Summer 2022 CMT Implementation Special Report[1]
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EXECUTIVE SUMMARY

The Aquatic Weed Control Methods Test (CMT) was implemented in late May 2022 in the Tahoe Keys West Lagoon for the purpose of identifying new approaches to managing invasive and non-native aquatic weeds in the Keys as well as reducing the threat from these plants to Lake Tahoe. The planning, design, and implementation of CMT is the result of a 5-year sustained collaboration among Tahoe Keys homeowners (Tahoe Keys Property Owners Association), regulatory agencies (Lahontan Reginal Water Quality Control Board and Tahoe Regional Planning Agency), The League to Save Lake Tahoe and other stakeholders, and with a high-level of public input and interest. The major funding for the CMT is being provided by the Tahoe Keys Property Owners, and TRPA with the League supporting the Laminar Flow Aeration (LFA) study. The 3-year project is estimated to cost between $10 to 12 million, driven primarily by the extensive monitoring and data collection effort.

The impetus for the CMT is the continuing rapid spread of invasive aquatic plants both in the Keys as well as Lake Tahoe and the consensus that the historic management tools and methods have not been sufficiently successful. As the League to Save Lake Tahoe has stated, “Immediate action is required to stop the infestation in the Tahoe Keys lagoons from growing, spreading to other areas of the Lake, degrading water quality, and harming recreational opportunities.” For this reason, the CMT incorporates both well-established, successful methods that have not been allowable before such as EPA approved herbicides, with new, innovative tools such as ultraviolet (UV) light, and strategically placed laminar flow aeration (LFA) systems. The approach is simple: find the best and safest way to integrate methods that alone may be insufficient, but when combined could greatly improve aquatic weed control.

The CMT is both unique and complex not only in the highly collaborative planning phases, but also because it is the first ever permitted use of aquatic herbicides in Lake Tahoe, and the first large scale open water testing of the UV light systems. The CMT only incorporates herbicide use in the first year of the three-year project. However, to ensure the protection of the Keys water, and Lake Tahoe, the CMT includes intensive monitoring of water quality in general, and frequent and specific monitoring of herbicides and their degradants. To add further protection of Lake Tahoe, the CMT also required that areas where herbicides were to be applied be separated from the main West Lagoon by double turbidity curtains. These curtains were maintained until herbicide reached non-detect levels.

As of this report, all CMT herbicide treatments, some of the combination herbicide and UV treatments, some of the LFA, and all the UV-stand-alone treatments have been implemented. The curtains have been removed in all areas, although this took significantly longer than anticipated due to extended degradation times. The longer herbicide degradation time presumably resulted from a combination of stagnant conditions behind the curtains, high water temperatures and related increases in turbidity which in turn reduced the light-driven breakdown of one of the herbicides (triclopyr).

Preliminary results from the CMT appear quite promising: The herbicides dramatically reduced the target aquatic weeds while minimally impacting desirable native plants. The UV system has

[1]This serves as the interim report required in the APAP.

also reduced target plants and will be used during the rest of the 2022 season, as well as in years 2 and 3. Some of the LFA treatments sites were started and the rest will be implemented in spring 2023.

Successful implementation of this first phase of the CMT is the result of highly skilled and coordinated teams consisting of over 100 people, coupled with effective communication. As the first year of the CMT comes to a close, additional progress reports will be provided as well as reports required in the enabling permits. Review of "Lessons Learned" and planning for field work in years 2 and 3 are underway.

INTRODUCTION

This report provides an interim summary of progress to date in the implementation of the Tahoe Keys Control Methods Test (CMT) project. The report primarily focuses on the implementation and monitoring actions taken between May and August of 2022. Extensive monitoring for Year 1 treatment success, and water quality affects, will continue through Fall 2022. Preliminary results of this extensive monitoring will be included in the next report expected in late Fall of 2022. Periodic progress reports will also be provided at key intervals and milestones in the various phases of the three-year CMT.

Background and Context

The CMT is a three-year project that began implementation in 2022 by the Tahoe Keys Property Owners Association. The CMT addresses the need to respond to serious environmental and recreational impacts caused by increasing growth and spread of invasive and nuisance aquatic weeds in the Keys lagoons, and the recognition that successful management of these weeds in the Keys will also help reduce their continued impacts and spread within Lake Tahoe proper. The expanding growth of the relatively new invasive curlyleaf pondweed populations in the Keys and in Lake Tahoe adds further urgency to develop improved, effective management strategies and tools.

Although mechanical cutting and harvesting of the aquatic weeds in the Keys lagoons to remove biomass and improve navigation has been ongoing for several decades, this method has operational limitations and negative impacts. Harvesting encourages the spread of the weed infestation through movement of plant fragments that can start new populations. Mechanical harvesting also adversely affects native aquatic plants that are beneficial to sustaining a healthy aquatic ecosystem.

Based on these current conditions, the key CMT project objective is to assess the effectiveness and utility of different and innovative tools and methodologies that may improve the management of invasive and nuisance aquatic plants in the Tahoe Keys lagoon system, and in turn, reduce the spread of these plants into Lake Tahoe. While this project is important to Tahoe Keys Homeowners, it is also the top priority for aquatic invasive species control in Lake Tahoe.

The overarching goal of the CMT is to determine what combination of new methods are most likely to achieve a 75% reduction of weeds so that TKPOA may gain better control of the infestation and maintain that level of reduction with non-chemical methods over time. The results of this test will ultimately inform a long-term strategy for how to manage weeds in the Tahoe Keys and prevent their spread to other areas of Lake Tahoe.

