City of Napa

Water Division

Request for Proposals: Master Plan for Reservoir and Watershed Operations

Lake Hennessey & Milliken Reservoir

Proposals Due:	**Thurs, November 17, 2016**
	2 PM PST
Office Address:	**1340 Clay Street**
	Napa, CA 94559

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I. Notice to Proposers

The City is accepting proposals from consulting teams offering expertise in a number of areas as it relates to policy and procedures associated with short and long term planning for reservoir and watershed operations for the City of Napa, California.

Sealed proposals from qualified proposers, as described herein, will be received at the City of Napa (City) Water Division office, 1340 Clay Street, 94559. Any changes to this Request for Proposal (RFP) are invalid unless specifically modified by the City and issued as a separate addendum document. Should there be any question as to changes to the content of this document; the City's copy shall prevail. It is the Proposer's sole responsibility to ensure that the proposal, inclusive of any or all addenda, is either hand delivered or mailed to the appropriate address identified below prior to the due date listed herein.

Submit one (1) original proposal and required forms, written in ink or typed, along with three (3) copies of the proposal and required forms, and one USB of the proposal and required forms in Microsoft Word or PDF format. Proposals shall be clearly marked "Master Plan for Reservoir and Watershed Operations" and enclosed in a sealed envelope.

Proposals shall be hand delivered or sent to:

City of Napa Public Works-Water Division

ATTN: Joy Eldredge, P.E.

1340 Clay St

Napa, CA 94559

Proposals must be submitted by the due date and time outlined in the Project Schedule (see below).

FAXED OR EMAILED PROPOSALS WILL NOT BE ACCEPTED. PROPOSALS RECEIVED AFTER THE DEADLINE WILL NOT BE CONSIDERED AND WILL BE RETURNED UNOPENED.

All project inquiries shall be emailed to the City's points of contact which are as follows:

To: squilon@cityofnapa.org (Sharon Quilon, Secretary)

Cc: jeldredge@cityofnapa.org (Joy Eldredge P.E., Water General Manager

Subj: PROJECT INQUIRY – RFP Master Plan for Reservoir and Watershed Operations

The RFP is available at http://www.cityofnapa.org/water

II. Background

The City of Napa (City) owns and operates two local surface water dams, reservoirs, and treatment plants that are vital to the municipal water supply for the City of Napa and surrounding areas in unincorporated Napa County. The City provides treat & wheel services to the Cities of Calistoga and American Canyon as well as wholesale water to the City of St. Helena. The City's water system provides water for 84,000 people throughout Napa County.

In recent months, there have been a number of important issues that have arisen relating to these critical water supplies and staff has determined there is a need to review multiple aspects of the operation, document the current situation, assess future scenarios and make recommendations for the short term and long term management of the reservoirs and watershed facilities to assure a stable, sustainable high quality water supply for the City's water customers.

The topics to be assessed include but are not limited to:

- flow releases from the Hennessey and Milliken Dams
    - streambed alteration agreement process
        - existing downstream habitat
        - habitat restoration and enhancement
- watershed monitoring and analyses of water quality in tributaries and reservoir
    - watershed protection and management (Enhanced Sanitary Survey)
    - existing water quality vs historical data
    - enhanced sampling parameters and frequency
- reservoir water quality management
    - algal control
        - PAC 27 vs $CuSO_4$
        - Solar covers with mixers
        - biological controls
- recreation and management of public access on and around reservoirs

- invasive species prevention of Quagga and Zebra Mussels

- spillway capacity
  - bathymetric survey

A qualified team will have demonstrated experience and abilities in the following areas:

Drinking water quality

Watershed protection for municipal water supplies

Fisheries and habitat

Land use and water

Familiarity with municipal water supply reservoir management

Navigating processes for environmental documentation, land use and conservation easements.

Engineering design and cost estimating

Water rights for surface and groundwater resources

III. Scope of Project and Deliverables

The Master Plan will develop a series of Technical Memorandums (TM) focused on the following topics:

A. TM1: Flow releases from the dams

This TM will be the first deliverable for the Master Planning effort. An assessment of current operations under existing agreements will be reviewed and recommendations for future bypass flow releases relative to the downstream habitat for sensitive species including but not limited to steelhead trout will be developed. The work will cover both water supply reservoirs of Lake Hennessey and Milliken Reservoir.

