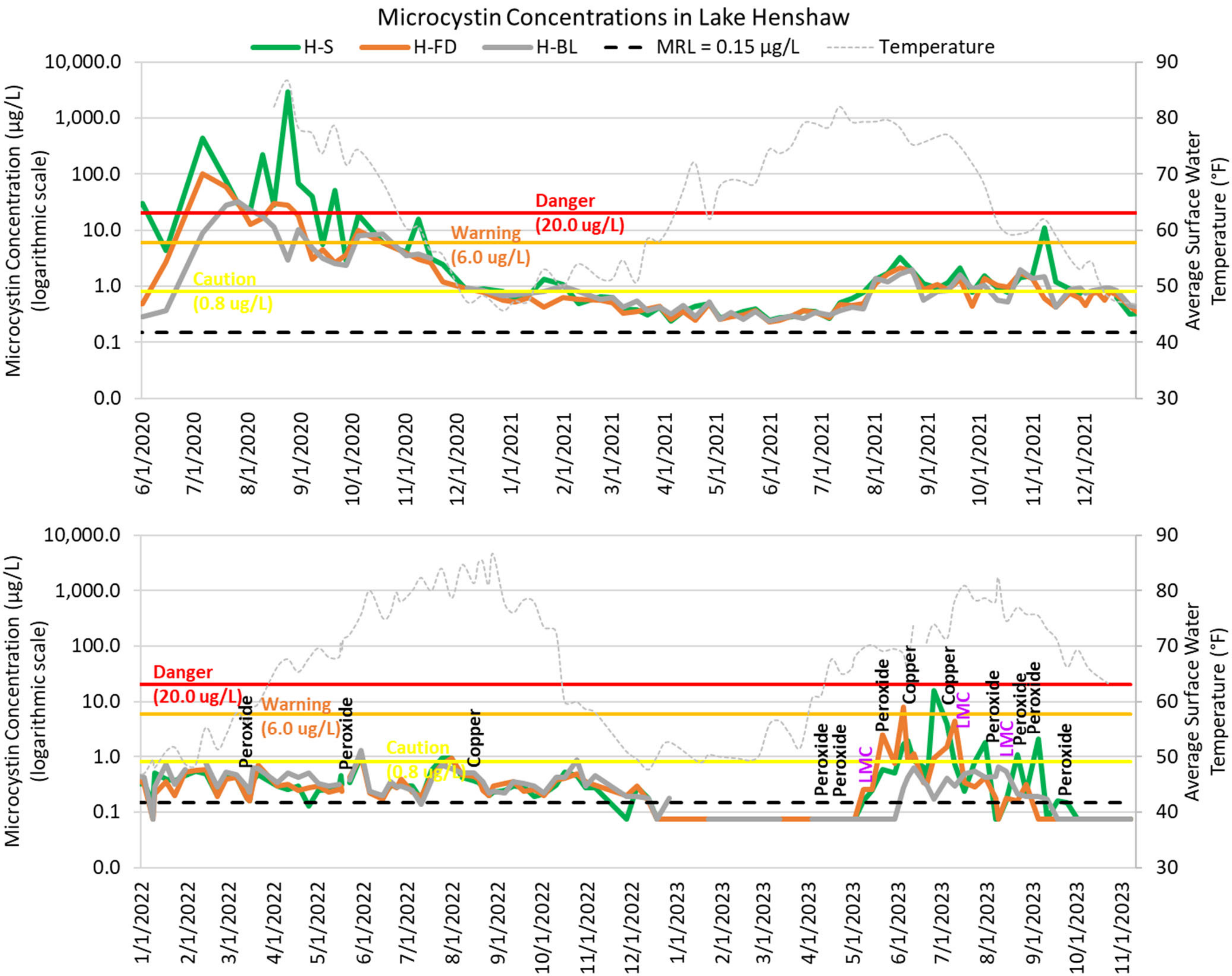
AGENDA

- Background
- Project phases and objectives
- Conceptual models of factors influencing HABs production and treatment effects
- Phase II summary recommendations for HABs prevention and mitigation

BACKGROUND

- **Excessive cyanobacteria often results in seasonal water quality problems**
  - Low dissolved oxygen
  - High pH
  - High un-ionized ammonia
  - Cyanotoxins – microcystin, cylindrospermopsin, anatoxin-a, saxitoxin

- **At elevated concentrations, cyanotoxins can cause**
  - Public health concerns
  - Bioaccumulation in aquatic biota - shellfish, fish, marine mammals



Microcystin Concentrations in Lake Henshaw
H-S
H-FD
H-BL
MRL = 0.15 µg/L
Temperature
Microcystin Concentration (µg/L) (logarithmic scale)
Average Surface Water Temperature (°F)
10,000.0
1,000.0
100.0
10.0
1.0
0.1
0.0
90
80
70
60
50
40
30
Danger (20.0 ug/L)
Warning (6.0 ug/L)
Caution (0.8 ug/L)
6/1/2020
7/1/2020
8/1/2020
9/1/2020
10/1/2020
11/1/2020
12/1/2020
1/1/2021
2/1/2021
3/1/2021
4/1/2021
5/1/2021
6/1/2021
7/1/2021
8/1/2021
9/1/2021
10/1/2021
11/1/2021
12/1/2021
Microcystin Concentration (µg/L) (logarithmic scale)
Average Surface Water Temperature (°F)
Danger (20.0 ug/L)
Warning (6.0 ug/L)
Caution (0.8 ug/L)
Peroxide
Peroxide
Copper
Peroxide
Peroxide
LMC
Peroxide
Copper
Copper
LMC
Peroxide
LMC
Peroxide
Peroxide
Peroxide
1/1/2022
2/1/2022
3/1/2022
4/1/2022
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8/1/2022
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10/1/2022
11/1/2022
12/1/2022
1/1/2023
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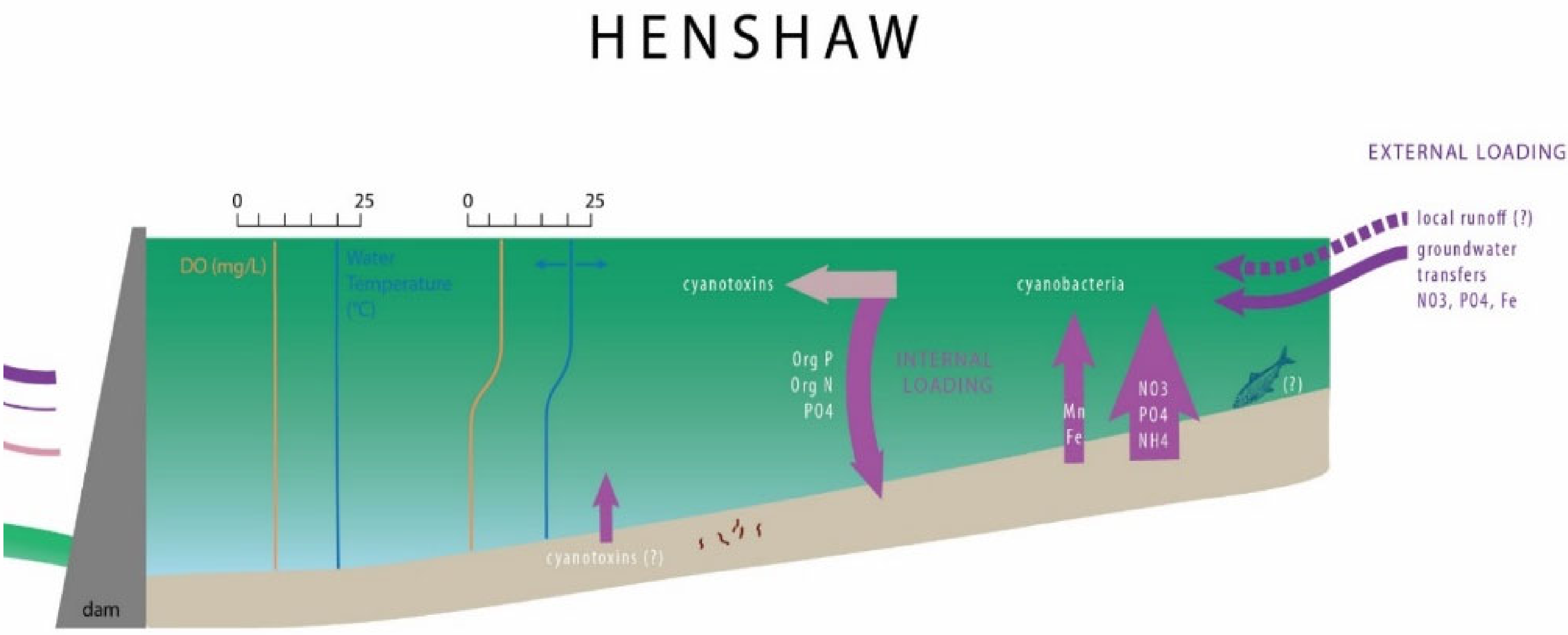
8/1/2023
9/1/2023
10/1/2023
11/1/2023

