For Immediate Release
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USIBWC Successfully Completes Ozone Pilot Project in Tijuana River

The U.S. Section of the International Boundary and Water Commission (USIBWC) has successfully completed a small pilot project that tested ozone nanobubble technology to kill bacteria and eliminate odors in Tijuana River sewage flows.

Working with contractor Green Water Solutions LLC of Ohio, USIBWC conducted the pilot project from September 9 to October 15, 2025, just downstream of the international boundary.

The project demonstrated that ozone nanobubble technology has the capability to kill bacteria and eliminate odors associated with sewage.

The project allowed USIBWC engineers to gain experience with the technology under actual Tijuana River conditions that included significantly fluctuating flows and non-homogeneous conditions due to the mixture of sewage effluent, trash, and silt.

While demonstrating the effectiveness of the technology, USIBWC learned that significant equipment design modifications would be required for an effective scale-up and larger application in the Tijuana River or other similar river systems that exhibit troublesome, unpredictable flow conditions.

The USIBWC will continue to investigate and evaluate technologies that can provide relief to U.S. citizens in the region. The USIBWC remains interested in potential funding and application partnerships that can demonstrate cost and operationally large-scale effectiveness.

"The USIBWC continues to work toward implementing President Trump's and U.S. EPA Administrator Zeldin's commitment to achieving a 100 percent solution to the Tijuana River pollution crisis," said USIBWC Commissioner Chad McIntosh. "I want to thank our engineers and Green Water Solutions for their work on this ozone nanobubble project."

USIBWC is an independent federal agency whose mission is to protect Americans from exposure to Mexican sewage, ensure fair allocations of water from the Colorado and Rio Grande Rivers, efficiently and effectively maintain and operate critical flood infrastructure, and reduce border flood hazards.

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Pilot Treatment Report

Prepared for the International Boundary and Water Commission (IBWC)

Location: Tijuana River – U.S. Entry Point, San Diego, California

Pilot Period: September 9 – October 14, 2025

Prepared by Greenwater Services

Executive Summary

Greenwater Services (GWS) conducted a pilot project to evaluate the feasibility and effectiveness of its patented Nano Bubble Ozone Technology (NBOT) for reducing microbial contamination in the Tijuana River. Four (4) NBOT units were deployed with the intention of operating continuously; however, due to operational debris and river flow patterns, it was determined that limiting operation to daytime hours would be preferable.

Water Quality Results

NBOT produced significant reductions in total coliforms and *E. coli* despite the abbreviated operational period.

- **Near-field downstream samples, ~5 yards (10 samples):**
  - 91.5% cumulative reduction in total coliforms
  - 83.8% cumulative reduction in *E. coli*
- **Far-field downstream samples, ~250 yards (4 samples):**
  - 82.4% cumulative reduction in total coliforms
  - 89.3% cumulative reduction in *E. coli*
- **Far-field upstream sample (~250 yards):**
  - 34.8% reduction in total coliforms
  - 27.6% reduction in *E. coli*

Daily pre- and post-treatment sampling revealed pre-treatment concentrations ranging from 4.7 million to over 241 million Most Probable Numbers (MPN) for total coliforms, and from 1.3 million to over 29 million MPN for *E. coli*. Post-treatment concentrations were substantially lower, ranging from 300,000 to 14.1 million MPN for total coliforms and from 464,000 to 9.2 million MPN for *E. coli*. One pre-treatment and one post-treatment sample were considered outliers and were included in the full dataset.

Conclusion

NBOT demonstrated strong effectiveness in reducing contaminants and pathogens in the Tijuana River. While the pilot measured only total coliforms and E. coli, the technology's oxidative process would be expected to address additional bacteria, pathogens, and viruses simultaneously, as well as improve air quality. Border Patrol Agents stationed in close proximity to the treatment site commented on a reduction of offensive odors during treatment. Full-scale implementation would require additional units to accommodate daily flow volumes, as well as an integrated filtration system for continuous 24/7 operation. With these enhancements, NBOT represents a viable solution for improving river water quality, facilitating beach reopenings, and enhancing public health and community conditions in the surrounding area.

Project Background

Purpose of the Pilot

The primary purpose of this pilot was to evaluate whether Greenwater Services' Nano Bubble Ozone Technology (NBOT) could safely and effectively reduce pathogen loads in the Tijuana River. By demonstrating measurable reductions in microbial contamination, the pilot sought to support broader regional goals related to:

- Environmental health
- Public safety
- Beach reopening efforts
- Long-term ecological restoration
- Reduction of offensive odors

Context and Need

The Tijuana River has long faced severe water quality challenges as it reenters the United States. Chronic cross-border flows carry untreated or partially treated wastewater, stormwater runoff, industrial discharge, and high concentrations of pathogens—including total coliforms and *E. coli*—into the river channel. These flows exceed public health standards and contribute to coastal pollution, beach closures, poor air quality, and degraded estuarine habitat.

Compounding these issues, episodic releases and tidal movements cause highly variable flow conditions that spread contamination downstream, affecting residential communities, recreational areas, and environmentally sensitive zones. Persistent odors, elevated bacteria levels, and ecological stress have created significant public health, environmental, and economic impacts.