The City has started assessments of streamflow improvements over recent years and has submitted funding applications through the Integrated Regional Water Management Program (IRWMP) process but has not been able to achieve the priority level sufficient to accomplish final outcomes. The City operates under agreements for flow releases established decades ago

and recognizes the need to negotiate permits with resource agencies to include agreements for maintenance and streambed alterations to insure all known storage and water supply parameters. Release requirements under existing agreements are reflected in attached summary sheets. (See Exhibit A) Recommendations will be completed through this effort with appropriate biological expertise providing input on options for efficacy of seasonal releases, quantification of benefits, identification of partnerships and potential grant opportunities to maximize results.

The assessment will consider existing conditions, habitat potential, and environmental benefits as well as health, safety, reliability, and economic implications of proposed changes to system operations.

B. TM2: Watershed monitoring, analyses, and modeling

This TM will be similar to the efforts required by the California State Water Resources Control Board Division of Drinking Water (DDW) every five years by law known as the Sanitary Survey, however more robust than previous efforts. The Sanitary Survey reviews the existing watershed where drainage contributes to the municipal drinking water supply and identifies contributing runoff and discharge factors that affect water quality as well as potential threats to the municipal water supply. The City's update to the Sanitary Survey is due in 2017. In 2007 Watershed Sanitary Surveys recommended water quality monitoring of tributaries at the outfall into the lake and the City has been monitoring the water quality in the major tributary outfalls for nearly a decade and in the reservoir for nearly three decades, specifically since the treatment plant was constructed in 1982. The 2012 Sanitary Survey continued in the same fashion and identified the major threats to the Hennessey watershed as Pacific Union College Wastewater Treatment Plant, older septic tank systems, vineyards, spills of hazardous materials along Highway 128 near the lake, wildfires, and erosion from maintenance roads. (Exhibit B) As of 2012 the most significant potential sources of contaminants in Milliken watershed are wild animals, wildfires, and erosion from maintenance roads. Establishment of vineyards in the watershed since 2012 will be identified in the 2017 update.

To further develop the existing data and understand with greater precision the source of the constituents of concern that are observed in the water supply, this effort will focus on establishing monitoring sites upstream in the tributaries such that the locations represent the varied land uses within the watershed including but not limited to unimproved land, urban wastewater and storm runoff, rural residential septic systems and storm runoff, ranches and grazing, farming and agricultural uses which are most commonly vineyards.

The TM will include a monitoring and analysis plan to define the constituents of concern, recommend locations and frequency of analyses throughout the watershed and in the reservoir to enhance the historical information and build on enhancing the future understanding of factors that affect water quality. The monitoring plan shall consider installation of instruments and real-time data recording to track seasonality of water quality and quantity.

To develop a monitoring and analysis plan historical land use, review of zoning information, planned and potential land use changes within the contributing watershed areas shall be assessed. (See Exhibit C) Outreach to stakeholders within the watershed include but are not limited to property owners associated with urban, rural residential, wastewater operations, private and commercial agricultural farming. The inventory of septic systems and wastewater treatment processes will be reviewed and nutrient contributions will be defined through data gathering. Staff from County Planning, Building and Environmental Services Department and the County Resource Conservation District will be interviewed and information requested to understand historical, existing and future policies related to stormwater pollution prevention plans and enforcement activities. Effectiveness of policy implementation for no increased discharge is to be confirmed in the field. Stakeholders such as ranch managers and owners will be interviewed to understand management and farming practices for ranches, vineyard managers and owners will be engaged to define practices for vineyard conversions: tilling, plowing, deep ripping, crop cover, fertilizer and pesticide management, harvesting practices as well as replants of existing vineyards.

A bathymetric survey will be part of TM 5, identified later in this document. Analyses of core samples taken from strategic locations identified as part of the bathymetry where sediment has accumulated will assist in understanding historical and current factors that may affect water quality.

Watershed Model. The hydrology of the creeks and streams will be modeled to simulate quantity and quality of run-off and flows within the municipal watershed(s). The watershed model will mimic existing land uses from GIS data and run-off coefficients using existing USGS soils data and tributary water quality data to estimate and establish water quality and model future land use changes and future water quality.

C. TM3: Reservoir water quality

This TM will identify recommendations for managing water supplies to maintain water quality. SWP and local supply sources have seasonal taste and odor challenges due to algal growth as well as episodes of high total organic carbon (TOC) that increases the formation potential for disinfection byproducts. The City has consistent data for speciated algae counts since 2000 and has seen episodes of increased algal growth since 2010. (Exhibit D) Staff is cognizant of these challenges and uses vigilance to provide the highest quality water to its customers but is often left with no good choices. An assessment of the existing known algae speciation, definition of limiting nutrients and correlation of nutrients in tributary influent shall be performed to develop recommendations for the future monitoring plan.