PROJECT PLANNING AND DESIGN

It is helpful to review the complexity and unique conditions through which the CMT was proposed and is now being implemented. Although the Tahoe Keys West Lagoon is connected to Lake Tahoe through a narrow channel (West Channel), its environment is quite different from Lake Tahoe proper. The Keys includes many dead-end coves and several relatively shallow areas as well as some open areas that connect the coves. Most of the shoreline has boat docks and there are a few launch ramps are used for TKPOA service vessels. The movement of water into and out of the West Lagoon is determined mainly by the rate and amount of spring snowmelt into Lake Tahoe. Daily water exchanges near the West Channel also result from temperature differentials between the lake and West Lagoon, as well as winds. Seasonal flow conditions as well as water temperature at which aquatic plants begin to grow were incorporated in the planning and design of the CMT.

Planning

The planning and development process resulting in the CMT included input and collaboration from a wide range of public agencies, non-governmental groups (NGO's) and Tahoe Keys homeowners, as well as with extensive input from the public.

CMT planning included development of timely and effective coordination and communications among the implementation teams as well as regulatory agencies (Lahontan and TRPA). Preliminary planning and development of the CMT, including test design, the environmental reviews (EIR/EIS) and permitting processes by the Lahontan Regional Water Quality Control Board (Lahontan) and the Tahoe Regional Planning Agency (TRPA), spanned over five years prior to implementation.

As part of the planning process, during the environmental review, baseline "benchmark" metrics were established to carefully assess the baseline conditions existing before the CMT implementation. These metrics provided the scientific data needed to better understand water and nutrient dynamics in the Tahoe Keys lagoons. To inform CMT planning and design, additional pre-project measurements included assessing: aquatic plant biovolume (mass of plants in the water column), water quality, type, distribution, and relative abundance of aquatic plants; and the condition of invertebrates living in the lagoon sediments.

Permitting

Launching the CMT required several regulatory approvals since it was the first ever authorized use of aquatic herbicides in Lake Tahoe. These permits were developed following extensive environmental studies including an Environmental Impact Report (EIR) and Environmental Impact Statement (EIS). The purpose of these documents is to analyze and disclose the CMT project's potential effects on the natural and human environment and to identify potential or necessary mitigation measures and alternatives to avoid significant effects.

Regulatory approvals also included meeting the requirements of a Lahontan "Basin Plan Exemption" (BPE), (an exception to the general prohibition on the use of aquatic pesticides in Lake Tahoe). In addition to meeting the criteria for the BPE, two specific permits were required to implement the CMT: a National Pollutant Discharge Elimination System permit (NPDES) issued by Lahontan, and specific Environmental Threshold findings and an Environmental Improvement Program Permit from TRPA.

The permits are identified here:

NPDES: Lahontan issued Order R6T-2022-0004
The Lahontan Board certified the Environmental Impact Report and adopted the NPDES Permit No. CA 6202201 on January 13, 2022; Effective March 1, 2022; (Expires January 12, 2027)
(For reference: WDID No. 6A 09 1701001)

The TRPA Governing Board certified the Environmental Impact Statement and
TRPA issued an Environmental Improvement Program permit on January 26, 2022. (Expires January 26, 2025)
Project 510-101-00
File No. EIP C2018-0011

NOTE: All project documents and permits can be found here:
https://tahoekeysweeds.org/project-details/

Design

The CMT is designed to meet several criteria:

1. Utilize rigorous scientific and technical methodologies so that data and results can be relied upon.
2. Incorporate sufficiently replicated test sites and data collection points so that the results of the project can be statistically analyzed.
3. Time treatment types to maximize control of target plants.
4. Incorporate extensive monitoring to comply with permits and to assess effectiveness of treatments and attainment of CMT goals.
5. Provide adaptability to respond to unanticipated events such as weather, water level, or other unanticipated conditions.

The CMT incorporates field-site treatments that are replicated three times for each treatment type so that the results can be statistically compared. Test sites consisted of seven stand-alone locations using two aquatic herbicides (separately), three locations using UV light only, and six sites using both methodologies (reduced area herbicide treatment and UV treatments). A third type of treatment includes Laminar Flow Aeration (LFA), which employs submersed air-diffusers that inject air at the bottom and is designed to reduce organic sediments and the sediment-borne nutrients. Furthermore, the CMT design includes replicates of comparable untreated “control” sites in which the same Pre-CMT baseline and post-CMT effects will be assessed. Figure 1 shows the locations of CMT treatments and details of the monitoring locations. The CMT treatment types by site and size are provided in Table1.