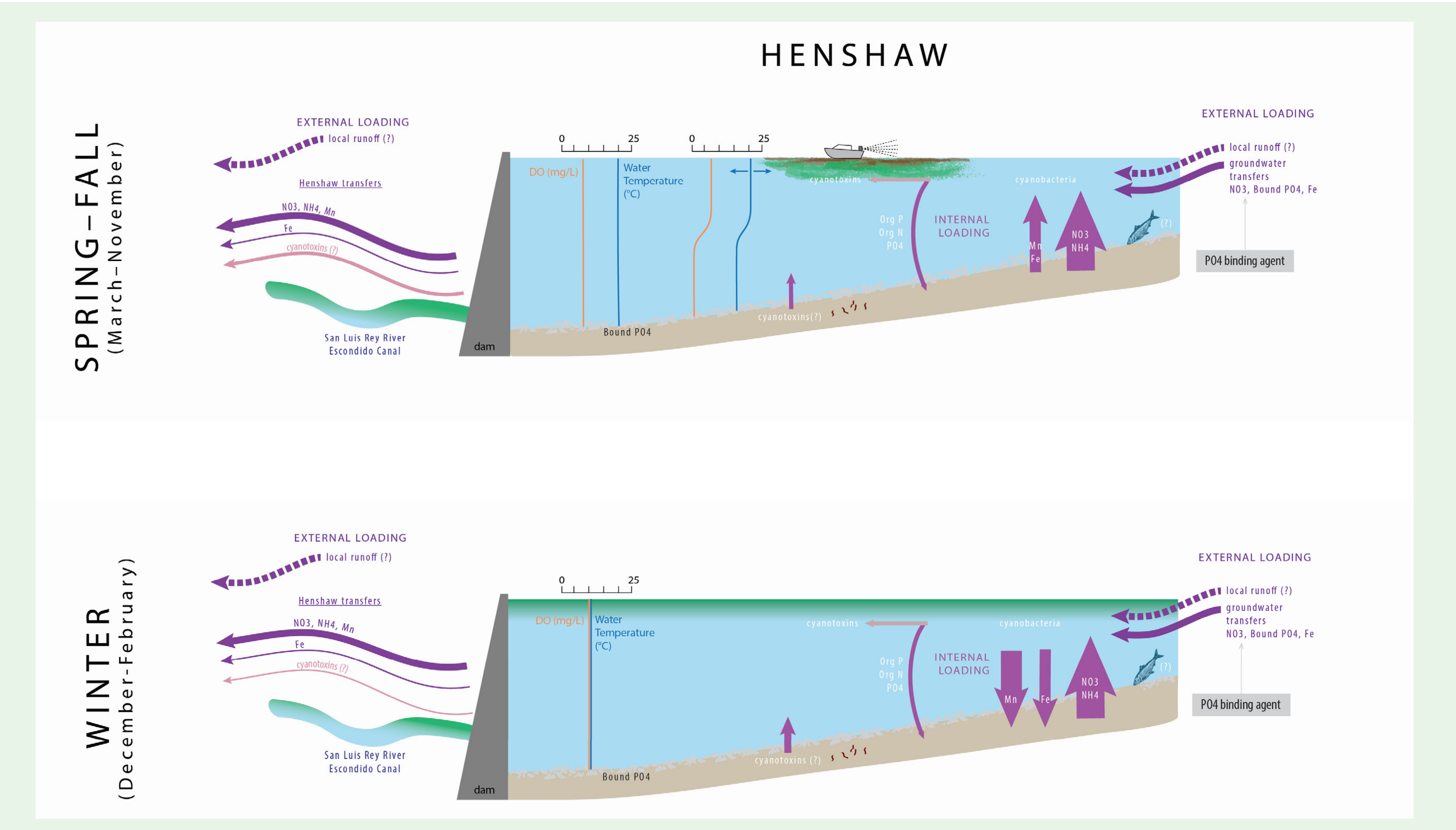
PROJECT PHASES AND OBJECTIVES

- ***Phase I (2021-2022)***
  - Develop short-term solutions for mitigating or treating HABs
  - Screen potential long-term alternatives for preventing or minimizing HABs
  - Develop Water Quality Monitoring Plan
  - Develop HABs Management and Mitigation Plan
  - Gather data to inform Phase II
- ***Phase II (2023)***
  - Continued efforts to collect Henshaw data to inform implementation of long-term prevention/minimization alternatives selected during Phase I
  - Decide whether to proceed with pilot test(s) for selected long-term alternatives, consistent with recommendations in the HABs Management and Mitigation Plan

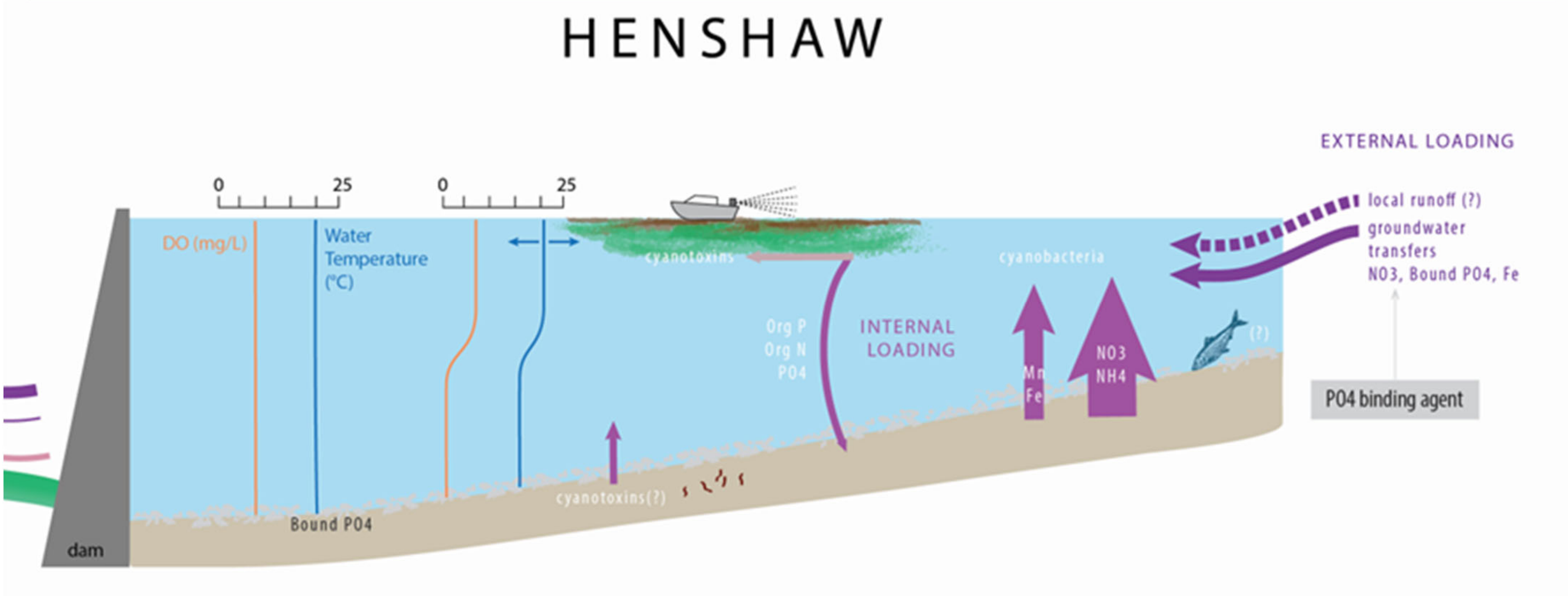
PHASE I - EXISTING CONDITIONS CONCEPTUAL MODEL



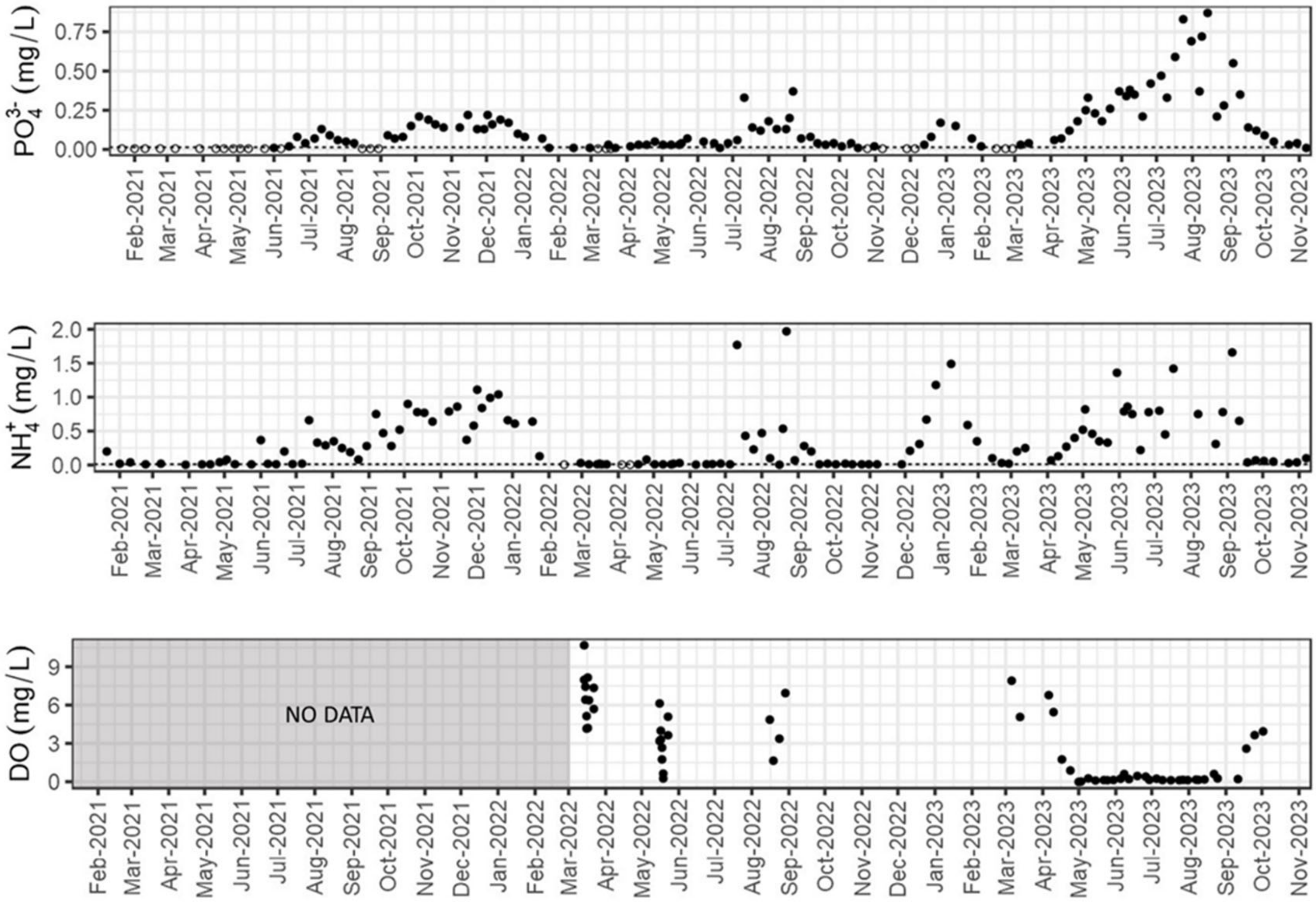
PHASE II - HYPOTHESIZED EFFECTS CONCEPTUAL MODEL



PHASE II - HYPOTHESIZED EFFECTS CONCEPTUAL MODEL



KEY FACTORS INFLUENCING HABS PRODUCTION



PHASE II SUMMARY RECOMMENDATIONS

(DRAFT SYNTHESIS REPORT TABLE 6-1)

HABS PREVENTION AND MITIGATION METHODS

Prevention (P)

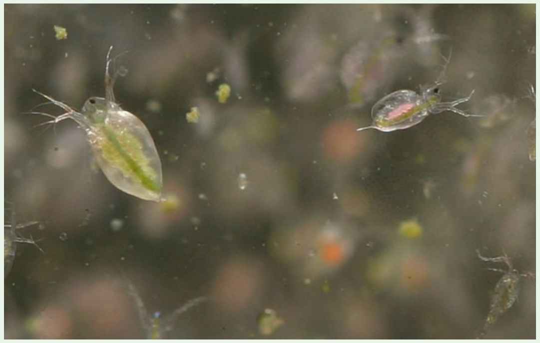
Treat the *source* of the problem

Mitigation (M)