Modifications to reservoir releases may change the frequency of local reservoirs spilling and filling. Increased stagnation of water supplies will increase water temperatures and further exacerbate the taste and odor challenges that are on the rise due to water quality degradation, increased nutrient loading and other factors. A plan to manage existing reservoir water operations to address loss of quality will be defined along with recommendations to address impacts on the operation.

The City currently uses PAC 27 an eco-friendly algaecide. Other mechanical and chemical alternatives exist and need to be assessed to address nutrient management and algal growth that adversely affects finished drinking water. An assessment of hypolimnation was performed in 2008 (Exhibit E). Alternative chemical and physical treatments including but not limited to solar covers, solar powered agitators, and mechanical harvesting, shall be assessed and recommendations made in light of effectiveness and estimated lifecycle costs.

D. TM4: Recreation uses and invasive species prevention

This TM will focus on the current recreational uses allowed on the lake including boating and fishing. The introduction of invasive species including zebra and quagga mussels would devastate the water supply. The threat of these species known to recreate in a prolific fashion, clog intake pipes and quickly imbalance the ecological balance in any water body. Recommendations for preventing the introduction of these species will be defined including revisions to the outdated ordinance for recreational uses associated with the reservoir. The team will assist in completing the Vulnerability Assessment of invasive species infestation in accordance with the State Division of Boating and Waterways Zebra and Quagga Mussel Invasive Species Prevention Program. The Vulnerability Assessment is approved in accordance with the Grant Program and must be finalized before the Prevention Plan will be developed. (Exhibit F) The Vulnerability Assessment is included in this RFP but the Prevention Plan will be authorized under a separate, future effort.

E. TM5: Dam spillway capacity

This TM will include a review of existing work performed and build on the available information. The City has had communications with the California Department of Water Resources Division of Safety of Dams (DSOD) dating back to the mid-1980s regarding the infrastructure that allows for the overflow from the Hennessey reservoir and the credible hydrologic contribution from storm events. The peak storm event and hydrograph will be assessed and confirmation of sufficiency or recommendations for alterations of infrastructure and or operations will be defined. DSOD has indicated an updated hydrograph model is forthcoming but the information has yet to be received by the City of Napa. The HEC-RAS model, when received shall be assessed to insure assumptions and outputs are accurate and reflect the watershed environment and runoff conditions.

A bathymetric survey will be performed to determine the reservoir capacity that has been lost due to siltation and sedimentation that has been deposited since original dam construction. Survey information of the baseline construction conditions during original construction of Conn Dam and establishment of Lake Hennessey storage reservoir will be available to the selected proposal team.

Many of these items have interactive effects on how the overall dam and watershed is managed and operated. The Master Plan will be developed by a team that has expertise in biological species including but not limited to anadromous fish, invasive mussels, and algae as well as water quality, water resource protection and how it affects drinking water treatment.

IV. Selection Criteria

Proposals will be evaluated by a committee of City staff. The evaluation committee will be contacting references and/or conducting all required inquiries the City deems necessary to assist in the evaluation of all proposals. Proposals will be qualifications-based. City staff evaluations will be measured and tallied across the following dimensions:

1. **Statement of Qualifications and Experience:** 30 points, summary of the proposer's qualifications and recent experience in providing services for similar Projects. Experience referenced shall be of similar or greater scope, size and complexity (proposer shall furnish information of similar work performed within the past ten years, including current contact information for each project).

2. **Project Approach and Understanding of Objectives:** 20 points, describe your firm's approach and team organization to perform services. Include a brief description on the collaborative process/methods to be used by key personnel, stakeholder outreach, as well as a summary of your Firm's understanding of project, broad technical requirements, constraints affecting implementation.

3. **References and Completeness**: 20 points, summary of references as outlined in Exhibit G and overall quality/completeness of proposal package.

4. **Cost**: 2 0 points, price to include all labor, equipment, etc. for consultant services as outlined in Exhibit H and shall be delivered in a separate sealed envelope.

5. **Work Schedule and Timeline:** 10 points, summary of durations for submittal of TMs and milestone dates/events. The City acknowledges and understands that completion schedule will be dependent on timely City responses, seasonal data gathering and analyses, and the full scope of

consecutive technical memoranda will be dependent on processing information from stakeholder outreach and discussions.

V. **Proposal Format**.

Submit one (1) original proposal with three (3) copies and required forms, along with a USB in Microsoft Word or PDF format which shall include, but not be limited to the following:

A. **Letter of Transmittal** (not to exceed one page).

B. **Table of contents** (not to exceed one page). Provide an outline of material presented.

C. Proposer's Business Information (not to exceed one page per firm or sub-consultant included in the proposal – see Exhibit I).