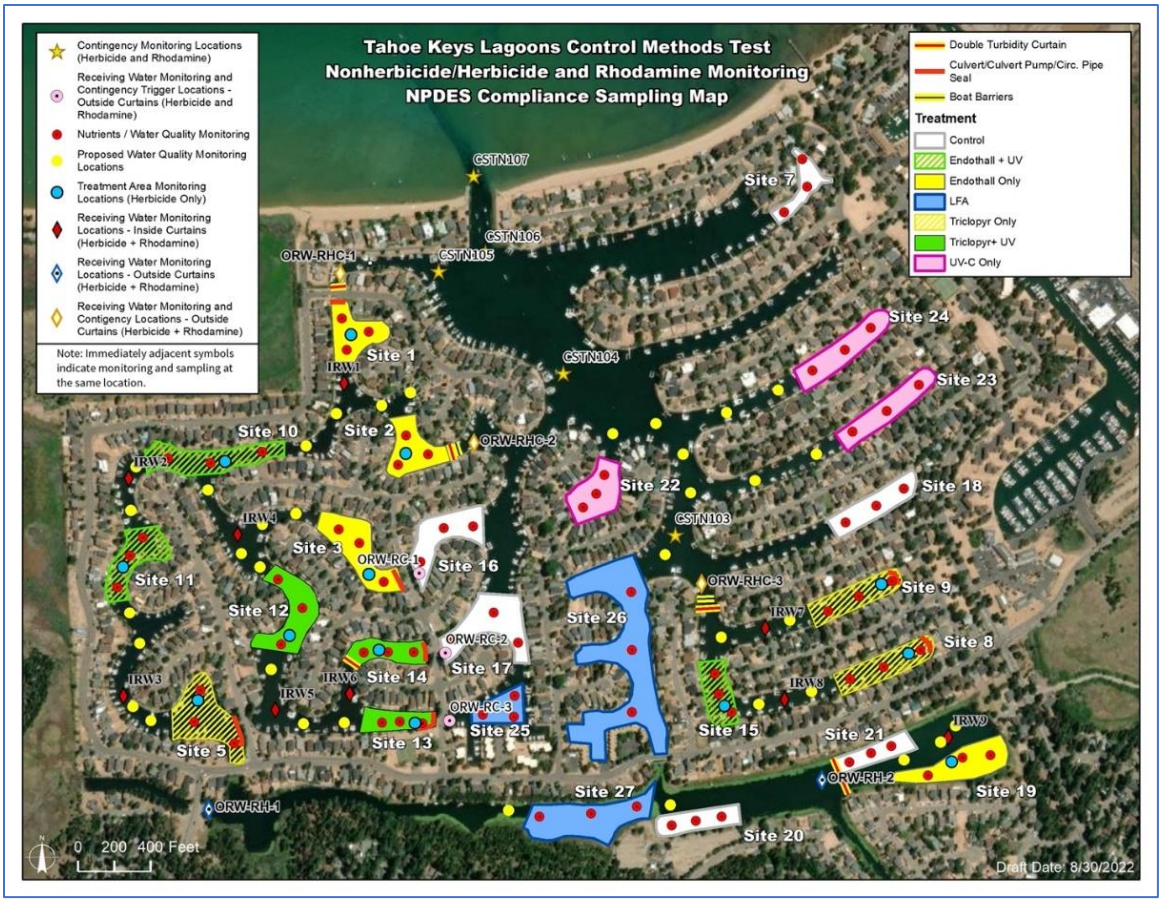

Figure 1. Overview map of CMT Sites and monitoring locations.

The scale of all CMT treatment sites is designed to be relatively small: less than 50 acres compared with the total size of the West Lagoon (about 110 acres), or the total Tahoe Keys size of 170 acres. Within the total of all sites in the CMT, herbicides were only applied to 15.5 acres. Within Lake Tallac, herbicide was applied to only 2 acres of the total 30 acres in that site (Table 1). Specific treatment areas comprising the CMT included: UV light-only (4.9 acres); UV- light in combination sites (5.6 acres); herbicide in combination areas (3.1 acres); herbicide-only (23.7 acres); controls (6.6 acres); LFA (12.9 acres).

The design for environmental monitoring is an integral part of the CMT to assess efficacy of test treatments, herbicide fate and transport, nutrients, general water quality parameters, and harmful algal blooms. Implementation of monitoring is described below. (For details of monitoring requirements and other specific conditions of the CMT, please consult the CMT Project NPDES Permit No. CA6202201 and associated Aquatic Pesticide Application Plan (APAP) and other related documents available on the Lahontan website.

https://www.waterboards.ca.gov/lahontan/water_issues/programs/tahoe_keys_weed_control/#docs-adopted2022

Table 1. Summary of CMT treatments sites and respective treatments.

Site Number	Treatment	Area (ac)	Herbicide Treated Area (ac)
1	Herbicide	1.5	1.5
2	Herbicide	1.5	1.5
3	Herbicide	2.1	2.1
5	Herbicide	2.2	2.2
7	LFA Control	1.1	0.0
8	Herbicide	1.6	1.6
9	Herbicide	1.5	1.5
10	Herbicide/UV-C Light	2.0	0.7
11	Herbicide/UV-C Light	1.6	0.5
12	Herbicide/UV-C Light	1.9	0.7
13	Herbicide/UV-C Light	1.0	0.5
14	Herbicide/UV-C Light	1.0	0.3
15	Herbicide/UV-C Light	1.2	0.4
16	Control	1.8	0.0
17	Control	2.2	0.0
18	Control	1.5	0.0
19	Herbicide	2.0	2.0
20	Control	1.0	0.0
21	Control	1.0	0.0
22	UV-C Light	1.5	0.0
23	UV-C Light	1.6	0.0
24	UV-C Light	1.8	0.0
25	LFA	4.1	0.0
26	LFA	6.1	0.0
27	LFA	2.7	0.0
	Total acreage:	47.5	15.5

Notes:
The numbers 4 and 6 were not used in the site numbering. An additional LFA Control Site 7 was added (See Figure 1).
Combination sites (Herbicide/UV-C) are a small part of the total area to which herbicides were applied because applications were only made to the areas between the docks and shoreline and only the center areas of the combination sites are being treated using UV- light.

INITIATING THE CMT (FEBRUARY-MAY 2022)

Environmental review and permitting was completed in January 2022. Permit conditions required the CMT be implemented when water flows were filling in the Tahoe Keys from Lake Tahoe and when biomass of plants was low, coupled with appropriate water temperatures that support plant growth and having plants present to be affected by treatments. This window was estimated to be between May 1-June 15, but due to limited snowfall in the Winter/Spring of 2021/2022, this was a much tighter time frame. To meet this shortened implementation window (and not entirely miss the season), the project team had to accomplish many tasks and tackle many challenges in a short amount of time, including:

- Communicating with Tahoe Keys homeowners and the public
- Establishing the measurement techniques and assessing hydraulic flows to meet permit conditions
- Pre-CMT surveys of plants and the environment
- Establishing vendor and monitoring contracts
- Organizing staff teams
- Organizing implementation schedule across multiple teams

MANAGEMENT OF THE CMT

The CMT is a scientifically rigorous test project implemented under field conditions that require flexibility and adaptations, as well as cooperation and communications with affected TKPOA homeowners and boaters and regulatory agencies. The successful initiation of the CMT utilized 12 teams (contractors and agency staff, TKPOA staff, and volunteers) totaling about 100 people for different phases of the CMT. Fielding these teams and supporting associated operational costs have been provided by TKPOA, TRPA and the League to Save Lake Tahoe for LFA components.