In response to these longstanding challenges, the pilot was designed to assess NBOT as a potential treatment option capable of reducing pathogens directly within the moving water system. A successful demonstration could help design future strategies for improving water quality, mitigating public health risks, and supporting regional efforts to reopen beaches and restore coastal ecosystems.

Technology Overview

Greenwater Services ("GWS") provides algae prevention, mitigation, and remediation services using a patented technology known as NBOT or Nano Bubble Ozone Technology. NBOT technology has been tested and validated by research institutions and government agencies, including the National Oceanic & Atmospheric Administration ("NOAA"), U.S. Army Corps of Engineers, Ohio EPA, The Ohio State University, and The University of Florida. NBOT has consistently proven to be a safe and effective solution for reducing the impact of harmful algal blooms (HABs) and their toxic by-products both in freshwater and saltwater. No harmful side effects to marine life or to the environment have been observed (i.e., no chemical residues, exempted from FIFRA algaecide requirements). NBOT is a true “GREEN” technology. The by-product of NBOT is an increased level of dissolved oxygen, which improves overall water quality and restores the depleted oxygen levels.

More specifically, the NBOT system uses a patented gas-infused nanobubble generator to inject ozone (O3) impregnated nanobubbles into the water. Research conducted at Ohio State University has demonstrated that NBOT generates roughly 256 million nanobubbles per milliliter of water. The nanobubbles do NOT rise to the surface and burst. Instead, the nanobubbles diffuse naturally throughout the entire water column like a gas, slowly introducing ozone into the water like a time-released vitamin. Ozone is a very strong chemical oxidant; however, dissolved ozone averages only a 20-minute ½ life in water, which limits its effectiveness for water treatment. By contrast, ozone inside a nanobubble can persist for days, which is the secret to NBOTs effectiveness.

The implosion of an ozonated nanobubble creates a powerful physical and chemical reaction. Heat and energy generated by the nanobubble instantly react with the ozone and water molecules to create three (3) powerful oxidizing agents - hydroxyl radicals, peroxides and molecular oxygen. These reactive oxidants will effectively denature or destroy compounds by “shredding” the organic molecules of their functional groups (carboxylic acids, amines, sulfides, phosphates, etc.). The NBOT technology is proven to not only inactivate harmful cyanobacteria and other microbes but is effective at destroying toxins and organic contaminants throughout the water column by eliminating or significantly reducing their functionalized molecules. The oxidizing agents quickly decompose into oxygen leaving behind more highly oxygenated water.

The following treatment results and observations have been consistent across all NBOT project locations and have been corroborated by NOAA, The Ohio State University, and the University of Florida:

1. Harmful cyanobacteria and bacteria are significantly reduced, depending on how exhaustive operations are conducted, which is fully controllable.

2. Chemical contaminants, biomolecules, and toxins are reduced. To date, NBOT has been able to degrade all natural toxins that have been evaluated (including microcystins, anabaenopeptins, and anatoxins).

3. Nutrients (Nitrogen, Phosphorus, Carbon) have been significantly reduced or transformed from the water column. Nitrogen can be converted via oxidation to a few volatile species in addition to being scavenged by oxidized metals. Phosphorus in the water column is significantly reduced as well.

4. Water clarity (apart from “silty” water) is greatly improved as pigments of all types are rapidly destroyed via ozone, radicals, and peroxides.

5. Nanobubbles do exist for extended periods of time. The slow and constant release of ozone/oxygen into the water results in extended treatment time and ongoing protection.

6. Oxygen content in the water column has increased.

7. Odor compounds will be destroyed as sulfides, amines, etc., will be oxidized under NBOT conditions.

8. No harmful impacts to wildlife. Marine life and waterfowl activity noticeably increase at each treatment location due in part to increased levels of dissolved oxygen.

Additionally, an important observation has been validated in laboratory testing as it relates to water quality and survivability of non-target species (i.e., "good" organisms) and impacts to human cell lines. The Ohio State University observed higher levels of diatoms, beneficial green algae, and zooplankton in post-treatment water, which suggests that harmful cyanobacteria and bacteria concentrations are reduced, and beneficial organisms can once again proliferate and restore the natural ecosystem. Youngstown State University found a significant increase in the survivability rates of human skin, liver, and lung cells in post-treatment water as compared to pre-treatment water.

Greenwater Services has been implementing NBOT technology for six (6) years in canals, lakes, ponds, and rivers. The NBOT units are easily portable and may be deployed either on land or water. The NBOT units can run unattended 24/7 and only require a 220 / 240 power source. Limited to no site preparation is required in most cases. There are no additives or consumables, and no site cleanup is needed (i.e., no disposables or residues left behind). NBOT creates oxygen and ozone onsite, so no canisters of O_2 or O_3 are required on site.

If required, signage may be applied at the treatment site to alert the public. If required, GWS will coordinate water sampling and laboratory testing to monitor pre-, during, and post-treatment water quality parameters (e.g., algae, bacteria, and toxin levels). All data would be shared with the appropriate state and local agencies.

Pilot Details

The pilot began on September 9, 2025, with four NBOT units deployed at the flood control plain west of the border with Mexico. (See Appendix A, Location Maps and photos 1–4.) The units remained operational until September 17, 2025, when they were temporarily removed due to concerns over potential flooding. Upon advanced notification of potential flooding from the IBWC, all units and supporting equipment were removed from the site within hours. Following a reduction in risk, the units were reinstalled on September 25, 2025, and treatment operations resumed.