D. Statement of Qualifications & Experience (not to exceed ten pages).

Proposals must contain a statement as to qualifications of the proposer and any sub-consultants; identify the project manager, additional staff and/or sub-consultant staff having assignments under the contract. Resumes of all staff shall fully describe qualifications, experiences, and projects for which they had progressive responsibility, along with the duration of time with the proposer's firm. The project manager will be expected to be fully involved and conversant in the schedule and deliverables, namely the technical memoranda as well as coordinate with the technical experts contributing to specific subject areas.

Describe the organization structure of staff members and sub-Contractors and provide a summary of the business' general experience in providing the Scope of Work listed in the work described in Section III. This section shall also include a description of three recent projects of similar scope and magnitude.

E. Approach & Methodology (not to exceed five **pages).**

Proposals must address the minimum tasks outlined in Section III. The City requests that any additional list of tasks which the proposer expects City staff to perform (i.e. any not contained in this RFP) be included in their proposal.

F. Work Schedule and Timeline (not to exceed two pages).

Proposals must contain an outline of a proposed work schedule and timeline that includes all tasks and deliverables for completion. The work schedule shall explain what respective roles and tasks that City staff would be expected in order to complete the Scope of Work.

G. Exceptions to Scope of Work.

Any deviation from Specifications and Scope of Work must be identified on Exhibit J (Additions, Deletions and/or Exceptions). Failure to note said exceptions will be interpreted to convey that the proposer proposes to perform in the manner described and/or specified in this solicitation. If exception(s) are taken or alternatives offered, complete descriptions must be shown separately.

H. **Exceptions to Terms of Agreement.**

It is recommended that the Proposer's legal counsel review the terms and conditions in Exhibit K (Sample Agreement). If there are changes to any terms in Exhibit K, these pages with proposed changes must be marked and submitted with the proposal.

I. Project Cost (not to exceed two pages).

Not-to-Exceed project cost for the performance of all services described in the scope of work, must be identified in the format outlined in Exhibit H which shall be delivered in a separate sealed envelope.

J. Billing schedule (not to exceed two pages).

A payment schedule shall accompany the project cost sheets which shall be delivered in a separate sealed envelope. The billing schedule shall clearly identify:

1) Proposed rates and method of payment for all services to be performed by the Proposer including hourly rates, description of any reimbursable charges, and rental or purchase of equipment and/or instrumentation.

2) An estimated cost breakdown for each major component of the scope of work, with a cross-reference to each component identified in Section III.

K. References and completeness (not to exceed one page):

Provide a minimum of three (3) references from recent projects of similar or greater size and scope on Exhibit G, preferably those from other California agencies.

VI. Award of Contract

Staff expects to select the team in November 2016 and return to council in early December to request authorization to award the contract to the best qualified team.

VII. General Terms and Conditions

Exhibit K shows the City's standard Agreement for Professional Services. All proposers including their legal counsel shall review the terms and conditions and submit any exceptions to the terms with tracked changes along with the proposal. No submission assumes the proposer takes no exception and accepts the standard terms and conditions of the City's Agreement for Professional Services.

VIII. Exhibits

A. Exhibit A Existing Reservoir Release Requirements

(Pages A1-A2)

DATE	IF LAKE HENNESSEY WATER SURFACE ELEVATION IS GREATER THAN OR EQUAL TO:	STREAM MAINTENANCE RELEASE REQUIREMENT			HEIGHT OF FLOW OVER FARMER'S WEIR
	FEET	CFS	=GPM	=GPD	FEET
NOV 1- MAY 1:	305.00	0.5	224	323,136	0.28
	302.00	0.4	180	258,509	0.25
	299.00	0.3	135	193,882	0.22
	296.00	0.2	90	129,254	0.19
	293.00	0.1	45	64,627	0.14
	292.99	0	0	0	0.00

STREAM MAINTENANCE RELEASE REQUIREMENT					
	FEET	CFS	=GPM	=GPD	FEET
MAY 1- OCT 31:	305	Greater of 0.5 or inflow	Greater of 224 or inflow	Greater of 323,136 of Inflow	Greater of .28 or Inflow
	302.00	0.4	180	258,509	0.25
	299.00	0.3	135	193,882	0.22
	296.00	0.2	90	129,254	0.19
	293.00	0.1	45	64,627	0.14
	292.99	0	0	0	0.00

WATER USER ACCOUNTS	
FEB 15 - MAY 15: NOV 1	NOT TO EXCEED TOTAL OF 900 A-FT
	POSITIVE BALANCE ZEROS OUT
	NEGAITIVE BAL CARRIED FORWARD