Sierra Ecosystem Associates (SEA) has overall Project Management responsibilities and coordinates on-line and in person meetings among the lead agencies, service contractors and consultants. However, an important separation was made between management responsibilities: TKPOA has responsibilities for managing and contracting for the CMT Herbicide and Rhodamine Dye applications and standard water quality monitoring, whereas TRPA has responsibilities for ensuring that an independent team conduct monitoring of conditions during treatments, in addition to its regulatory role.

TRPA's selection of contractors was based on their extent of experience in herbicide monitoring, water quality knowledge, and experience/knowledge with the aquatic weeds persisting in the Tahoe Keys. TRPA's management of contract services includes key monitoring compliance actions such as sampling and analysis for herbicides and degradants, specific water quality sampling for nutrients and specific monitoring for effects of CMT treatments on aquatic plants. Table 2 provides the contractors, responsible contracting entity and services provided. Figure 3 summarizes the CMT management organization and tasks associated with CMT implementation.

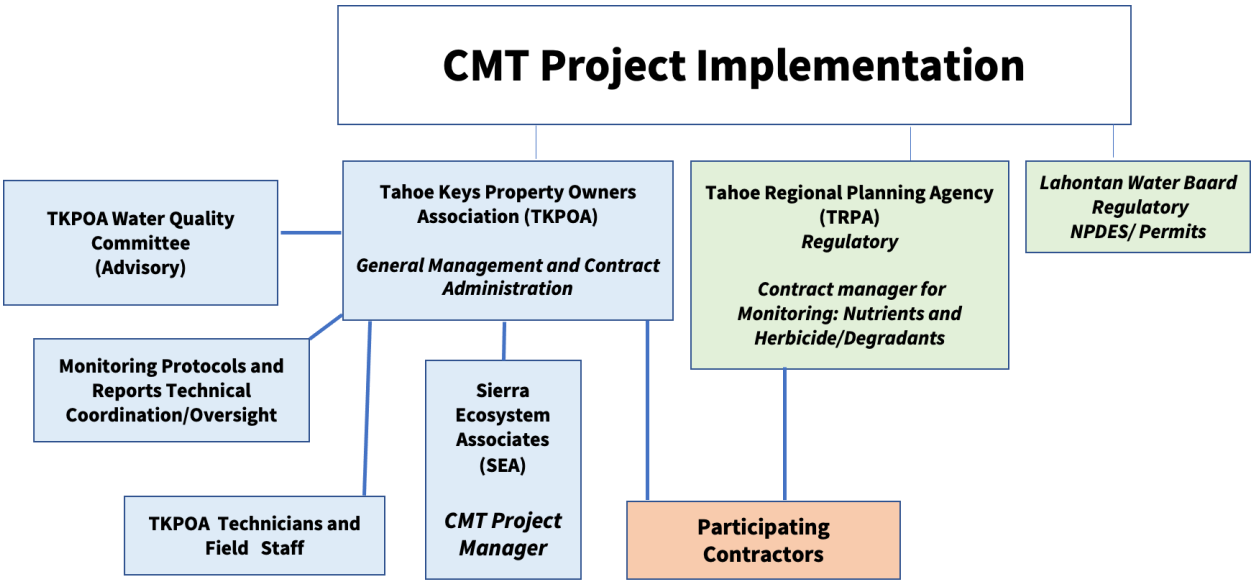

Figure 2. CMT Project Management Organization

Table 2. CMT Contracted Services.

TKPOA Contractors	TRPA Contractors

• Stratus Environmental Inc.
  ○ Well Water Monitoring
  ○ Environmental Program Manager for Spill Prevention and Response
• AquaTechnex
  ○ Herbicide and Rhodamine Water Tracer (RWT) Dye Application
  ○ Lanthanum Modified Clay (LMC) Application
• Mountain Pipeline/Pacific Built
  ○ Culvert Seals
  ○ Culvert Pump and Pipe Socks
• Hiuga Divers
  ○ Turbidity Curtain Install and Removal
• Shoreline Engineering
  ○ Installation of Boat Barriers
• Clean-Flo (Restorative Lake Sciences LLC)
  ○ Laminar Flow Aeration
• Sierra Ecosystem Associates
  ○ CMT Project Management
• Tahoe Keys Property Owners Association
  ○ Standard (sonde) Water Quality Monitoring
  ○ On-water Support to Contractors
  ○ Homeowner Communications
	• Blankinship & Associates, Inc.
	  ○ Herbicide & RWT Dye Monitoring
	  ○ Laboratory Services – Herbicide Residues/Degradants
	• Environmental Science Associates (ESA)
	  ○ Nutrient Grab Water Quality Monitoring
	  ○ Benthic Macroinvertebrate (BMI) Monitoring
	  ○ Macrophyte Monitoring
	  ○ Lanthanum Modified Clay (LMC) – Lab Coordination
	  ○ Lab Services for TKPOA Cyanobacteria analyses and Split Samples
	• Stratus Environmental Inc.
	  ○ Logger Downloads Water Quality (miniDOT loggers)
	• Inventive Resources, Inc. (IRI)
	  ○ UV Treatment Vessel and Operations

Note: Key monitoring actions are conducted under the direction and contract management of TRPA.

IMPLEMENTATION OF THE CMT

Launching the CMT required an extensive range and schedule of specific, coordinated actions. A brief summary of those actions includes the following:

Pre-Project Field Work Implementation and Approach

To ensure scientific rigor for the implementation and monitoring of the CMT and to comply with the permits, multiple team efforts and frequent coordination meetings were held to coordinate actions including:

a) Reviewing and communicating compliance and scheduling requirements to contractors.

b) Coordinating installation of containment curtains, culvert and pipe seals, and boat barriers.

c) Notifying homeowners and boating community of actions that may affect them.

d) Pre-CMT treatment sampling for benthic macroinvertebrates in sediment, water quality and macrophytes.

e) Scheduling and coordinating herbicide and UV light treatments

f) Monitoring schedules, documentation, quality assurance posttreatment

g) Coordinating sample shipments to laboratories

h) Coordinating available watercraft (work boats) to accomplish monitoring tasks.

i) Determining if hydraulic conditions were acceptable before herbicides could be applied.

j) Responding rapidly to changing conditions and taking contingency mitigation steps where necessary.

k) Preparing and submitting of all pre-herbicide application compliance documents to Lahontan and TRPA

l) Meeting with permitters (Lahontan and TRPA) to ensure compliance actions were taken, and to communicate any conditions warranting contingency measures or additional monitoring. (Also see Monitoring Work Group description below.)