Treat the *symptom*

Physical

Chemical

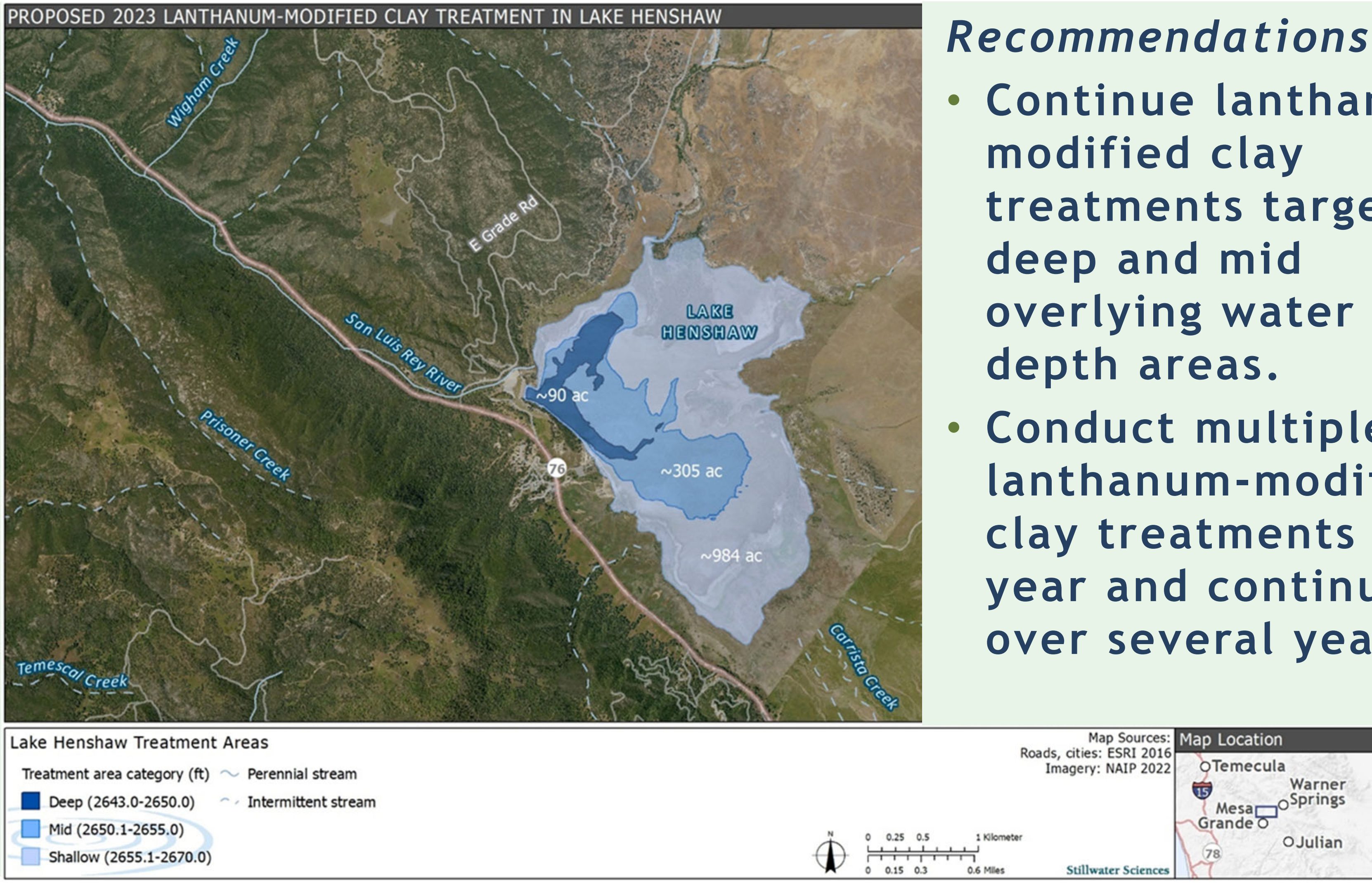


Biological

PHOSPHORUS INACTIVATION/CHEMICAL SEDIMENT SEALING

- HABs *Prevention*
- Chemical method
- In-lake treatment
- Implemented during Phase II
- Continue to implement in short term (2024-2025)

PHOSPHORUS INACTIVATION/CHEMICAL SEDIMENT SEALING



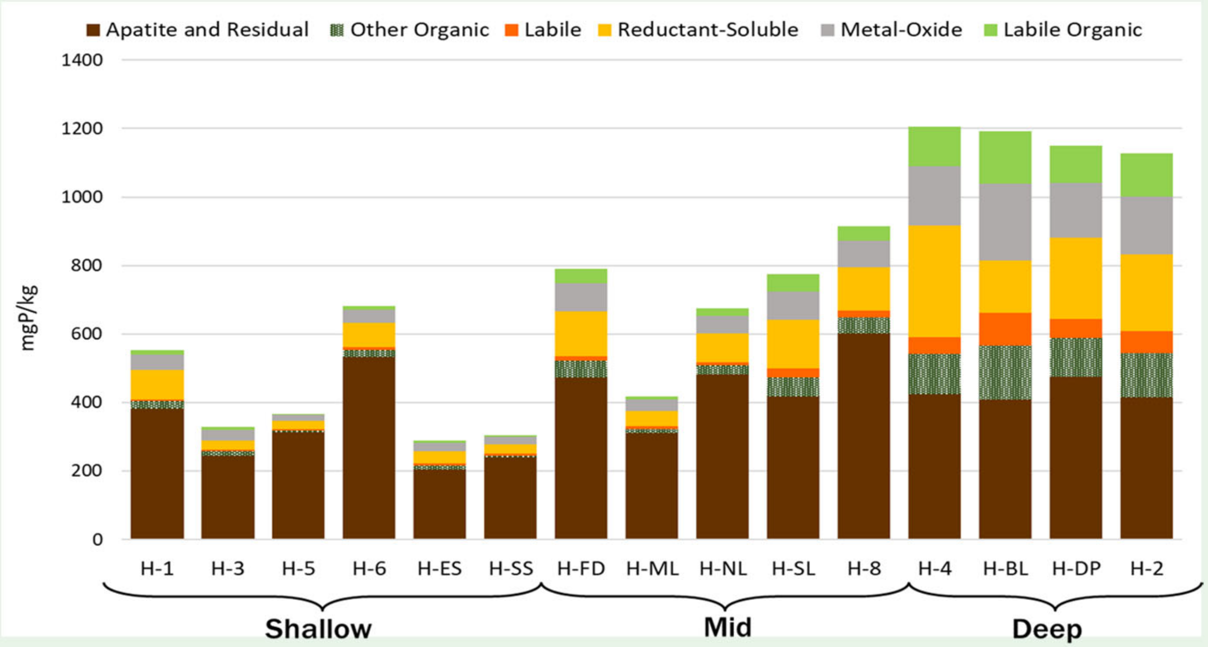
Recommendations

- Continue lanthanum-modified clay treatments targeting deep and mid overlying water depth areas.
- Conduct multiple lanthanum-modified clay treatments each year and continue over several years.

PHOSPHORUS INACTIVATION/CHEMICAL SEDIMENT SEALING

Recommendations (cont.)

- Conduct analysis of phosphorus fractions in Lake Henshaw surficial sediments every two or three years to demonstrate whether and how BAP fractions change over time in response to treatments.



SOURCE WATER NUTRIENT CONTROL

- HABs *Prevention*
- Chemical method
- Out-of-lake treatment
- Planning during Phase II
- No potential to implement in short term (2024-2025) due to permitting limitations

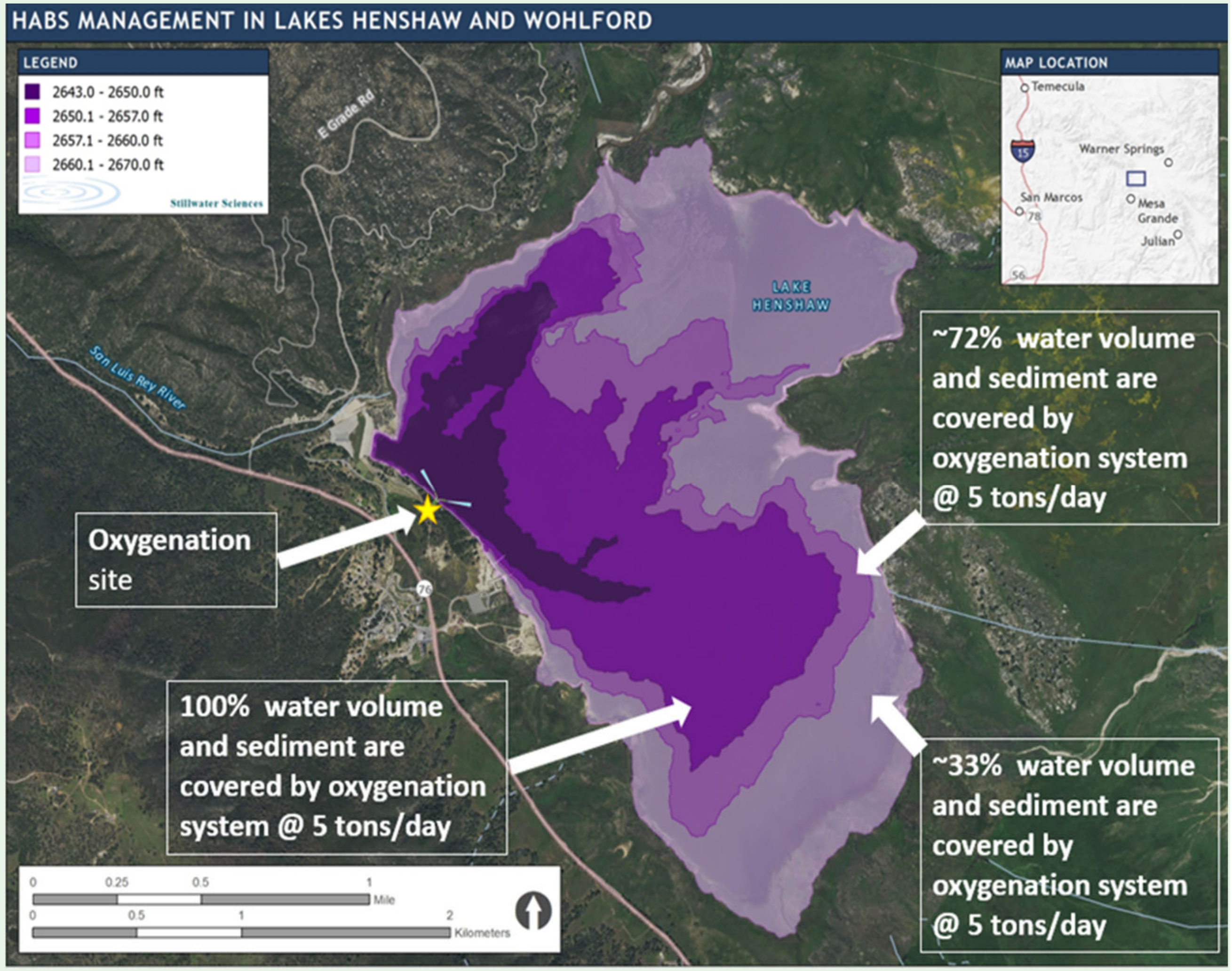
SOURCE WATER NUTRIENT CONTROL

Recommendations

- Coordinate with product manufacturers and Regional Board to determine whether there is a P binding agent that would be considered an allowable additive under the District’s existing water supply permit.
- After permit issuance, conduct operational trial for treatment of the wellfield terminus.