DATE	MILLIKEN RESERVOIR	STREAM MAINTENANCE RELEASE REQUIREMENT
November - March	If Water Level is at or below 873' msl	Lesser of 0.50 cfs or natural streamflow down to 0.12 cfs
	If Water Level is above 873' msl	Lesser of 5 cfs or natural streamflow down to 0.12 cfs

DATE	MILLIKEN RESERVOIR	STREAM MAINTENANCE RELEASE REQUIREMENT		
April - October	No diversion; inflow = outflow			
	If very low inflows ≤ 2 cfs exist, maintain outflow of 1.74 x low flow until inflow reaches zero.	**INFLOW (CFS)**	**x 1.74 =**	**OUTFLOW (CFS)**
		1.9	1.74	3.3
		1.8		3.1
		1.7		3.0
		1.6		2.8
		1.5		2.6
		1.4		2.4
		1.3		2.3
		1.2		2.1
		1.1		1.9
		1.0		1.7
		0.9		1.6
		0.8		1.4
		0.7		1.2
		0.6		1.0
		0.5		0.9
		0.4		0.7
		0.3		0.5
		0.2		0.3
		0.1		0.2
		0		0.0

Notes	
Nov-Mar	Months can store 2,000 acre feet for use at any time. New passive spillway (cored holes) are at storage level 1,413 A-Ft.
April-Oct	No diversion to storage.
1924 Judgment in Mary Eudora Miller Clover v. City of Napa requires a bypass of 1.74 x inflow during dry months and 0.12cfs during wet months.	

B. Exhibit B City of Napa Watershed Sanitary Survey 2012

(Pages B1-B78)

CITY OF NAPA WATERSHED SANITARY SURVEY

Prepared for

City of Napa, Napa, California

November 28, 2012

CITY OF NAPA WATERSHED SANITARY SURVEY

Prepared for
City of Napa, Napa, California
November 28, 2012

Brett Farver, P.E. #C58466
Technical Advisor

Brown AND Caldwell
10540 White Rock Road, Suite 180
Rancho Cordova, CA 95670

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LIST OF ACRONYMS

Ag	Agricultural
ac-ft	acre-feet
AFY	acre-feet per year
AL	action level
bgs	below ground surface
BMP	best management practice
BOD	biochemical oxygen demand
$CaCo_3$	calcium carbonate
CALFIRE	California Department of Forestry and Fire Protection (formerly known as CDF)
CAP	*Cryptosporidium* Action Plan
CCL	Contaminant Candidate List
CDFG	California Department of Fish and Game
CDPH	California Department of Public Health
CEQA	California Environmental Quality Act
cfs	cubic feet per second
CFU	colony forming units
City	City of Napa
County	Napa County
CT	contact time
CU	color units
DBP	Disinfection By-Products
D/DBP	Disinfectants/Disinfection By-Products
DO	dissolved oxygen
DOC	dissolved organic carbon
DPR	Department of Pesticide Regulation
DWR	California Department of Water Resources
EPA	Environmental Protection Agency
EQIP	Environmental Quality Incentives Program
FSZ	farmland security zone
gpd	gallons per day
gpm	gallons per minute
HAA	haloacetic acid
HPC	heterotrophic plate count
hp	horsepower
IESWTR	Interim Enhanced Surface Water Treatment Rule
ICR	Information Collection Rule
IDSE	Initial Distribution System Evaluation
L	liter
LRAA	location running annual average
LT1ESWTR	Long Term 1 Enhanced Surface Water Treatment Rule
LT2ESWTR	Long Term 2 Enhanced Surface Water Treatment Rule
MCL	maximum contaminant level
MCLG	maximum contaminant level goal
MDL	method detection limit
mg	million gallons
mgd	million gallons per day
mg/L	milligrams per liter
mL	milliliter
MPN	most probable number
MSL	mean sea level
MTBE	Methyl tert-Butyl Ether
MRDL	maximum residual disinfectant levels
NCRPOSD	Napa County Regional Park and Open Space District
ND	non-detect
NL	notification level
NOM	natural organic matter
NO_x	nitrogen oxides
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
NTU	nephelometric turbidity units
OES	Office of Emergency Sercives
pCi/L	picocuries per liter
ppb	parts per billion
psi	pounds per square inch
POC	particulate organic carbon
PWS	public water system
RAA	running annual average
RCD	Resource Conservation District
RWQCB	Regional Water Quality Control Board
SbMA	Subdivision Map Act
SDWA	Safe Drinking Water Act
SFRWQCB	San Francisco Bay Regional Water Quality Control Board
SWRCB	State Water Resources Control Board
SWTR	Surface Water Treatment Rule
THMs	trihalomethanes
THMFP	trihalomethane formation potential
TTHM	total trihalomethanes
TMDL	total maximum daily load
TOC	total organic carbon
TONs	threshold odor numbers
TSS	total suspended solids
UCMR	Unregulated Contaminant Monitoring Rule
UCMR 1	First Cycle of the Unregulated Contaminant Monitoring Rule
UCMR 2	Second Cycle of the Unregulated Contaminant Monitoring Rule