Throughout the pilot, no adverse effects were reported, and U.S. Customs and Border Protection (CBP) personnel noted a substantial reduction in odors in the treatment area during NBOT operation.

Operational Challenges

During the initial days of the pilot, substantial volumes of trash traveling downstream—particularly during evening and overnight periods of higher flow due to the release of contaminated water from Mexico—caused frequent clogging of the NBOT unit inputs and output nozzles. (See Appendix A, Photos 5–6.) Various forms of trash, including plastic bags, small plastic fragments, and pieces of metal, repeatedly obstructed the units, making overnight operation impractical. As a result, GWS adjusted the operational plan and ran the units only during daytime hours, when river flow was lower, and clogging risk was reduced. This operational window allowed GWS to evaluate treatment performance under more stable conditions.

Adjustments for Trash Boom Installation

On October 9, 2025, at the request of the International Boundary and Water Commission (IBWC), GWS paused operations to allow for the installation of a trash boom at the site. (See Appendix A, Photos 7–8.) Two NBOT units were relocated to accommodate the boom's placement. NBOT operations resumed on October 14, 2025. Although rain was forecast that evening, precipitation levels were expected to be light (0.25–0.50 inches), and treatment commenced as requested. Mid-morning, a call from the IBWC that pumps were down in Mexico, causing an increased flow, led to an early shutdown, with plans to resume treatment the following day.

Flooding Event and System Damage

On September 17, 2025, the IBWC advised evacuation of the site during a 0.5-inch rain event. During that incident, the river level never rose to the elevation of the treatment units. Based on that experience, when another 0.5-inch rain event was forecast for October 14, 2025, it was determined that fully evacuating the units would not be necessary. At approximately 8:30 p.m. on October 14, GWS personnel returned to the site and observed rising water levels. The units were promptly repositioned to a higher elevation within the treatment area to maintain operational safety and ensure continued protection.

However, between 10:00 p.m. and 3:00 a.m. that night, an unexpected flooding event occurred. The following morning, the site was found to have been overtaken by floodwater, which carried large quantities of trash and debris that inundated and damaged the NBOT units and auxiliary equipment, including generators and fuel cells (see Appendix A, Photos 9–10). River flow data confirmed that water volume increased dramatically and unexpectedly. Flows surged from approximately 40 million cubic meters per second (m^3/s) to 247 million m^3/s, resulting in a significant water level rise (See Appendix B, River Flow Charts.) Due to safety concerns and site conditions, the location was deemed unusable for the remainder of the pilot, and the project was halted.

Site Remediation

GWS coordinated with Sunbelt Rentals and contracted EFR Environmental Services, an environmental remediation company, to safely clear hazards and contaminants from the site. All hazards, including a minor 5-gallon diesel spill, were remediated. Remediation activities were completed on October 22, 2025.

Results and Findings

The NBOT pilot on the Tijuana River produced measurable and meaningful reductions in microbial contamination despite operational constraints, limited treatment windows, and the premature conclusion of the project due to flooding. Water quality results consistently demonstrated that NBOT is capable of significantly reducing total coliform and *E. coli* concentrations under real-world river conditions and increasing dissolved oxygen levels at the treatment site.

Pathogen Reduction Performance

Water samples collected throughout the pilot (See Appendix A, Photos 11–12) showed substantial reductions in bacteria during periods of NBOT operation:

- **Near-field downstream sampling ~5 yards (10 samples):**
    - 91.5% cumulative reduction in total coliforms
    - 83.8% cumulative reduction in *E. coli*
- **Far-field downstream sampling at ~250 yards (4 samples):**
    - 82.4% cumulative reduction in total coliforms
    - 89.3% cumulative reduction in *E. coli*
- **Far-field upstream sampling at ~250 yards (1 sample):**
    - 34.8% reduction in total coliforms
    - 27.6% reduction in *E. coli*

These results confirm that NBOT effectively reduces microbial contamination both immediately downstream of the treatment zone and at a distance.

Daily Pre- and Post-Treatment Sampling

Morning pre-treatment samples and afternoon post-treatment samples (See Appendix C, Testing Data & Graphs) further demonstrated NBOT's ability to consistently lower bacterial loads:

- **Pre-treatment total coliforms ranged from:**
  4.7 million to >241 million MPN
- **Post-treatment total coliforms ranged from:**
  300,000 to 14.1 million MPN

- **Pre-treatment *E. coli* ranged from:**
  1.35 million to 29.09 million MPN
- **Post-treatment *E. coli* ranged from:**
  464,000 to 9.2 million MPN

One pre-treatment and one post-treatment value fell outside expected ranges but were retained in the analysis for transparency. All other values demonstrated the expected clear downward trends during NBOT operation. Environmental Laboratory Network (ELN) personnel also collected samples, corroborating samples taken by GWS personnel.

Observational Findings

In addition to laboratory-verified reductions in pathogens, several qualitative observations further supported the effectiveness and safety of NBOT:

- **Odor Reduction:**
  CBP personnel consistently reported a noticeable decrease in odor within the treatment zone during NBOT operation, indicating oxidation of odor-causing compounds such as sulfides and amines.
- **No Adverse Impacts Reported:**
  No negative environmental or public health effects were observed or reported during the pilot.