OXYGENATION

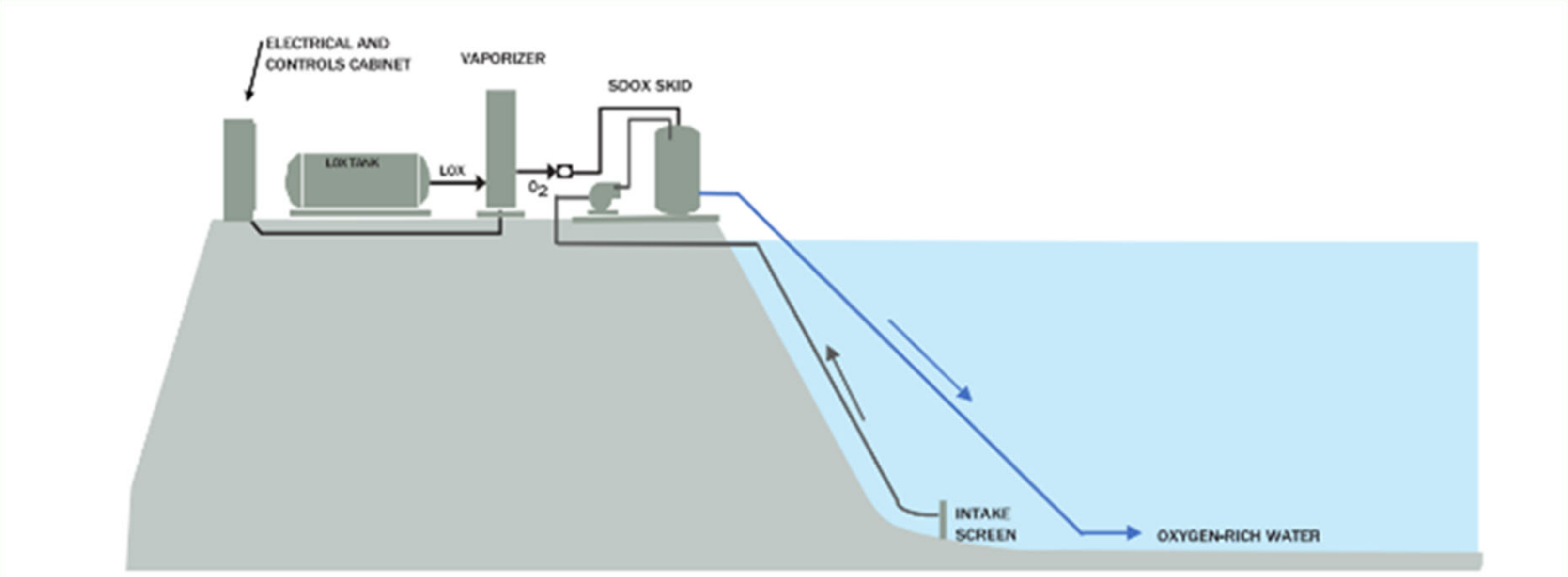
- HABs *Prevention*
- Chemical method
- In-lake treatment
- Planning during Phase II
- Continue preparations to implement in short term (2024-2025)



OXYGENATION

Recommendations

- Prepare to implement a full-scale field trial SDOX system in Lake Henshaw.



OXYGENATION

Recommendations

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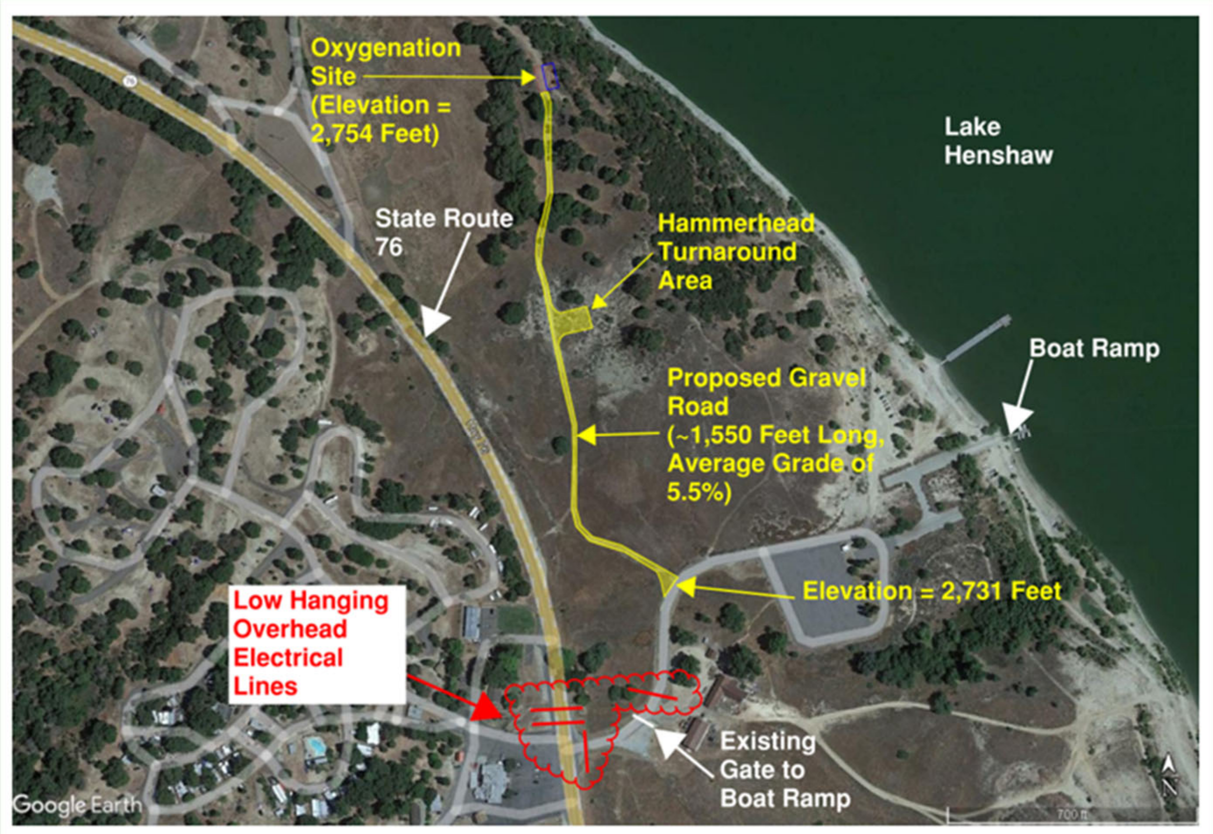

Figure 2-3. Roadway access map

OXYGENATION

Recommendations

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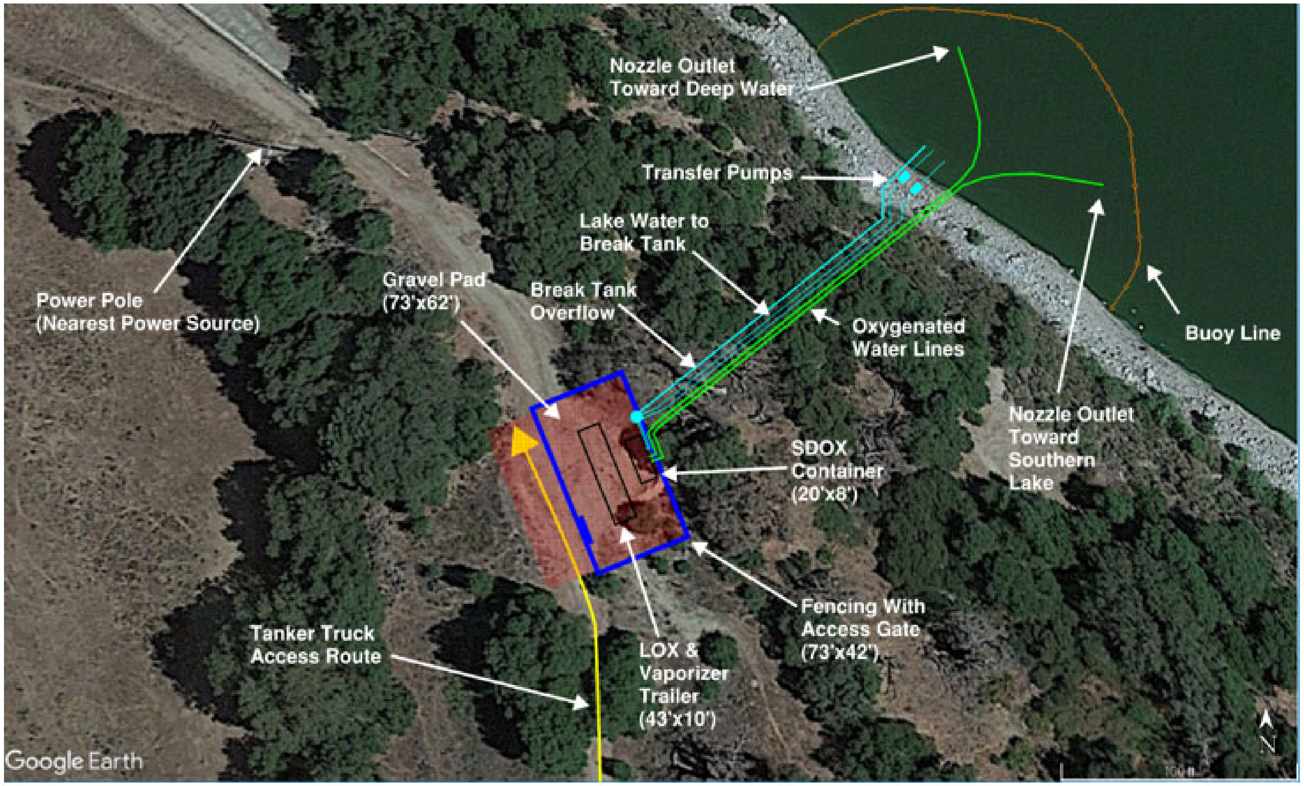