UCMR 3	Third Cycle of the Unregulated Contaminant Monitoring Rule
µg/L	micrograms per liter
USC	United States Code
USDA	United States Department of Agriculture
US EPA	United States Environmental Protection Agency
USFWS	United States Department of the Interior Fish and Wildlife Service
USGS	United States Geological Survey
UV	ultraviolet
VOCs	Volatile Organic Compounds
WMP	Watershed Management Plan
WTP	Water Treatment Plant
WWTP	Wastewater Treatment Plant
#	number

EXECUTIVE SUMMARY

The California Surface Water Treatment Rule (SWTR) requires that all domestic water suppliers using surface water supply sources conduct a watershed sanitary survey of their water supply watersheds, and to update that survey every five years thereafter. The survey is required to evaluate potential contaminant sources within the watershed that may impact drinking water quality. The City of Napa (City) conducted a sanitary survey of the Lake Hennessey and Lake Milliken watersheds in 1996, 2001, and 2007. This watershed sanitary survey is an update to the previous surveys, and focuses on changes in the watershed since the 2007 Watershed Sanitary Survey (2007 Update).

Watersheds and Water Supply Systems

The Lake Hennessey and Lake Milliken watersheds are subsets of the Napa River watershed. The Napa River originates in northern Napa County, and flows south, paralleling Highway 29. Conn Creek, the discharge from the Lake Hennessey watershed, flows into the Napa River from the east, as does Milliken Creek, the discharge from the Lake Milliken watershed, which joins the Napa River just north of the City of Napa (see Figure 2-1). The Lake Hennessey and Lake Milliken watersheds are adjacent and are characterized by a similar topography.

The City has three sources of water: Lake Hennessey, Lake Milliken, and the North Bay Aqueduct. Water from Lake Hennessey is treated at the Hennessey Water Treatment Plant (WTP), located near Conn Dam at Lake Hennessey. Lake Milliken water is treated at the Milliken WTP, located approximately 3 miles downstream of Lake Milliken on Milliken Creek. This sanitary survey covers the watersheds of Lake Hennessey and Lake Milliken.

Water from Lake Hennessey is treated at the 20 million gallon per day (mgd) Hennessey WTP. Water from Lake Milliken is treated at the 5 mgd Milliken WTP. The Milliken WTP is typically not used during the winter months when raw water turbidities are too high to be treated effectively at this plant. When the City's water demands are lower, it can be supplied solely by the recently expanded 20 mgd Jamieson Canyon WTP, which treats North Bay Aqueduct water.

Potential Contaminant Sources in the Watershed

The vast majority of both the Lake Hennessey and Lake Milliken watersheds are undeveloped. Much of the remaining watershed is under agricultural production, primarily vineyards. There is cattle grazing limited to a few adjacent properties in each watershed.

The most significant potential sources of contaminants in the Lake Hennessey watershed are the Pacific Union College Wastewater Treatment Plant, older septic tank systems, vineyards, spills of hazardous materials along Highway 128 near the lake, wildfires, and erosion from the City's maintenance roads around Lake Hennessey. The expansion of recreation use of trails in the Lake Hennessey watershed has the potential to be a significant source of potential contaminants if not properly maintained, but trail development has not yet occurred.

The most significant potential sources of contaminants in the Lake Milliken watershed are wild animals, wildfires, and erosion from the City's access roads around Lake Milliken.

Water Quality Compliance and Concerns

Overall, the water quality data results are similar to that presented in the previous City of Napa watershed sanitary surveys. However, the increase in recreational use in the Lake Hennessey watershed that has been approved by the City of Napa is anticipated to have a measurable impact on the influent water quality monitoring data. In particular, the increased usage of the recreational trails, by hikers, bicyclists, dogs, and horses, can be expected to result in increased erosion, resulting in higher turbidity and organic loading to Lake Hennessey.

Increased raw water turbidity levels are a particular concern because, although the Hennessey WTP is a fully conventional treatment plant, the facilities are old and inefficient and cannot operate at the design capacity of 20 mgd for an extended period of time. At flow capacities of 17 mgd and higher, the filters have to be backwashed every two hours which is very inefficient and generates a large amount of spent backwash water for disposal. Additional backwash water could exceed the allowable discharge to the sludge ponds of 1.1 mgd. The sedimentation basin currently operates at a barely adequate level under current conditions. If raw water turbidity is further increased, these problems would be exacerbated and flow capacity would need to be reduced.