Impact of Operational Constraints

Several operational limitations affected pilot duration and treatment consistency:

- Trash and debris clogged NBOT inputs and output nozzles during nighttime periods of higher flow, restricting operations to daytime hours.
- Scheduled installation of the trash boom resulted in a temporary treatment pause.
- A significant flooding event on October 14, 2025, abruptly halted operations, damaged equipment, and rendered the site unusable for the remainder of the pilot.

Despite these challenges—and a total operational window far shorter than originally planned—NBOT consistently produced a very high percentage of pathogen reductions as shown in Appendix C.

Overall Findings

The cumulative data from the pilot demonstrates that:

- NBOT effectively reduces total coliform and *E. coli* concentrations in moving river water.
- Pathogen reductions were observed across varying distances downstream of the treatment area.

- Operational performance remained strong even with intermittent runtimes caused by river debris and flow variability.
- Observed odor reduction and lack of adverse impacts further support NBOT's environmental compatibility and safety.

These findings strongly support NBOT as an effective microbial treatment option for the Tijuana River and warrant further evaluation under longer, continuous operational conditions.

Conclusion

The NBOT pilot on the Tijuana River demonstrated that Nano Bubble Ozone Technology is a safe and effective method for reducing microbial contamination in a complex and unpredictable river system. Despite substantial operational challenges, including debris-related clogging, limited treatment windows, site access limitations, and an unexpected flooding event, the pilot consistently produced significant reductions in both total coliforms and *E. coli* levels. These reductions occurred even within a shortened operational timeline, highlighting NBOT's strong treatment capacity under constrained conditions.

In addition to measurable pathogen reductions, qualitative observations further supported NBOT's effectiveness. CBP personnel reported a noticeable decline in odors within the treatment zone during NBOT operation, and no adverse environmental or public health impacts were observed at any stage of the pilot.

While the pilot ended prematurely due to flooding, the results achieved during the available treatment windows confirm that NBOT has substantial potential as a tool for improving water and air quality in the Tijuana River.

Recommendations

Based on the results observed during this pilot, the following recommendations are provided to support future assessment and potential scale-up of NBOT treatment in the Tijuana River:

1. Expand Operational Capacity

A sufficient number of NBOT units should be deployed to match the river's variable flow volumes and to increase the overall treatment capacity. Scaling up system deployment and integrating a debris filtering strategy would enable more consistent pathogen reduction and improve the effectiveness of the treatment's operational results.

2. Integrate NBOT Into Future Water-Quality Strategies

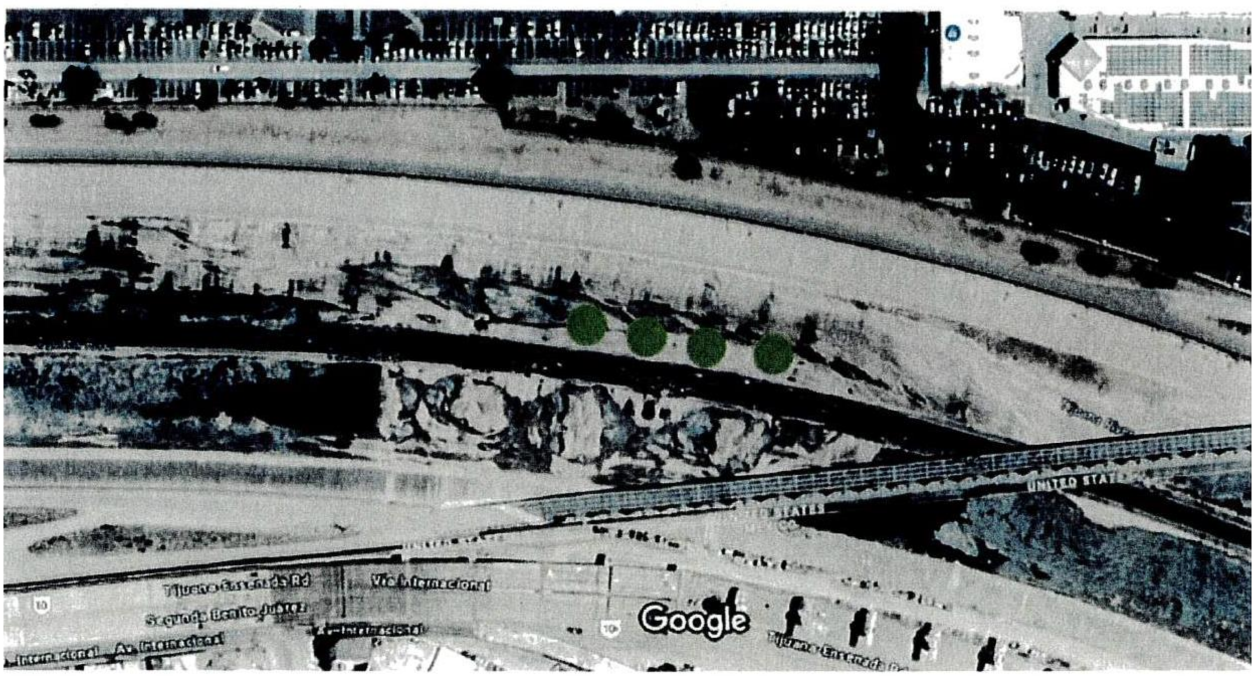
Given the demonstrated reductions in key pathogens, NBOT should be considered as part of a broader, multi-agency strategy for improving Tijuana River water and air quality, supporting beach reopening efforts, and protecting public health. Collaboration with regional, state, and federal partners will facilitate data sharing, regulatory alignment, and long-term planning.