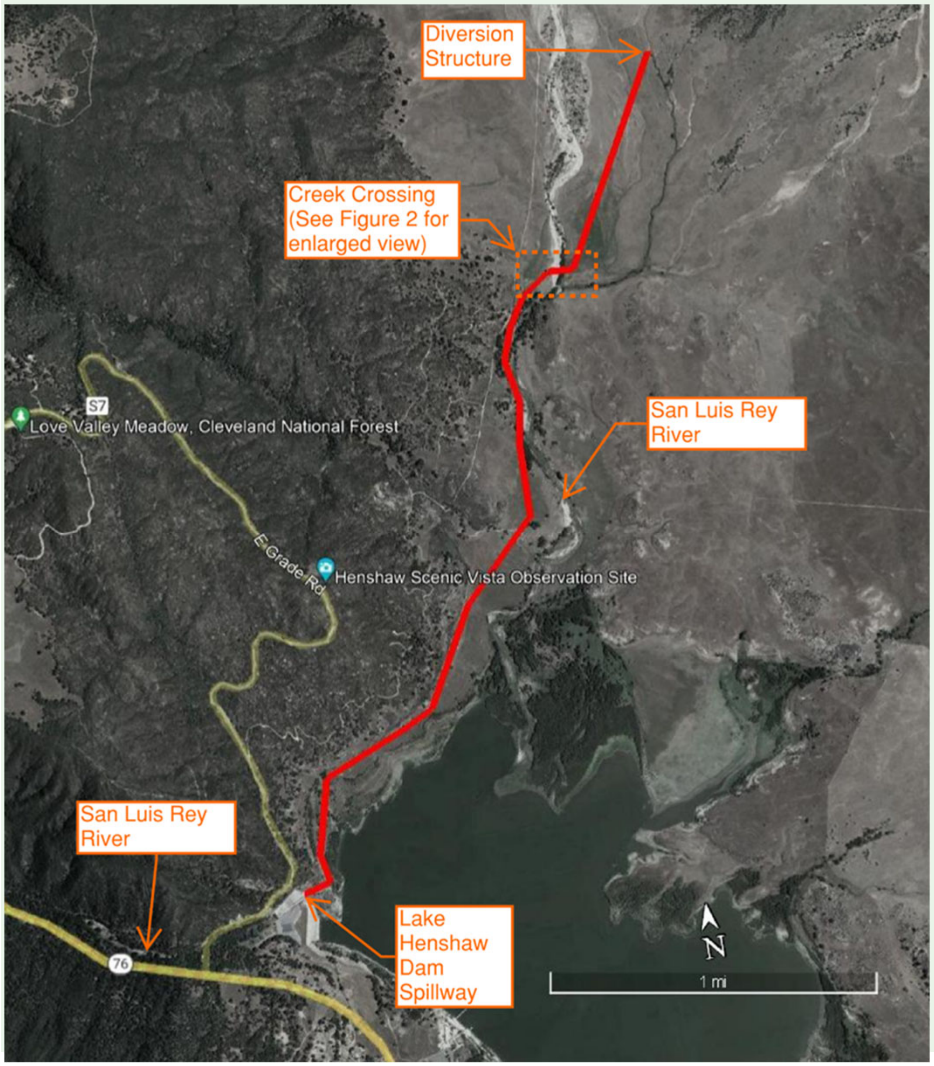
Figure 2-9. General piping layout

OXYGENATION

Recommendations (cont.)

- **During the field trial**
  - Monitor water quality conditions within the lake.
  - Test three different oxygen addition rates to compare effectiveness of each dose.
- **Consider hydrodynamic modeling as part of the field trial to help interpret targeted effectiveness monitoring results and to size and configure a permanent oxygenation system.**

BYPASS PIPELINE



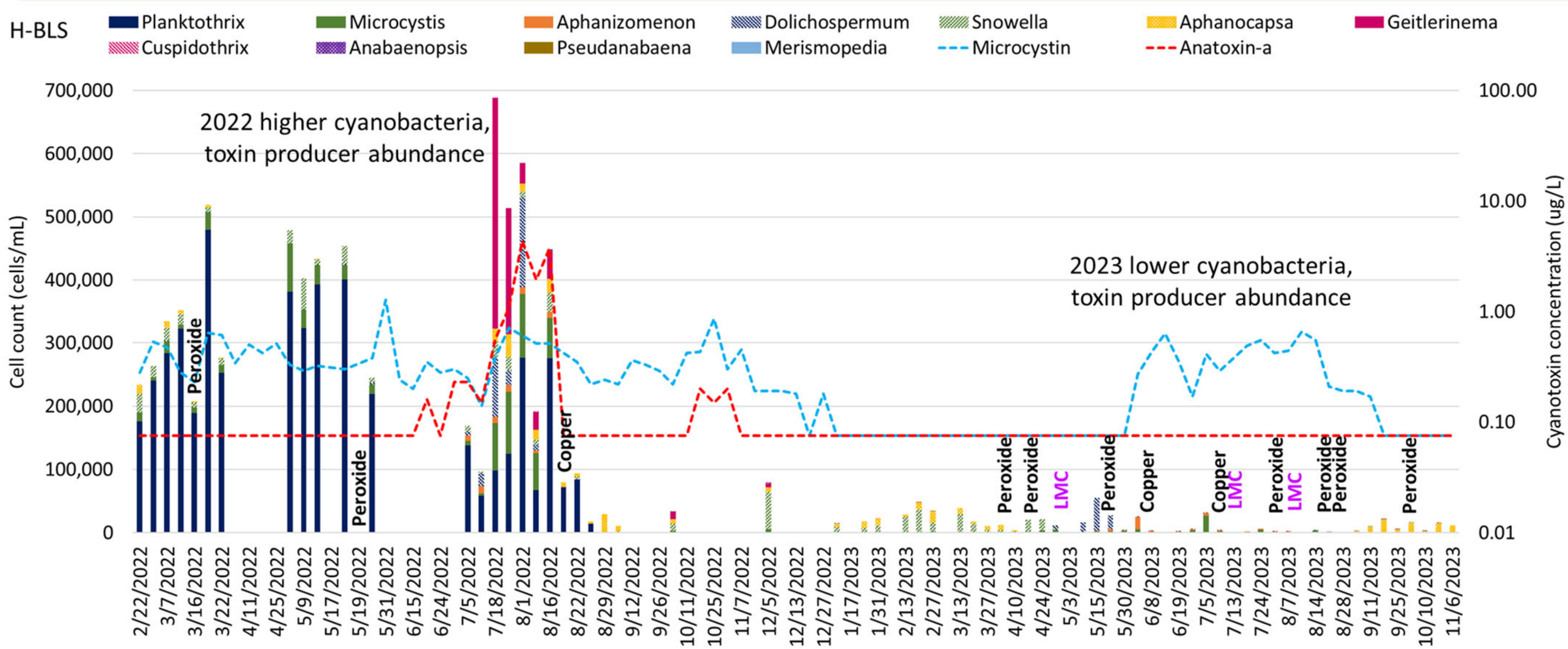
- HABs *Mitigation*
- Physical method
- Out-of-lake treatment
- Not implemented during Phase II
- No potential to implement in short term (2024-2025)
- Not investigated as part of Phase II of the Project given the relatively high capital costs and extended implementation timeline

ALGAECIDE TREATMENT

- HABs *Mitigation*
- Chemical method
- In-lake treatment
- Implemented during Phase II
- Continue to implement in short term (2024-2025)

ALGAECIDE TREATMENT

- 2023 windows for deciding on treatment lasted just two to three weeks.
- To be effective, low doses (< 5 ppm) of peroxide-based algaecide may need to be applied every two to three weeks - waiting may result in the need for copper-based treatment.



ALGAECIDE TREATMENT

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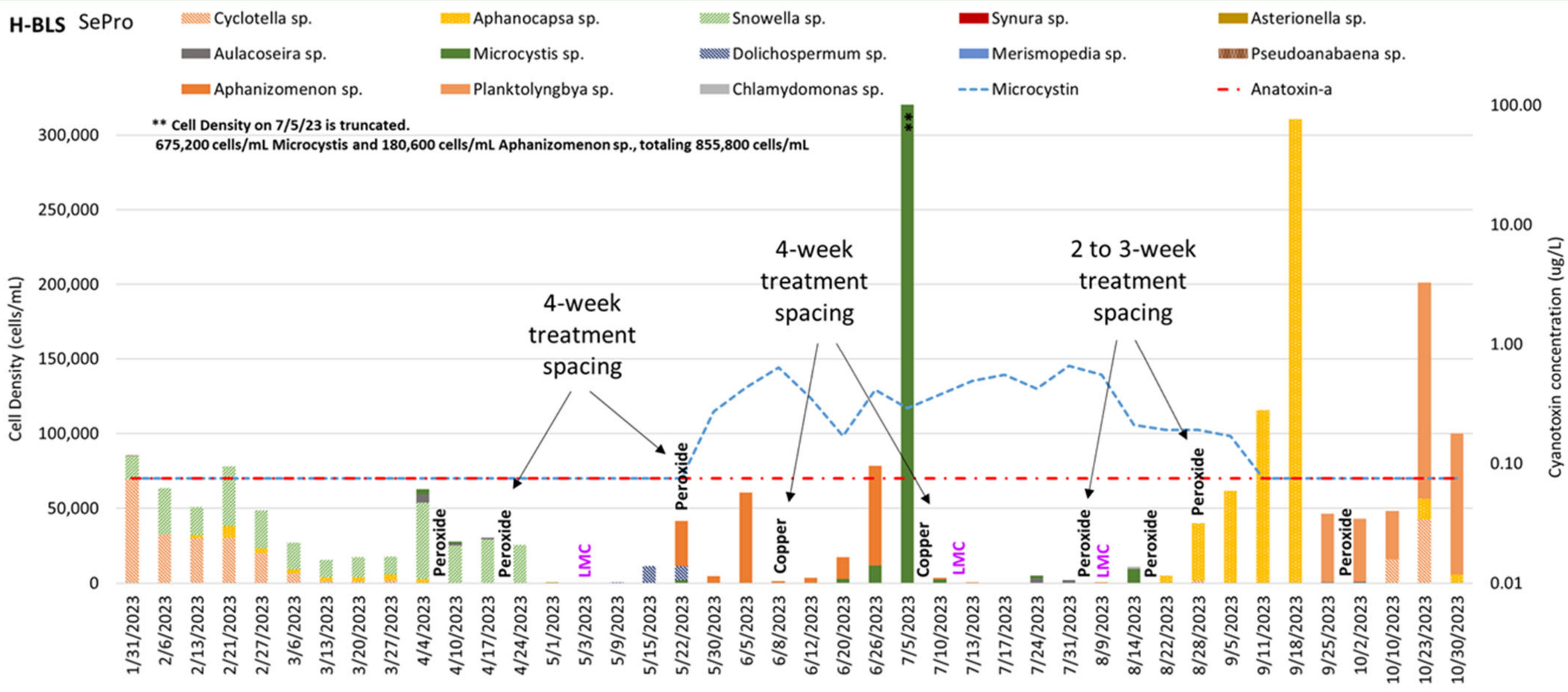
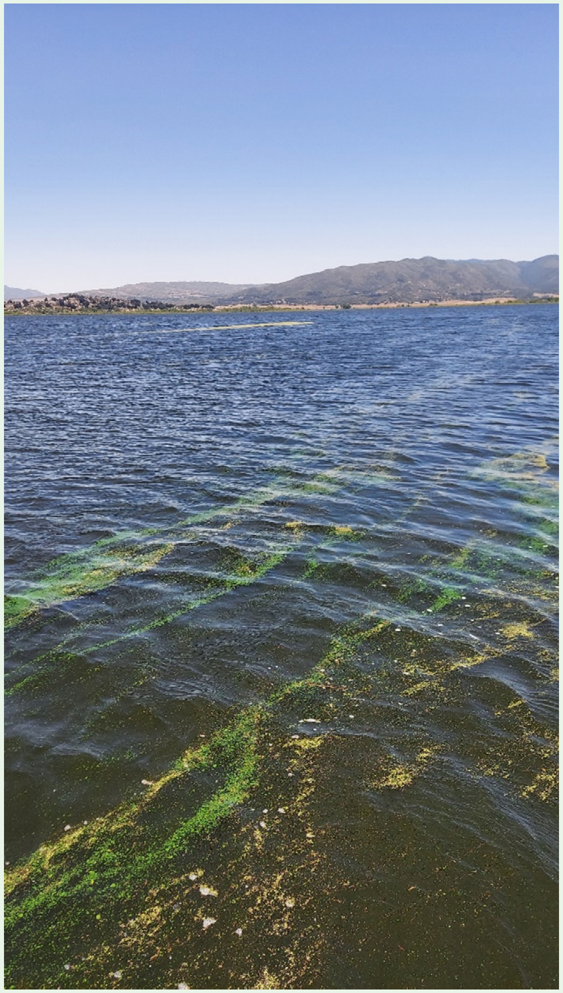