Coordination and Readiness of CMT Teams

For each CMT activity, training and practice of "action" was conducted by each team whether TKPOA staff, TRPA staff, or through contracted service providers. Since this was the first time such a complex and large, multi-team effort had been done in the Keys, and since this was the first permitted use of aquatic herbicides, both training and coordination were essential to successfully executing the actions needed. Specific examples of these actions include:

a) On-site team meetings. Daily briefing for each team was conducted to ensure that needed equipment, supplies, staff, and boats were ready.

b) Calibration of equipment/ field instruments was done regularly according to equipment manufacturer- or more frequently.

c) Teams documented their compliance/schedules using up loaded forms to a common data collection/ file submittal system.

d) Coordination and review meetings:

(1) Monitoring Work Group (MWG) (Zoom) weekly meeting to discuss the current status of monitoring and CMT treatment progress. Any problems identified were discussed and resolved either at the meeting or in subsequent MWG meetings, or at separate follow-up focused meetings.

The participants of the MWG include all contractors, in-house staff (TKPOA, TRPA), the League to Save Lake Tahoe, and Lahontan representatives when specific permit clarifications were necessary. As of September 20, 2022, the MWG has met 60 times.

(2) Agency/TKPOA (Zoom) meetings. Each week TRPA, TKPOA (representatives from TKPOA Water Quality Committee and the General Manager for TKPOA), and The League to Save Lake Tahoe meet to discuss the status of CMT implementation and to coordinate field activities as needed and any adjustments to activities.

(3) TKPOA Staff/TKPOA Management and representative(s) of the TKPOA Water Quality Committee meet weekly (Zoom/in person). Specific planning for CMT compliance, field activities, and other monitoring and weed control activities are discussed.

(4) TKPOA Water Quality Committee meetings. Monthly meetings (Zoom/in person) are held to discuss water quality and related matters affecting TKPOA; the agenda always includes an update and discussion of CMT progress, issues, and proposed actions.

Conditions and Protective Actions Required for CMT Implementation

a) Hydraulic Conditions (West Channel flow).

An NPDES permit prerequisite for initiating herbicide applications was a hydraulic gradient that drives flow from Lake Tahoe into the Keys via the West Channel (See top of Figure 1). The reason for this requirement is to add an additional "buffer" (or resource protection measure) to reduce the likelihood of herbicide or degradants from entering either the West Channel or Lake Tahoe proper. Typically, melting spring snowpack drives increases in Lake Tahoe water elevation, which in turn drives filling of the Tahoe Keys lagoons. Due to drought conditions, the winter and early spring snowpack was below normal for 2022 and the lake level in general was low. The snowpack and projected snowmelt-rise in Lake Tahoe was carefully monitored and the flow within the West Channel was measured in the weeks and days before and during the applications of herbicides. TKPOA provided Lahontan with the monitoring data showing predictive lake level elevations that indicated there was a window of likely inflow to the Keys during late May. Before the planned first herbicide applications (May 25, 2022), there was net inflow in the West Channel (measured with an in-line flow meter mounted on an anchored vessel) 24 hours before the first applications on May 25, 2022, and continued inflow through the last application on May 31, 2022. A series of storms beginning May 27,2022 contributed additional snowpack to the higher elevations, which produced additional lake-level and Keys lagoon level rise until mid-June. As the data predicted, hydrologic conditions had a net inflow before, during and after herbicide application.

b) Installation of Double Turbidity Curtains.

As part of the CMT permit requirements, sites identified for herbicide applications were required to be isolated from the main waterway areas of the West Lagoon, and Lake Tahoe. The use of containment curtains effectively isolated three major boating exclusion zones of the CMT sites: Area A (west side of the West Lagoon behind curtains installed at Site 2); Area B (containing sites 8,9 and 15 in southeast area of the West Lagoon); and Area C (Lake Tallac, all non-motorized boating). Figure 3 shows the boating restricted areas (A, B, and C).

To protect the integrity of the curtains, and to prevent boats from breaching the curtains, physical metal barriers and plastic fencing was installed outside the curtains for Areas A and B. Figure 1 shows where the curtains were installed prior to applications of herbicides. (Note: during installation and removal of curtains, turbidity is monitored to ensure disturbance is minimized.)

Figure 3. Map depicting restricted boating areas separated from the West Lagoons by sets of double turbidity curtains (A, B, and C) and boat barriers (A and B). The shaded zones also show where boating entrance and egress was prohibited from pre-herbicide applications (May 25, 2022) until removal of barrier curtains from each area.

Weather-Driven Rapid Response and Adjustments to Containment Curtains

During the first weeks after the herbicide applications had been made, several high-wind events occurred that caused small gaps and loosening of the anchors for the curtains for Area A at Site 2. RWT dye and water samples for herbicide analysis just outside Site 2 for Endothall showed that the curtains had been compromised and that receiving water levels for endothall had been exceeded. Similar high winds affected the curtains for Area B, but this did not result in receiving water limit exceedances. Within 24 hours of these events, the compromised curtains for both areas had been inspected and repaired by divers, and on the lake side of the Site 2 curtains, an additional set of double curtains was installed within 2 days (May 29, 2022). Therefore, Area A was further isolated from the main West Lagoon waterways with the addition of two more curtains at that location.