The Milliken WTP is also an older treatment plant that would have great difficulty treating higher levels of turbidity that might result if trails are developed in the Milliken watershed. The Milliken WTP is a direct filtration plant without the benefit of solids sedimentation ahead of the filters. Any additional raw water turbidity with associated increase in coagulant chemical dosages would increase the solids loading directly on the filters and cause shorter filter runs and potential filtered water quality deterioration. The filters are especially vulnerable because they are pressure filters.

The water quality monitoring conducted on the raw water supplies for the Hennessey WTP and the Milliken WTP show that the primary maximum contaminant levels (MCLs) are not exceeded in the untreated water. The concentrations of iron, manganese, turbidity, and color in the untreated water occasionally exceed the secondary MCLs. All treated water is below the MCLs.

The five-year average total organic carbon (TOC) concentrations in for the Hennessey WTP reported in the 2007 Update were high enough to cause potential issues with treatment: 12 milligrams per Liter (mg/L). The 2001-2005 average for the Milliken WTP was 5-6 mg/L. The 2006-2012 averages are 4.2 mg/L for the Hennessey WTP, and 4.0 mg/L for the Milliken WTP.

With regard to pathogen removal requirements, the total coliform densities are consistent with the data presented in the three previous watershed sanitary surveys. Monthly median total coliform densities at Milliken are usually greater than 1,000 most probable number (MPN)/100 milliliter (mL) and at Hennessey are occasionally greater than 1,000 MPN/100 mL. Therefore, removal/reduction requirements vary between 3-log *Giardia* and 4-log virus and 4-log *Giardia* and 5-log virus reduction/inactivation.

Watershed Control and Management Practices

Historically, the City's ownership of large amounts of land in each watershed has enabled them to limit and control activities near the lakes. However, the increasing interest by recreational groups, both local and regional, in accessing the City's drinking water supply watersheds has recently led to the approval of trail development in the Lake Hennessey watershed. The prohibition against grazing and the previously extremely limited recreational use of the watershed has enabled the City to manage the properties with limited resources. The expansion of recreational uses within the watershed, adjacent to Lake Hennessey, may demand a commensurate increase in management of the watershed from the level that has been conducted by the City up to this time. Currently, the City has the equivalent of one half-time staff person patrolling the Lake Hennessey watershed.

In recent years, an increased interest in organic farming, combined with a State Water Resources Control Board focus on nonpoint sources, and specifically, agricultural sources of contamination, has resulted in significant changes in agricultural practices in the watersheds, including a decreased use of pesticides and herbicides. These trends have continued, resulting in 1 million fewer pounds, a 50 percent decrease, of pesticides being applied in Napa County from 2005 to 2010. The number and acreage of organic farms have doubled from 2006 to 2011. These trends are expected to continue.

Recommendations

In general, the City of Napa Water Division should study the extent to which current activities are discharging contaminants into the reservoir, and should document the extent of current use of the roads/trails and the state of the roads/trails through photographs, and by maintaining a record of Watershed Incident Reports, so that a comparison can be made after the recreational trails are developed.

1. The additional recreational activities in the Lake Hennessey watershed could significantly increase the risk to the WTP. Allowing public recreational access to the City's water supply watersheds should be done in conjunction with development of a watershed management plan which evaluates the risks, plans for mitigating existing or likely water quality consequences, and develops an optimum plan for this shared use.
2. The increased usage of the recreational trails can be expected to result in increased erosion, resulting in higher turbidity and organic loading to Lake Hennessey. Evaluating changes in these parameters between the water quality data reported in this 2012 Update and that recorded over the next five years should be the focus of the subsequent watershed sanitary survey.
3. The City should document the current physical condition of the Lake Hennessey watershed in the vicinity of the planned recreational trails. Documentation should include photographs of the following areas: trail locations currently subject to erosion; sites along the shoreline that are easily accessible to recreationists or accompanying animals from the recreational trail; and, sites along the trail that are easily accessible to recreationists to use as short-cuts, detours, vistas, or other non-trail activities. The City should also record the current number of users, the types of uses, unauthorized uses, and encroachments onto maintenance roads that are not open to the public.