NBOT's ability to reduce nutrients should also be harnessed to reduce downstream algal and bacterial growth.

Appendix A: Treatment Photographs

Treatment Location Map

Flood Control Plain



Site Photographs

Photo 1

Photo 2

Active Treatment (showing oxidized results)

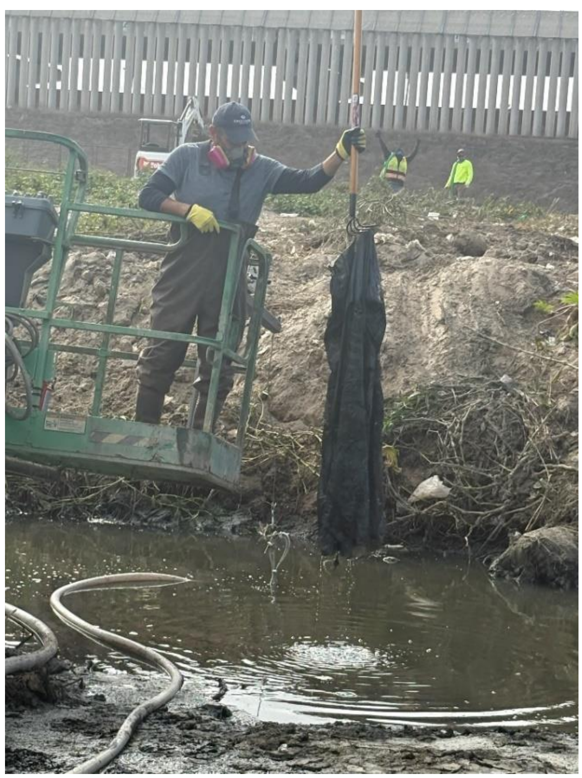
Photo 3:

Photo 4

Trash Challenges: Daily trash removals following debris-filled discharges from Mexico