Per requirements of the NPDES and related documents, TKPOA notified Lahontan by email within 24 hours of the discovery of the weather-induced curtain breaches and resultant exceedances. This triggered additional contingency sampling for herbicides described in the permits and implemented by TRPA's monitoring team. This contingency monitoring demonstrated that herbicides were not detected in areas that would allow them to enter the West Channel or into Lake Tahoe. Written reports to Lahontan were provided within five days of the event and exceedance discoveries. The effectiveness of this monitoring and the rapid response actions

illustrates the well-coordinated and management efforts by all teams as well as the constructive communications with regulatory agencies (Lahontan and TRPA).

A separate receiving water exceedance of endothall occurred within Area C that resulted from endothall levels greater than 100 ppb in the internal receiving water (behind curtains) beyond 21 days of herbicide application. This occurred adjacent to Site 19 (Lake Tallac), but not beyond the turbidity curtains blocking off Lake Tallac from Area C for the 2-acre endothall application. This was not surprising because separate treatments areas were not separated from each other in Area C and no impediment existed to herbicide diffusing from Site 19 to adjacent waters contained behind the Lake Tallac curtains.

Again, Lahontan was notified formally, and subsequent sampling showed that endothall levels decreased to below receiving water limits (100 ppb).

At Site 14, (combination triclopyr/UV treatment), once triclopyr levels had decreased to well below 100 ppb (non-effective levels), the curtain for this specific site was removed to increase mixing with adjacent internal receiving waters behind the Site 2 curtains.

Written reports regarding the exceedance events were submitted to Lahontan in accordance with the NPDES permit. For the Site 2 curtain events, the final report was submitted on June 22, 2022. For the internal receiving water limitation exceedance in waters adjacent to Site 19, the final report was submitted to Lahontan on July 13, 2022.

CMT Treatments and Schedule

a) UV- Only Treatments

UV-only sites 24, 23, and 22 were treated in this sequence beginning 31 May (Table 3). These sites were treated to the extent possible, with some limitations due to dock/ boat interferences and due to shallow water limitations near the shoreline. The second rounds of UV treatment were started July 27, 2022. Note that the pre-and post-UV water quality and nutrient sampling were performed on schedule to determine if UV treatments affected those variables.

Table 3. Dates of treatments made in the UV-sites.

CMT UV-Only Treatments 2022	First Round Start date	First Round Finish date	Duration of Treatment (Days)	Second Round Start date	Second Round Finish date	Duration of Treatment (Days)
Sites:						
24 (UV Only)	5/31	6/7	6	7/27	8/9	7
23 (UV Only)	6/7	6/15	7	8/31	9/9	7
22 (UV Only)	6/21	6/29	7	8/18	8/26	7
15 (Combo)	9/12	9/16	5	TBD	TBD	
10 (Combo)	9/26	9/30	4	TBD	TBD	
11 (Combo)	10/3	TBD				

b) UV Combination treatments

The first UV combination treatments were started September 12 in Site 15 after the turbidity curtains were removed in Area B (Table 3). Access to the Area A combination sites required removal of turbidity curtains separating Area A at Site 2, which occurred September 22/23. The first combination site in Area A (Site 10) was started September 26. Site 11 will be started the week of October 3, 2022. Due to the delayed access to Area A, combination sites 12,13,14 may not receive UV treatments in 2022.

c) Herbicide applications

Following the pre-CMT baseline monitoring, the herbicide applications were made at the sites and on the dates shown in Table 4. Note that the applications were staggered, including days without any applications, to provide sufficient time for monitoring teams to carefully implement sampling, water quality monitoring and nutrient sampling in compliance with the NPDES permit and related requirements.

Applications of endothall and triclopyr products were performed on schedule and without any incident. The applications were also observed by staff from TRPA and Lahontan. UV-C Light treatments in the UV-C only sites were initiated within a few days of the herbicide treatments and three sites were completed on set schedules (about 5-7 days per site). The second round of UV-C only treatments began in early August and were completed in early September.

UV Combination site treatments were delayed due to the need to maintain barriers and curtains longer than expected, and due to logistic limitations for launching the UV vessels to access the Combination sites, which are located behind curtains in areas A and B. The delay in curtains removal for Areas A and B was caused by a combination of slower than projected degradation rates for triclopyr and the “non detect” requirement established for the CMT set equal to the very low laboratory reporting limit of 1 ppb.

LFA (Laminar Flow Aeration) was started in Site 26 prior to CMT. LFA sites 25 and 27 will be installed/started in late Fall 2022 or Spring 2023.

Table 4. CMT Herbicide application dates for each site.

Site Number	Treatment	Proposed Herbicide	Herbicide Rate (final concentration)	Application Date	Application Day
8	Herbicide only	Triclopyr	1.0 ppm	5/25/22	1
9	Herbicide only	Triclopyr	1.0 ppm	5/25/22	1
15	Combination	Endothall	2.0 ppm	5/25/22	1
No Applications				**5/26/22**	
1	Herbicide only	Endothall	2.0 ppm	5/27/22	2
2	Herbicide only	Endothall	2.0 ppm	5/27/22	2
3	Herbicide only	Endothall	2.0 ppm	5/27/22	2
No Applications				**5/28/22**	
5	Herbicide only	Triclopyr	1.0 ppm	5/29/22	3
10	Combination	Endothall	2.0 ppm	5/29/22	3
11	Combination	Endothall	2.0 ppm	5/29/22	3
No Applications				**5/30/22**	
12	Combination	Triclopyr	1.0 ppm	5/31/22	4
13	Combination	Triclopyr	1.0 ppm	5/31/22	4
14	Combination	Triclopyr	1.0 ppm	5/31/22	4
19 (Lake Tallac)	Herbicide only	Endothall	2.0 ppm	5/31/22	4

Source: TKPOA APAP Amendment 2 dated May 24, 2022.