ALGAECIDE TREATMENT

Recommendations

- **Continue to adaptively manage HABs**
  - Refine routine and effectiveness HABs monitoring to reduce number of sites for conducting weekly cyanobacteria ID and enumeration and number of weeks for conducting full algal community ID and enumeration.
  - Use available remote sensing data as additional tool
- **Undertake frequent low doses of peroxide-based algaecide treatments during spring, summer, and early fall when chl-a and cyanobacteria are relatively low.**
- **If chl-a and/or cyanobacteria are relatively high and dominated by certain genus types, consider use of a copper-based algaecide at low to moderate doses.**

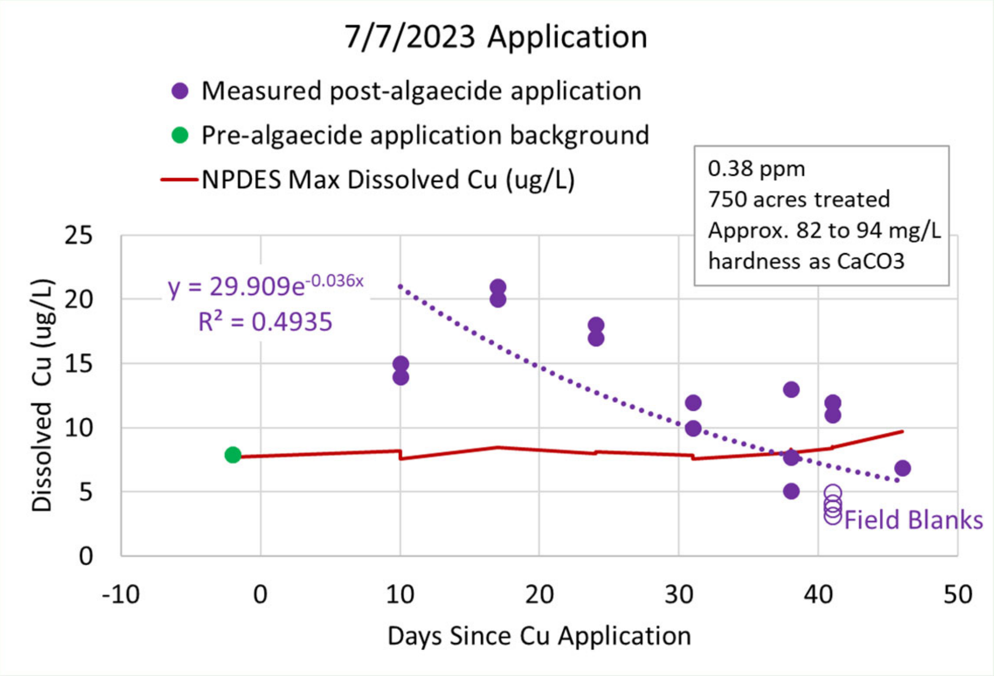


June 29, 2023

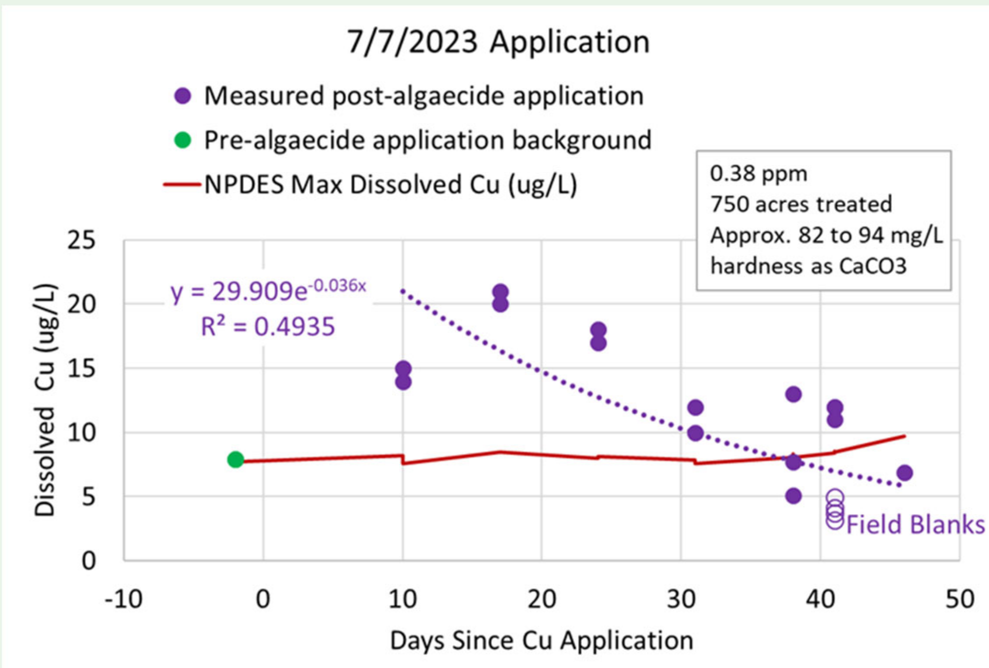
ALGAECIDE TREATMENT

Recommendations (cont.)

- Conduct weekly hardness, alkalinity, pH, DOC, Ca, Mg, Na, K, SO_4^{2-}, Cl, and S monitoring at least three weeks prior to, during, and following copper-based algaecide treatments at specific sites.
- Run BLM calculations for copper speciation to better inform conversations with the State Water Board regarding a BLM-based residual criterion.



ALGAECIDE TREATMENT



Recommendations (cont.)

- Analyze whether there is an effect of DOC concentration on copper residual.
- If possible, assess whether DOC is likely to affect the residual period before treatment occurs.
- Include at least one field blank every four weeks for future dissolved copper sampling events.

SUMMARY RECOMMENDATIONS AND COSTS FOR LAKE HENSHAW 2024-2025

Method	Henshaw Recommendation	Estimated Costs
Chemical sediment sealing (P)	Continue lanthanum-modified clay treatments targeting deep and mid depth areas	~$3M, over 4–5 years, not incl application costs
Source water nutrient control (P)	Hold until there is a P binding agent considered an allowable additive under existing water supply permit	$19K–$29K/month when pumping 40K–$100K application equipment 2 sites
Oxygenation (P)	Prepare to implement full-scale field trial SDOX system Consider hydrodynamic modeling during the field trial	$1.6M–$3.5M (SDOX monthly + fixed costs, 9-12 months) Est. $150K (modeling)
Algaecide treatments (M)	Continue frequent low doses of peroxide-based algaecide treatments and adaptively manage, incl use of remote sensing Consider use of a copper-based algaecide when chl-a and/or cyanobacteria are high • Increase weekly monitoring during and following treatments • Run BLM calculations to better inform conversations with State Water Board	$300K–$1.5M per year


ADDITIONAL
QUESTIONS?


EXTRA SLIDES

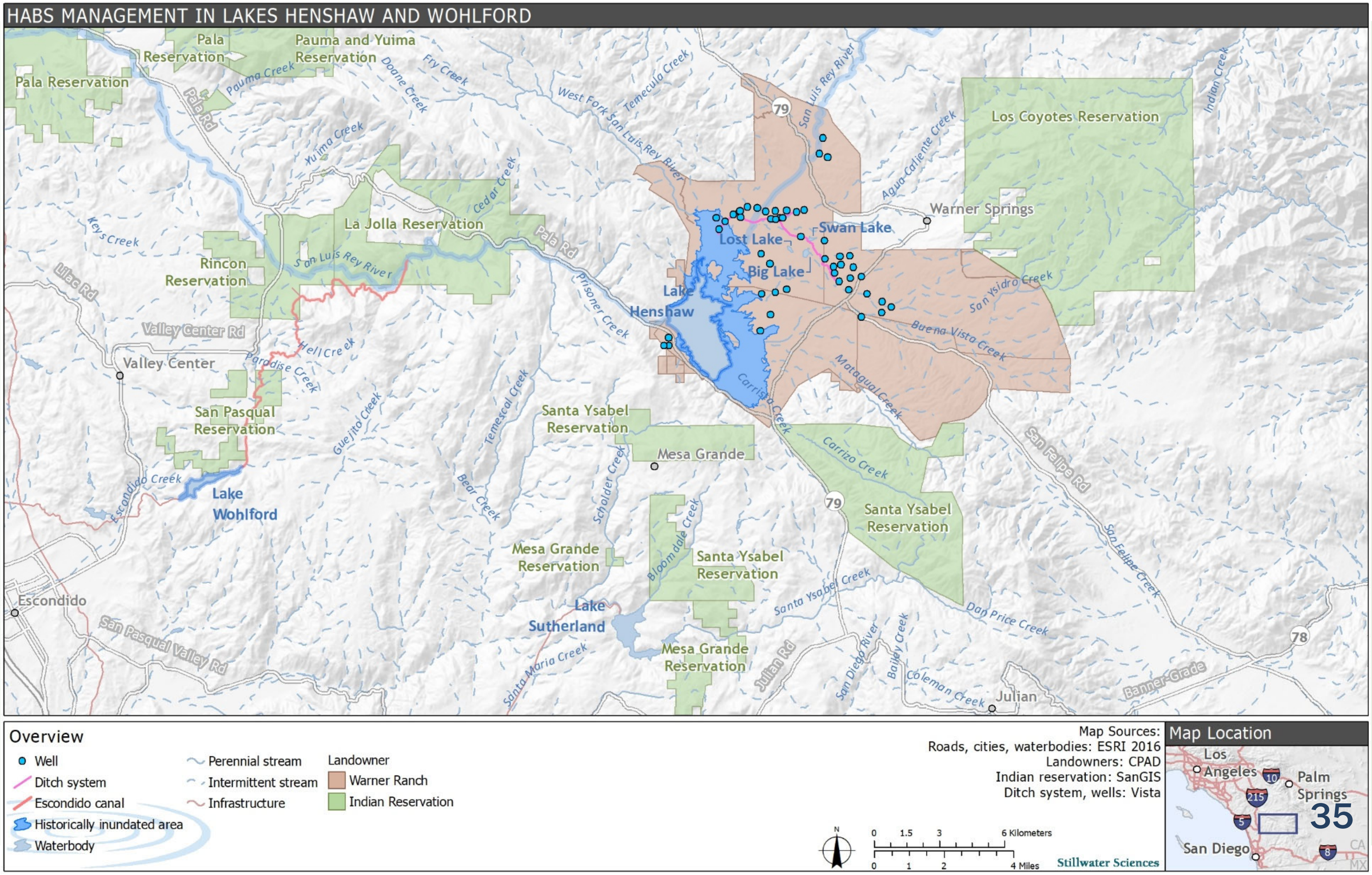
OVERARCHING APPROACH

- Apply the best available water quality science and engineering
- Identify feasible and cost-effective solutions for each reservoir to prevent HABs and elevated cyanotoxins
- In the event that HABs do occur, incorporate short- and long-term strategies to mitigate impacts to support beneficial uses:
  - MUN, AGR, FRSH, REC-1, REC-2, IND, RARE, POW, WARM, WILD