Photo 5

Photo 6



Trash Boom Installation

Photo 7

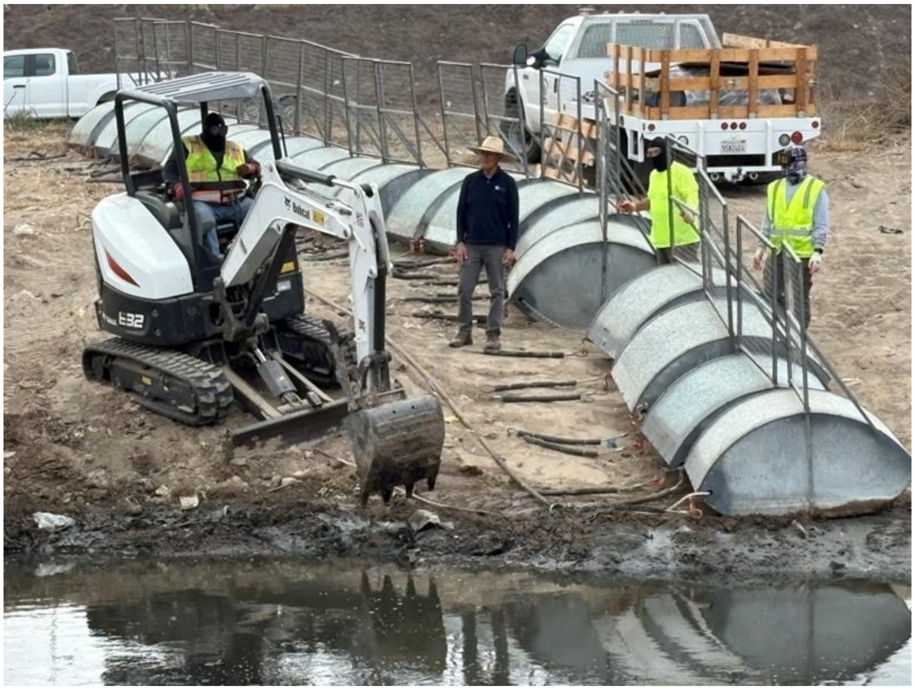


Photo 8

Flooding Aftermath

Photo 9

Photo 10

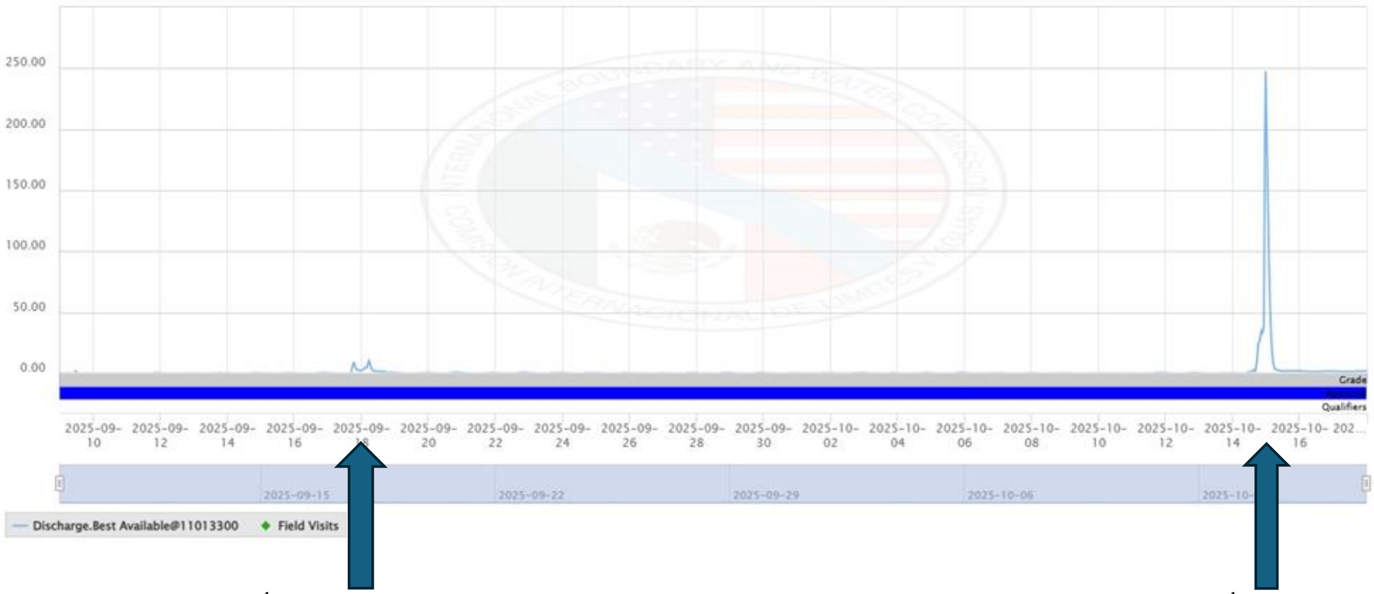
Sampling Photographs

Photo 11: Sample collection technique

Photo 12: Before and After Treatment Samples

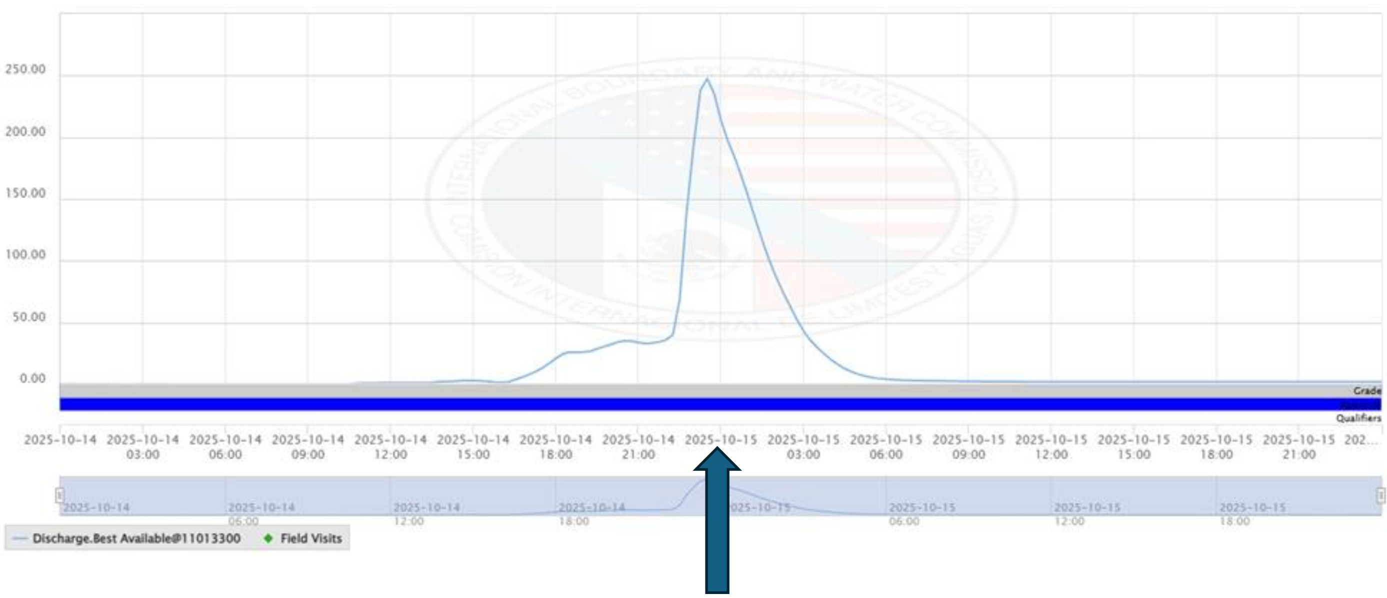
Appendix B: River Flow Charts

River Flow Data for the October 14th Flood



September 17th .5" rain event

October 14th .5" rain event