CMT MONITORING

The CMT is a very intensively monitored project, for both permit compliance and for scientific rigor that will ultimately inform a longer-term weed control strategy for the Tahoe Keys. The CMT is the first project of its kind and the first use of targeted aquatic herbicides (endothall and triclopyr) in the Lake Tahoe region. To ensure protection of water quality within the Tahoe Keys lagoons and Lake Tahoe proper, stringent, and specific permit conditions were applied. These include but are not limited to extensive water quality monitoring and the placement of double turbidity curtains separating herbicide treatment sites in Areas A, B and C from the main channels and Lake Tahoe as described above in "Conditions and Protective Actions."

One of the most important monitoring components is the level of herbicide in the CMT sites and associated areas. This data is important not only to assure that proper levels are achieved for effectiveness, but also because herbicide levels determine when the turbidity curtains can be removed. These curtains must remain in place until monitoring results show "non-detect" levels of herbicide, defined as less than 1 ppb for triclopyr and less than 5 ppb for endothall in two consecutive samplings, 48 hours apart.

Figure 1 shows the various monitoring locations and spatial relationships of sampling sites to the treatment sites, control sites, and proximity to the rest of the West Lagoon and Lake Tahoe. However, this map does not reveal the full extent of monitoring that is driven by the required frequency of each monitoring event at each location, the extent of "contingency" sampling driven by either RWT dye detection or herbicide detection, nor the multiple types of sampling analysis whether on-site (standard water quality variables), or analysis done through laboratory procedures. Figure 1 also does not indicate specifically the locations of macrophyte sampling or extent of hydroacoustic scanning that represent part of the assessments used to determine the effectiveness of the CMT methods in controlling the target aquatic plants. Table 5 provides a more complete summary of the CMT monitoring actions and approximate numbers of data points projected to the end of August 2022, about 3 months after the start of the CMT project field work. This information is based on required frequency of sampling per week per site and may be updated in any final reports due to contingency sampling and other samples taken during the current field season. (It contains only a partial summation since CMT years 2 and 3 also require monitoring, although not for herbicides or degradants as they will not be used in years 2 and 3). (Refer to Table 2 for specific teams/contractors assigned to monitoring tasks.)

Table 5. Summary of CMT monitoring activities by type and frequency.

Monitoring / Sample Type:	Weekly Data Points	Data points Projected to August 30, 2022
Herbicide: In 14 herbicide sites	14	168
Herbicide: outside herbicide sites Behind curtains	14	168
Herbicide Outside curtains	9	108
Herbicide Contingency Sites (Outside of curtains)	5	60
Water Quality (standard) 18 (includes controls) sites (3 times per week)	54	648
Water Quality (hourly loggers, two per site: DO, Temperature) at 18 sites.	12,096	145,152
Water Quality (nutrient) (Nitrate+nitrite, Total P, Ortho P, TKN)	34	408
Water Quality (stations between sites) (pH, DO, Temp)	14	168
Hydroacoustic scans (plants) NOTE: each scan has thousands of separate, georeferenced data points generated by on-board transducer	12	144

Physical rake (point sampling) 30 points per site (biweekly)	330	3,840
Plant Condition Rankings 30 per site (biweekly)	330	3,840
Physical rake photo image (biweekly)	330	3,840
RWT Dye (behind curtains and outside curtains including contingency sample site)	10	120
Sediment (biological: BMI)	48	48
Video assessments: UV-C sites	5	50
Total data points	**13,305**	**158,654**

Quality Assurance and Quality Control

As part of the CMT project with its range of treatments, monitoring and permit compliance requirements, all actions performed either by TKPOA staff, contractors or other lead agencies are carefully documented and follow prescribed standard accepted laboratory protocols or protocols and methods outlined in the Quality Assurance Protection Plan (QAPP). These quality assurances range from the Pre-CMT baseline monitoring through all phases and types of post-CMT monitoring. Compliance with the Plan is documented through use of either on-line forms, hand-written and initialed or signed forms and through training and oversight. For physical samples taken for analysis by laboratories, the handling, or "custody" of each sample or set of samples is documented through a "Chain of Custody" form. This ensures the integrity of the sample as well as providing the ability to "track" samples for future reference.

Data collected directly in the field is either digitally stored or written on field data sheets, georeferenced, and subsequently reviewed for accuracy and for completeness. Given the very large numbers of data sets (see Table 5), and the need for careful QA/QC review, the details of results will be discussed in subsequent reports.

Specific sets of data including herbicide and herbicide degradant levels and levels of Rhodamine WT dye are subjected to timely, continuous QA/QC. This includes specific laboratory protocols and reporting of QA/QC standards for each set of samples analyzed. Since these data are used for both permit compliance as well as "triggers" for mitigation actions, or planned actions such as barrier curtain removal, these data are reviewed daily. Details of QA/QC methods will be provided in the annual reports for the CMT project.

MONITORING RESPONSES

Herbicide Degradation and Curtain Removal

Based on the environmental analysis and years of experience of using these specific aquatic herbicides in other regions, the projections for herbicide degradation and subsequent removal of turbidity curtains were approximately 30 to 40 days after treatment ("DAT"). For example, with an application date of May 31, this would mean that the non-detect level might be reached by early July, with curtains being removed shortly thereafter. However, degradation of the herbicide triclopyr to non-detect levels took much longer than projected. The additional time to reach non-detect levels was due to a combination of slower than projected degradation rates for triclopyr and the "non detect" requirement established for the CMT set equal to the very low laboratory reporting limit of 1 ppb. Instead of an approximate 50 percent projected degradation rate, the actual degradation rate to reach the 1 ppb threshold turned out to be closer to 40 percent for Area B and 20 to 30 percent for Area A. The extended closure periods required re-notifications to

affected homeowners and associated limitations to the boating season. Curtains in Area B were finally removed September 2, 2022. Curtains in Area A were removed September 22,2022.