BACKGROUND

<table>
<tr><th rowspan="3">Criteria</th><th colspan="5">Recreational Water</th><th colspan="3">Drinking Water</th></tr>
<tr><th colspan="4">CCHAB Trigger Levels for Human and Animal Health</th><th rowspan="2">WHO 2020 Provisional Guideline Value</th><th rowspan="2">OEHHA 2021 Recommended Notification Level</th><th rowspan="2">WHO 2020 Provisional Guideline Value</th><th rowspan="2">WHO 2020 Provisional Reference Value</th></tr>
<tr><th>No Advisory</th><th>Caution (TIER 1)</th><th>Warning (TIER 2)</th><th>Danger (TIER 3)</th></tr>
<tr><td rowspan="2">Total microcystins</td><td rowspan="2">< 0.8 µg/L</td><td rowspan="2">0.8 µg/L</td><td rowspan="2">6 µg/L</td><td rowspan="2">20 µg/L</td><td rowspan="2">24 µg/L</td><td>ST NL: 0.03 µg/L for up to 3 months</td><td>1 µg/L (lifetime)
12 µg/L (short-term)</td><td>-</td></tr>
<tr><td>Acute NL: 3 µg/L for 1 day</td><td></td><td></td></tr>
<tr><td rowspan="2">Anatoxin-a</td><td rowspan="2">Non-detect</td><td rowspan="2">Detected</td><td rowspan="2">20 µg/L</td><td rowspan="2">90 µg/L</td><td rowspan="2">60 µg/L</td><td>ST NL: 4 µg/L for up to one month</td><td>-</td><td>30 µg/L (short-term)</td></tr>
<tr><td>Acute NL: 8 µg/L for 1 day</td><td></td><td></td></tr>
</table>

PROJECT LOCATION OVERVIEW



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VISTA IRRIGATION DISTRICT	**Agenda Item: 12**
STAFF REPORT	**Board Meeting Date:** **December 6, 2023** **Prepared By:** **Don Smith** **Approved By:** **Brett Hodgkiss**

SUBJECT: LAKE HENSHAW TREATMENTS FOR HARMFUL ALGAL BLOOMS

RECOMMENDATION: Authorize the General Manager to amend the as-needed services agreement to provide services related to the treatment of harmful algal blooms in Lake Henshaw with Aquatechnex LLC for Fiscal Year 2024 in amount not to exceed to $2,403,195.

PRIOR BOARD ACTION: At its April 6, 2022 meeting, the Board authorized the execution of an as-needed services agreement with Aquatechnex LLC (Aquatechnex) to provide services related to the treatment of Harmful Algal Blooms (HABs) in Lake Henshaw in an amount not-to-exceed $600,000. In March 2023, the Board authorized an amendment to the as-needed services agreement with Aquatechnex to increase the not-to-exceed amount under the agreement from 600,000 to $1,130,000 for Fiscal Year (FY) 2023. In June 2023, the Board authorized an extension and amendment to the as-needed services agreement with Aquatechnex to increase the not-to-exceed amount under the agreement from $1,130,000 to $1,748,000 for FY 2024.

FISCAL IMPACT: The not-to-exceed amount contained in the agreement is proposed to increase by $655,195 from $1,748,000 to $2,403,195. This cost will be shared equally by the District and the City of Escondido (Escondido), resulting in a net cost to the District of $1,224,000 in FY 2024. The District budgeted $874,000 for its portion of treatment costs in FY 2024 budget; the District's portion of the proposed amended cost ($327,597.50) will be funded from District reserves.

SUMMARY: The District has gained important experience treating HABs in Lake Henshaw in 2023, much of which is summarized in the draft Synthesis Report for Phase II of the HABs Management Plan (reference agenda item 11). A key recommendation in the report is to perform low-dose peroxide treatments on a two to three week basis during the spring, summer and fall as long as chlorophyll-a and cyanobacterial cell counts remain low. The proposed amendment to the Aquatechnex agreement is needed to implement this recommendation through June 2024.

DETAILED REPORT: While copper-based algaecides have proven effective at reducing cyanobacterial cell counts and cyanotoxin concentrations at Lake Henshaw, the most recent use of copper in July 2023 had the undesirable effect of preventing releases from Lake Henshaw until August 23, 2023. This delay in releases was caused by the unexpectedly long time for dissolved copper concentrations in the lake to fall below the District's National Pollutant Discharge Elimination System (NPDES) permit requirement for the resumption of lake releases. The extended delay affected both the La Jolla Band of Mission Indians, which derives recreational benefit from released water flowing through the La Jolla Campground, and the District and Escondido (together referred to as the Local Entities), which had to purchase more water from the San Diego County Water Authority to replace local water that could not be delivered during the delay.

In the short term, the most promising way to avoid a similar delay in 2024 is the preferential use of frequent low-dose peroxide-based algaecide treatments when conditions suggest that they will be effective (low chlorophyll-a concentrations and low cyanobacterial cell counts). While this strategy is costly, it has the potential to allow the Local Entities to avoid the purchase of higher cost water from the Water Authority. As the peak summer use of local water by the Local Entities approaches 1,500 acre-feet per month, the value of this local water approaches $1.9M per month; the value of local water delivered throughout the year will far exceed the amended cost of the Aquatechnex agreement.

In the long term, the Local Entities are pursuing strategies to both reduce our reliance on the use of algaecides in general and to facilitate the use of copper-based algaecides without being subject to an extended delay in the resumption of releases. The District started to apply lanthanum-modified clay in 2023 to reduce the availability of phosphorus needed to support cyanobacterial growth, and plans to continue that strategy in 2024 and beyond. (The cost of the lanthanum-modified clay treatments comprises about 40% of the proposed not-to-exceed upper limit of the Aquatechnex agreement.) The Local Entities are also considering a strategy to oxygenate the bottom waters of Lake Henshaw. Both these strategies have the potential to reduce our reliance on algaecides to manage HABs in the future.

While the cause of the extended elevated dissolved copper concentrations in Lake Henshaw after the use of copper-based algaecide last summer is not known with certainty, a likely cause is that the dissolved copper ions formed complexes with dissolved organic carbon (DOC) in the lake. The current NPDES Permit governing the District's use of copper as an algaecide in Lake Henshaw estimates the allowable freshwater dissolved copper concentration necessary to avoid harm to aquatic life based on the hardness of that water; the higher the hardness, the greater the allowable dissolved copper concentration (Lake Henshaw water currently has unusually low hardness; hence the allowable dissolved copper concentration is unusually low). The theory is that the ions which comprise water hardness form complexes with the dissolved copper (these complex-forming materials are referred to as "ligands") and that the dissolved copper bound to these ligands is not available to harm aquatic life.

The US Environmental Protection Agency (EPA) has established a more comprehensive model of dissolved copper toxicity which considers all available ligands in water, not just the hardness-forming ions. Notably, this model, called the "Biotic Ligand Model" (or BLM), also considers the effect of DOC as a ligand which reduces dissolved copper toxicity. When applied retroactively to the lake conditions experienced last summer, the use of the BLM to assess allowable dissolved copper concentrations likely would have reduced the six to seven week delay in water releases to one to two weeks. As the Rincon Band has proposed the use of the BLM in their draft Tribal Water Quality Standards, and as the BLM seems to represent the current best practice proposed by EPA, there may be a benefit in engaging the State Water Resources Control Board to consider amending the current NPDES permit to allow the use of the BLM as an alternative to the current hardness-based dissolved copper criterion. If implemented, this use of the BLM could restore the beneficial use of copper-based algaecides for HABs management at Lake Henshaw without compromising aquatic life (or human health), resulting in a more effective and less costly algaecide application strategy.

The as-needed services agreement with Aquatechnex is for the application of both peroxide- and copper-based algaecides and lanthanum-modified clay to Lake Henshaw for FY 2024. The proposed not-to-exceed amount was developed based on an assumed treatment scheme (see table below). As reinforced by recent experience at Lake Henshaw, treatment needs can evolve quickly, and the treatment plan is intended to adapt to evolving lake conditions.

Tentative Schedule of Treatments at Lake Henshaw for FY 2024
Version Date: 11/22/2023

Start Date	End Date	Duration (Days)	Days between algaecide treatments	Description	Notes	Actual or Approx. Cost
Start of 2024 Delivery Season					FY 2024 expenses incurred to date:	$ 1,315,270.09
Tue, 04/02/2024	Wed, 04/03/2024	2	187	Peroxide Treatment	72,000 lbs	$ 112,447.80
Tue, 04/16/2024	Wed, 04/17/2024	2	14	Peroxide Treatment	72,000 lbs	$ 112,447.80
Mon, 04/29/2024	Tue, 04/30/2024	2	13	Peroxide Treatment	72,000 lbs	$ 112,447.80
Wed, 05/01/2024	Fri, 05/03/2024	3		Lanthanum Treatment	80,000 lbs; target water column P	$ 300,790.00
Tue, 05/14/2024	Wed, 05/15/2024	2	15	Peroxide Treatment	72,000 lbs	$ 112,447.80
Thu, 05/23/2024	Mon, 05/27/2024	5		Memorial Day Release		
Tue, 05/28/2024	Wed, 05/29/2024	2	14	Peroxide Treatment	72,000 lbs	$ 112,447.80
Tue, 06/11/2024	Wed, 06/12/2024	2	14	Peroxide Treatment	72,000 lbs	$ 112,447.80
Fri, 06/14/2024	Mon, 06/17/2024	4		Father's Day Release		
Tue, 06/25/2024	Wed, 06/26/2024	2	14	Peroxide Treatment	72,000 lbs	$ 112,447.80
Wed, 07/03/2024	Sun, 07/07/2024	5		Independence Day Release		
					Total, FY 2024:	**$ 2,403,194.69**

STAFF REPORT	Agenda Item: 13 **Board Meeting Date:** December 6, 2023 **Prepared By:** Brett Hodgkiss

SUBJECT: MATTERS PERTAINING TO THE ACTIVITIES OF THE SAN DIEGO COUNTY WATER AUTHORITY

SUMMARY: Informational report by staff and directors concerning the San Diego County Water Authority. No action will be required.

San Diego County Water Authority
And Its 24 Member Agencies

SUMMARY OF FORMAL BOARD OF DIRECTORS' MEETING
NOVEMBER 16, 2023

1. 2023 Energy Management Policy.
   The Board adopted the 2023 Energy Management Policy.

2. Wholesale Market Access Tariff Agreement with Clean Energy Alliance.
   The Board authorized the General Manager, or designee, to execute a Wholesale Market Access Tariff Agreement with Clean Energy Alliance for providing energy to Claude "Bud" Lewis Carlsbad Desalination plant.

3. Amend Agreement for Consulting Services with M Strategic Communications.
   The Board approved an agreement amendment with M Strategic Communications for continued consulting services for the Water Authority through February 29, 2026, by $370,000 for a period of 24 additional months with total contract funding not to exceed $2,370,000.