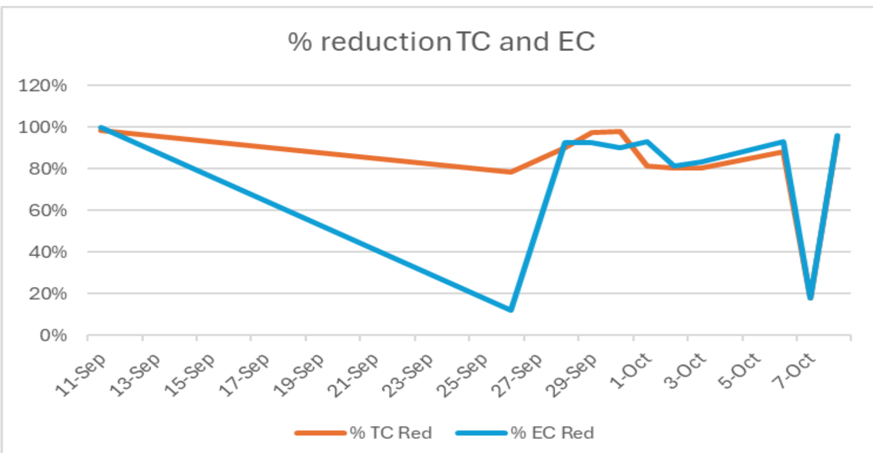


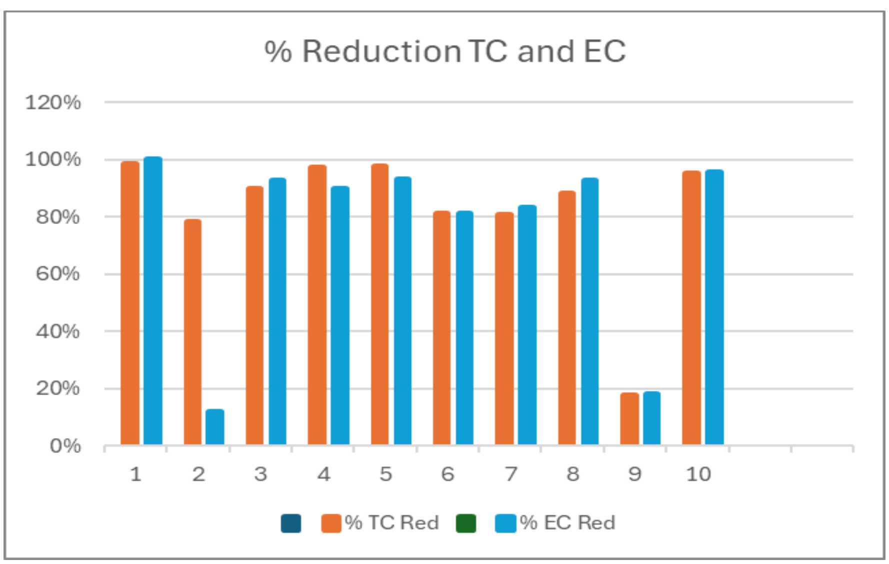
October 14th river flow
10:00 AM – 3:00 PM

Appendix C: Testing Data and Graphs

Percentage Reduction of total coliforms (TC) and *E. coli* (EC)

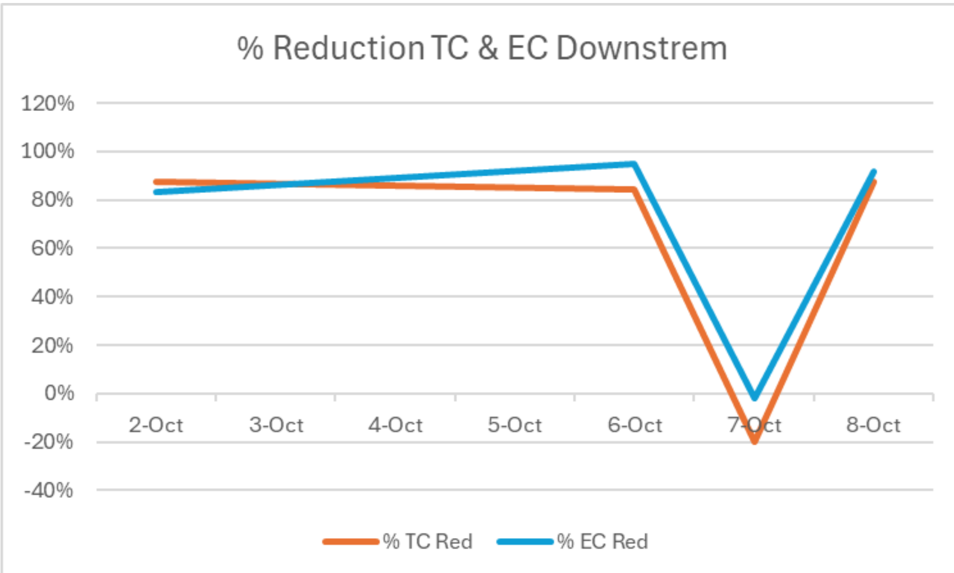
Sample number	% TC Red	% EC Red
1	98.49%	99.99%
2	78.39%	11.99%
3	90.00%	92.57%
4	97.47%	90.00%
5	97.74%	93.18%
6	81.32%	81.28%
7	80.56%	83.21%
8	88.07%	92.79%
9	17.77%	18.07%
10	95.27%	95.71%