The CMT monitoring team is currently assessing why the degradation rates did not follow projections, but likely are due in part to stagnant water, high water temperatures and high algae-driven turbidity that reduced UV-light penetration to the water. These factors and others listed in the "Lessons Learned" section below will be considered and addressed in future monitoring reports and will inform the long-term recommendations for weed management in the Tahoe Keys.

Activation of CMT Site Aeration: Planned Mitigation

From the water quality monitoring data, it appears that the combination of stagnant, entrapped water behind curtains in Areas A and B, coupled with turbidity, may have delayed the photo-degradation of triclopyr. The CMT design included the activation of aerations systems that were already deployed as a contingency. To accelerate degradation of triclopyr, these aeration systems were started in all CMT-herbicide sites between June 27, 2022 and July 7, 2022. Figure 4 shows the locations of aerators. Aeration in Area B continued until non-detect conditions were obtained. Aeration in Area A will continue through the week of September 26 because non-detect levels of triclopyr were confirmed September 21, 2022 and Area A curtains were removed beginning September 22, 2022. End of year analyses of the extensive water quality data sets are expected to help assess the reasons for the slow degradation rates and for the differences between Areas A and B.

Unexpected Interference with logging devices

Some unexpected challenges occurred with a few of the data loggers ("miniDOT") in Lake Tallac and other sites going missing due to curious bears displacing the loggers and buoys to which they were attached. Some loggers were later found, and others were quickly replaced. Different types of buoys will be installed in Fall 2022 in the future to deter further bear interactions. However, separate water quality measurements are made three times per week in each site, which ensured that water temperature and dissolved oxygen are carefully monitored. The temporary loss of these loggers did not significantly affect overall monitoring.

Figure 4. Locations of aerators (2 per site) installed and activated in CMT herbicide sites.

LESSONS LEARNED

A three-hour CMT Project progress review meeting was held July 14,2022 at which time CMT contractors, managers, TKPOA, TRPA, the League to Save Lake Tahoe, and Lahontan staff discussed a wide range of topics focused on actions taken to date, problems resolved, and suggestions for on-going management and actions. The meeting was facilitated by Zephyr Collaboration (consultant to TRPA). The first three months of the CMT has revealed both successes and some lessons to be considered moving forward. These include:

1. In spite of the short time between approvals of CMT permits and required timing for spring CMT implementation (approximately 3 months), the project team was able to evaluate contract proposals and complete contracts for the large teams of service providers on time (see Table 2). Ideally at least a 6-month lead time would be preferable.
2. The frequent coordination meetings among agency leads, contractors and staff resulted in highly adaptive actions and adjustments to changing field conditions. This level of coordination is critically important to the CMT due to the intensity of monitoring and complexity of field logistics.
3. Shared logistic and field equipment resources among contractors and teams helped ensure that work was completed on schedule.
4. Stagnant water and turbidity behind turbidity curtains may have caused slower herbicide degradation than expected. This will be furthered explored in future reports. If herbicide

treatment were to be considered in the long-term strategy, contingency for water circulation (e.g., portable pumps) in treatment areas to increase mixing could enhance post-treatment water quality. Including LFA- type aeration should also be considered as part of other CMT treatments.

5. More extensive discussion and clarity are needed of both “non-detect” thresholds and “receiving water” zones, prior to project implementation, particularly for use and removal of curtains with regulatory agencies (e.g., Lahontan, TRPA).
6. Consider the importance of using the UV treatments before any herbicide use so that “restricted” zones do not delay UV treatments in combination sites.
7. Contingency plans put in place prior to project implementation worked well to respond quickly in the event of a turbidity curtain breach and prevent any aquatic herbicide from entering Lake Tahoe proper.
8. The project is by design, a test, which required deploying new technologies in new environments with extensive monitoring and logistics. Continued documentation of lessons learned and successes will inform future work in the Tahoe Keys.

NEXT STEPS

a) Monitoring

During the remainder of Fall 2022, CMT monitoring will continue in compliance with permits and related requirements. Monitoring of herbicides and degradants in water was discontinued in Area A since non-detect levels of triclopyr were confirmed on September 21, 2022. Sediment samples for herbicide analysis will be taken from each CMT site where herbicides have been applied and from control sites within two weeks after all curtains have been removed. Sediment sampling began September 24, 2022 in Area B, and will continue in other CMT sites based on the when each site was treated (See Table 4).

Monitoring during years 2 and 3 will be continued per CMT plans.

b) Treatments

UV “Combination treatments sites and follow-up (second round) UV treatments in UV only sites will be completed. LFA devices will be installed in Site 25 and Site 27. Routine harvesting will continue outside CMT sites (except for Combination sites as noted before).

In years 2 and 3, Group B (non-herbicide) methods will be employed based on monitoring data collected on Year 1 treatments and target invasive plant growth and abundance.

c) Reporting

Analysis of monitoring data will be underway in fall of 2022 The Project Team expects the next report to be released later this year. The draft of a final CMT-Year 1 report to Lahontan will be provided by March 1, 2023.

SUMMARY

The CMT project was initiated as planned during the required conditions of Lake Tahoe and lagoon filling. This was a major collaborative and logistical undertaking. The teams responsible for myriad treatment and monitoring actions have performed well and as planned. Communications among the CMT monitoring teams, Agency leads, and Project Management team have been extremely effective not only on weekly coordination, but also with frequent additional, focused communications and responses pertaining to specific challenges or changing

conditions in the field. The rapid responses to brief exceedances in “receiving water” levels of herbicide due to storm-driven curtain displacement clearly demonstrated that such contingencies were planned for and executed well. More investigation and data analyses are needed to assess the reasons for the longer-than-anticipated time required for the herbicides to degrade in the water quality settings of test Areas A and B.

As a “test,” the first three months experience has already provided very useful information from both the responses of the aquatic plants to treatment as well as monitoring logistics and management. A follow-up report in late 2022 will present further information on the results of the CMT Year 1 test activities.

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