4. Sponsor legislation amending the California Public Contract Code Section 20642.
   The Board approved to sponsor legislation amending the California Public Contract Code Section 20642.

5. Monthly Treasurer's Report on Investments and Cash Flow.
   The Board noted and filed the Treasurer's report.

6. Vote Entitlement Resolution for Calendar Year 2024.
   The Board adopted Resolution No. 2023-32 establishing vote and representative entitlements of each member agency to be effective January 1, 2024.

7. Contract Amendment for Montague DeRose and Associates, LLC, for as-needed financial advisor services.
   The Board authorized the General Manager to amend the Montague DeRose and Associates, LLC, professional services contract to extend the agreement term for an additional two years, in the amount of $100,000, for continued as-needed financial advisor services, increasing the authorized contract amount from $149,000 to $249,000.

8. Adopt resolution designating authorized officers to act on behalf of the San Diego County Water Authority with respect to banking and investment accounts.
   The Board adopted Resolution 2023-33 designating authorized officers to act on behalf of the Water Authority with respect to certain banking and investment accounts.

9. Adopt the Annual Statement of Investment Policy, as amended, and continue to delegate authority to the Treasurer to invest Water Authority funds for calendar year 2024.
   The Board adopted the Annual Statement of Investment Policy, as amended, and continue to delegate authority to the Treasurer to invest Water Authority funds for calendar year 2024.

10. Audit Committee Annual Report.
The Board accepted and filed the Audit Committee Annual Report pursuant to the Administrative Code, Section 2.00.066; and accepted and filed the Annual Comprehensive Financial Report (ACFR) for fiscal year ended June 30, 2023, prepared in accordance with Generally Accepted Accounting Principles (GAAP).

11. Approval of Minutes.
The Board approved the minutes of the Special Board of Directors' meeting of October 12, 2023 and the Formal Board of Directors' meeting of October 26, 2023.

12. CLOSED SESSION.
The Board directed the General Counsel and General Manager to finalize and execute a settlement agreement with Fallbrook and Rainbow in material conformity with documents reviewed during the Closed Session.

VISTA IRRIGATION DISTRICT **STAFF REPORT**	**Agenda Item: 14.A** **Board Meeting Date:** **December 6, 2023** **Prepared By:** **Lisa Soto** **Approved By:** **Brett Hodgkiss**

SUBJECT: REPORTS ON MEETINGS AND EVENTS ATTENDED BY DIRECTORS

SUMMARY: Directors will present brief reports on meetings and events attended since the last Board meeting.

VISTA IRRIGATION DISTRICT	Agenda Item: 14.B
STAFF REPORT	**Board Meeting Date:** December 6, 2023 **Prepared By:** Lisa Soto **Approved By:** Brett Hodgkiss

SUBJECT: SCHEDULE OF UPCOMING MEETINGS AND EVENTS

SUMMARY: The following is a listing of upcoming meetings and events. Requests to attend any of the following events should be made during this agenda item.

	SCHEDULE OF UPCOMING MEETINGS AND EVENTS	**ATTENDEES**
1 *	**Vista Chamber Government Affairs** *Dec. 7, 2023; Noon-1:30 p.m.; The Film Hub, Vista* *Registration deadline: None*	Kuchinsky ◊
2 *	**Vista Chamber of Commerce Business Mixer** *Dec. 13, 2023; 5:00 p.m. – 7:00 p.m.; CoLab Public House, Vista* *Registration deadline: None*	
3	**Colorado River Water Users Association Conference** *Dec. 13-15, 2023; Paris, Las Vegas* *Registration still available at door; Cancellation closed.*	Miller (R, H, A) MacKenzie (R, H) Vásquez (R, H) Sanchez (R, H)
4 *	**State of the Community Luncheon** *Jan. 22, 2024; 11:00 a.m.-1:00 p.m.; Morris B. Vance Community Room* *Reservation deadline: TBD*	MacKenzie Sanchez Kuchinsky
5	**Urban Water Institute's Spring Water Conference** *Feb. 21-23, 2024; Palm Springs Hilton* *Early Bird Registration deadline: 12/31/23; Cancellation deadline: TBD*	
6	**Hoover Dam Tour** (MWD) *May 2-4, 2024; Registration deadline: TBD*	Kuchinsky
7	**ACWA Spring Conference** *May 7-9, 2024; Sacramento* *Registration deadline: TBD*	
8	**Special Districts Legislative Days** (CSDA) *May 21-22, 2024; Sheraton Grand Sacramento Hotel; Sacramento* *Registration deadline: TBD*	
9	**Diamond Valley Lake Tour** (MWD, Hosted by Director Miller) *June 7, 2024; Diamond Valley Lake (1-day tour)* *Registration deadline: TBD*	
10	**CSDA Annual Conference** *Sept. 9-12, 2024; Indian Wells* *Registration deadline: TBD*	
11	**ACWA Fall Conference** *Dec. 3-5, 2024; Palm Desert* *Registration deadline: TBD*	
12	**Colorado River Water Users Association Conference** *Dec. 4-6, 2024; Paris, Las Vegas* *Registration deadline: TBD*	

** Non-per diem meeting except when serving as an officer of the organization*

The following abbreviations indicate arrangements that have been made by staff:

R=Registration; **H**=Hotel; **A**=Airline; **S**=Shuttle; **C**=Car; **T**=Tentative; ◊=Attendee to Self-Register

VISTA IRRIGATION DISTRICT **STAFF REPORT**	**Agenda Item: 15** **Board Meeting Date:** **December 6, 2023** **Prepared By:** **Brett Hodgkiss**

SUBJECT: ITEMS FOR FUTURE AGENDAS AND/OR PRESS RELEASES

SUMMARY: This item is placed on the agenda to enable the Board to identify and schedule future items for discussion at upcoming Board meetings and/or identify press release opportunities.

Staff-generated list of tentative items for future agendas:

- Vista Flume Replacement Alignment Study Workshop (December 11, 2023 at 1:30 PM)
- Fiscal Year 2023 Audit (January)
- District Committees and Representatives to Outside Organizations (January)
- General Manager Performance Feedback (January)
- Leak Adjustment Policy
- Communication and Engagement Plan

VISTA IRRIGATION DISTRICT	**Agenda Item: 16**
STAFF REPORT	**Board Meeting Date:** **December 6, 2023** **Prepared By:** **Lisa Soto**

SUBJECT: COMMENTS BY DIRECTORS

SUMMARY: This item is placed on the agenda to enable individual Board members to convey information to the Board and the public not requiring discussion or action.

VISTA IRRIGATION DISTRICT	Agenda Item: 17
STAFF REPORT	**Board Meeting Date:** **December 6, 2023** **Prepared By:** **Brett Hodgkiss**

SUBJECT: COMMENTS BY GENERAL COUNSEL

SUMMARY: Informational report by the General Counsel on items not requiring discussion or action.

VISTA IRRIGATION DISTRICT	Agenda Item: 18
STAFF REPORT	**Board Meeting Date:** **December 6, 2023** **Prepared By:** **Brett Hodgkiss**

SUBJECT: COMMENTS BY GENERAL MANAGER

SUMMARY: Informational report by the General Manager on items not requiring discussion or action.

VISTA IRRIGATION DISTRICT	Agenda Item: 19
STAFF REPORT	**Board Meeting Date:** December 6, 2023 **Prepared By:** Lisa Soto **Approved By:** Brett Hodgkiss

SUBJECT: ANNUAL ORGANIZATIONAL MEETING

RECOMMENDATION: Conduct annual organizational meeting and appoint officers.

PRIOR BOARD ACTION: The District's last organizational meeting was on December 7, 2022.

FISCAL IMPACT: None.

SUMMARY: Per section 21375 of the California Water Code, Boards may reorganize (including election of President per section 21376) after the first Friday in December. According to Section 1.5.5.A of the District's Rules and Regulations, the President and First Vice President of the Board shall each serve a one-year term and shall be elected to such term by the members of the Board. The President shall preside over meetings of the Board of Directors. The First Vice President shall assume the duties of the President in his or her absence. The remaining directors shall serve equally as Vice Presidents for the same term.

DETAILED REPORT: The Board's practice has been to appoint officers at one meeting and then follow up with committee and other appointments at a subsequent meeting to allow time for the incoming President to deliberate regarding the appointments. Staff will prepare a staff report for the January 3, 2024 Board meeting for the District committee assignments and selection of representatives to outside organizations. For the convenience of the Board, listings of current Board President, First Vice President and Vice Presidents, Committees, and outside organization appointments as well as staff's recommendations regarding the appointments of Secretary, Assistant Secretary, Treasurer and Assistant Treasurer for 2024 have been included in this staff report.

The following is a list of the current President, First Vice President and Vice Presidents:

President	Jo MacKenzie
First Vice President	Richard Vásquez
Vice Presidents	Patrick Sanchez, Marty Miller, Peter Kuchinsky

Staff's recommendation for Secretary, Assistant Secretary, Treasurer and Assistant Treasurer for 2024:

Secretary	Ramae Ogilvie
Assistant Secretary	Brett Hodgkiss
Treasurer	Shallako Goodrick
Assistant Treasurer	Brett Hodgkiss

ATTACHMENT: 2023 Committees and Outside Organizations Appointments

STANDING COMMITTEES FOR 2023:

Water Sustainability Miller, Chair; and Sanchez
Programs related to water conservation and maintenance of current water sources. Development by VID and/or our supplier(s) of new sources such as desal, brackish water, and recycled water. Does not include Lake Henshaw and the Warner Ranch.

Fiscal Policy MacKenzie, Chair; and Vásquez
District budget and finances, including rates.

Warner Ranch MacKenzie, Chair; and Miller
Contracts, leases, historical assets, environmental issues, long-range planning, and relations with neighboring property owners.

Public Affairs Sanchez, Chair; and Kuchinsky
Public outreach on water conservation and legislation, and public education on major water issues.

Groundwater Kuchinsky, Chair; and Vásquez
Groundwater resources management and matters pertaining to the Sustainable Groundwater Management Act of 2014.

AD HOC COMMITTEE FOR 2023:

100th Anniversary Celebration Sanchez, Chair; and Vásquez

OUTSIDE ORGANIZATIONS FOR 2023

San Luis Rey Watershed Council Kuchinsky; Alternate-MacKenzie
A partnership of local landowners, agricultural growers, Native American bands, community and environmental organizations, government agencies and special districts with ties to this watershed. The Council's primary goal is to develop and implement a comprehensive resource management plan for the San Luis Rey River and its tributaries.

ACWA/JPIA Sanchez; Alternate-Brett Hodgkiss
The insurance pool formed by ACWA member agencies; VID obtains liability, property and workers compensation insurance through ACWA/JPIA.

Southern California Water Committee Miller; Alternate-Vásquez
A nonprofit, nonpartisan, public education partnership dedicated to informing Southern Californians about our water needs and our state's water resources; a cooperative effort of business, government, water agencies, agriculture, and public interests.

Groundwater Resources Association Kuchinsky; Alternate-Vásquez
Dedicated to resources management that protects and improves groundwater through education and technical leadership.