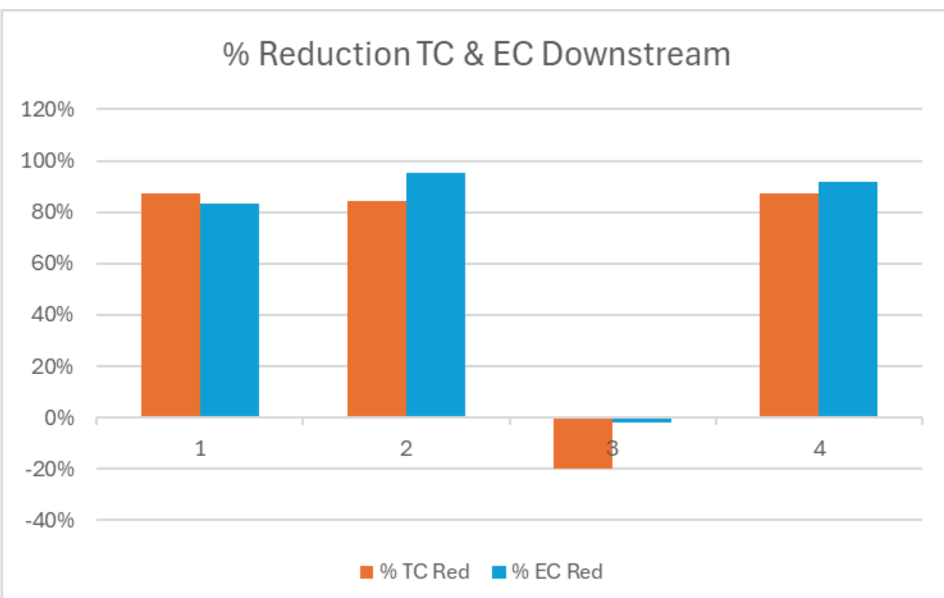




Percentage Reduction of TC & EC Downstream

Sample number		% TC Red		% EC Red
1		87.49%		83.21%
2		84.14%		95.12%
3		-19.96%		-1.78%
4		87.45%		91.75%

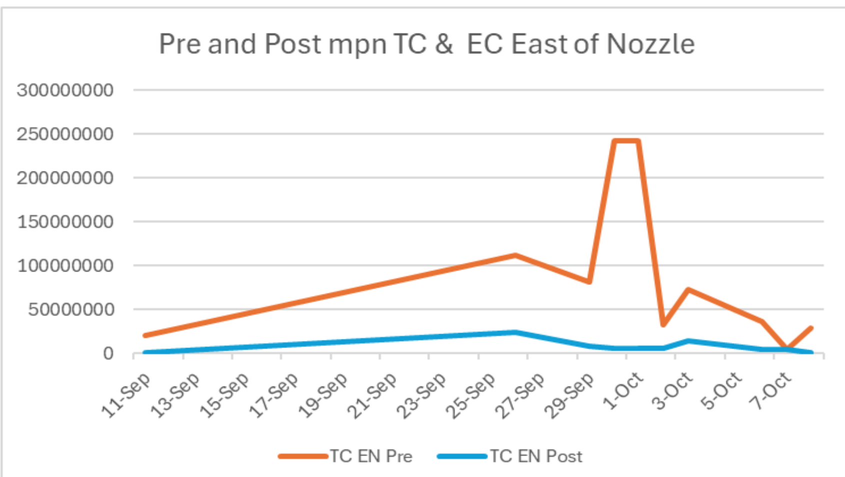


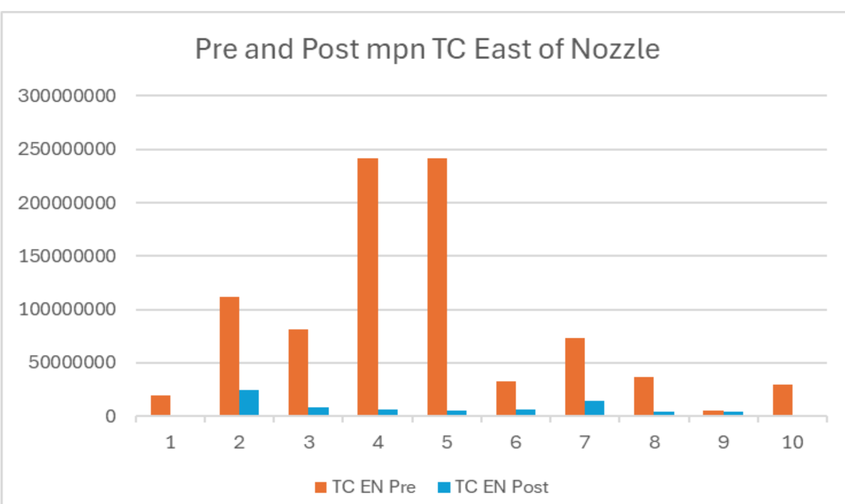


The graphs below show the daily pre and post-sample Most Probable Number (MPN) as reported by Environmental Lab Network. Outlier data is included.

Pre and Post MPN TC & EC East of the Nozzle

Sample date		TC EN Pre		TC EN Post
1		19863000		300000
2		111990000		24196000
3		81640000		8164000
4		241960000		6131000
5		241960000		5475000
6		32,820,000		6131000
7		72700000		14136000
8		36540000		4360000
9		4710000		3873000
10		29090000		1376000





Pre and Post MPN TC and EC East of Treatment

Sample date		EC ET Pre		EC ET Post
1		11,450,000		1,203,000
2		14,500,000		708,000
3		1,350,000		1,374,000
4		14,550,000		1,201,000