   Although the City currently prepares Watershed Incident Reports to record unauthorized uses of the lake or lands, an accurate depiction of the changes in use would require a consistent methodology. For example, patrolling the trail area from dawn to dusk on a weekday and a weekend during the same season and weather conditions, before and after the trails are developed.
4. The City should maintain their current practice of not allowing cattle grazing on City property in the watersheds of Lake Hennessey and Lake Milliken.
5. It is recognized that funding is a challenge, but the City should work towards establishing funds to implement a policy of purchasing privately held lands within the watershed. Gaining control of the lands is an effective method of preventing the long-term degradation of water quality.
6. The biological health of the food chain should be examined to determine if certain species can be introduced to reduce phosphorus and other constituents that support the growth of algae and coliform bacteria as well as reduce TOC.
7. A Hennessey Contaminant Load Study was recommended in both the 2001 and 2007 Updates. Although tributary monitoring takes place, several key parameters are not tested. The samples should be analyzed for TOC, total phosphorus, soluble orthophosphate, total nitrogen, ammonia, nitrate, total coliform, and fecal coliform. The combination of high TOC, a disinfection by-product (DBP) precursor, and high total coliform densities requiring additional *Giardia* and virus reduction requirements in the raw water may contribute to elevated DBP concentrations in the finished water and difficulties meeting the Stage 2 Disinfectants/Disinfection By-Products (D/DBP) Rule requirements. A contaminant load study will help the City identify the source of nutrients leading to algae growth, TOC, and coliform bacteria in the lake. If

necessary, targeted watershed management activities may then be enacted to improve the raw water quality in the lake. Samples should be collected from Conn Creek, Chiles Creek, and Sage Creek once a month during the dry season when flow in the tributaries is low. During the wet season, weekly sampling is recommended. In addition, the City should target several storm events and collect samples under storm conditions. Corresponding samples should be collected from the raw water entering the Hennessey WTP.

8. A Milliken Coliform Study would help identify the source of elevated total coliform densities in the raw water at Milliken WTP. If the coliform source is traced to cattle grazing in the upstream watershed, best management practices may be enacted to protect the stream from coliform loadings. Samples should be collected from Milliken Creek as it enters the lake, from the creek just downstream of the dam, and from the creek at the diversion dam and analyzed for total and fecal coliform and turbidity. Samples should be collected weekly during the summer months when the Milliken WTP is operating. In addition, samples should be collected weekly during two to three months of the wet season, ideally January to March, when flows in the creek are generally highest. Although the Milliken WTP does not currently have the capability to meet water quality regulations during the winter months, the winter sampling is needed to characterize the source of coliform bacteria. These data should allow the City to determine if the source of the coliform is upstream or downstream of the lake.

1. INTRODUCTION

The California Surface Water Treatment Rule (SWTR) requires that all domestic water suppliers using surface water supply sources conduct a watershed sanitary survey of their water supply watersheds, and to update that survey every five years thereafter. The survey is required to evaluate potential contaminant sources within the watershed that may impact drinking water quality. The City of Napa (City) conducted a sanitary survey of the Lake Hennessey and Lake Milliken watersheds in 1996, 2001, and 2007. This 2012 Sanitary Survey is an update to the previous surveys.

1.1 Conduct of the Study

Brown and Caldwell conducted this watershed sanitary survey by collecting and reviewing available information from government agencies and other stakeholders in the watershed. Brown and Caldwell and the City also conducted a field survey of the Lake Hennessey watershed on September 6, 2012, to identify the locations of planned trails. The field survey consisted of a driving and walking tour along shoreline and upland roads northwest of Lake Hennessey. Brown and Caldwell did not conduct a field survey of the Lake Milliken Watershed.

1.2 Report Content and Organization

The content and organization of this sanitary survey update report is consistent with the format recommended in the American Water Works Association California-Nevada Section Watershed Sanitary Survey Guidance Manual (1993). The report is divided into the following sections:

- Introduction
- Watersheds and Water Supply Systems
- Potential Contaminant Sources in the Watersheds
- Water Quality
- Watershed Control and Management Practices
- Conclusions and Recommendations

A complete list of references used in the preparation of this watershed sanitary survey is included at the end of this report.

2. WATERSHEDS AND WATER SUPPLY SYSTEMS

A description of the watersheds and the City's water supply system are provided in this section, and serve as a basis for information provided in subsequent sections. A regional map for the watersheds is shown on Figure 2-1.

The Lake Hennessey and Lake Milliken watersheds are part of the Napa River watershed. The Napa River originates in northern Napa County, and flows south, paralleling Highway 29. Conn Creek flows into the Napa River from the east, as does Milliken Creek, which joins the Napa River just north of the City of Napa (see Figure 2-1). The Lake Hennessey and Lake Milliken watersheds are adjacent, and are characterized by a similar topography. A general description of the watersheds, including land uses and ownership, and the water supply systems is provided in the following subsections.

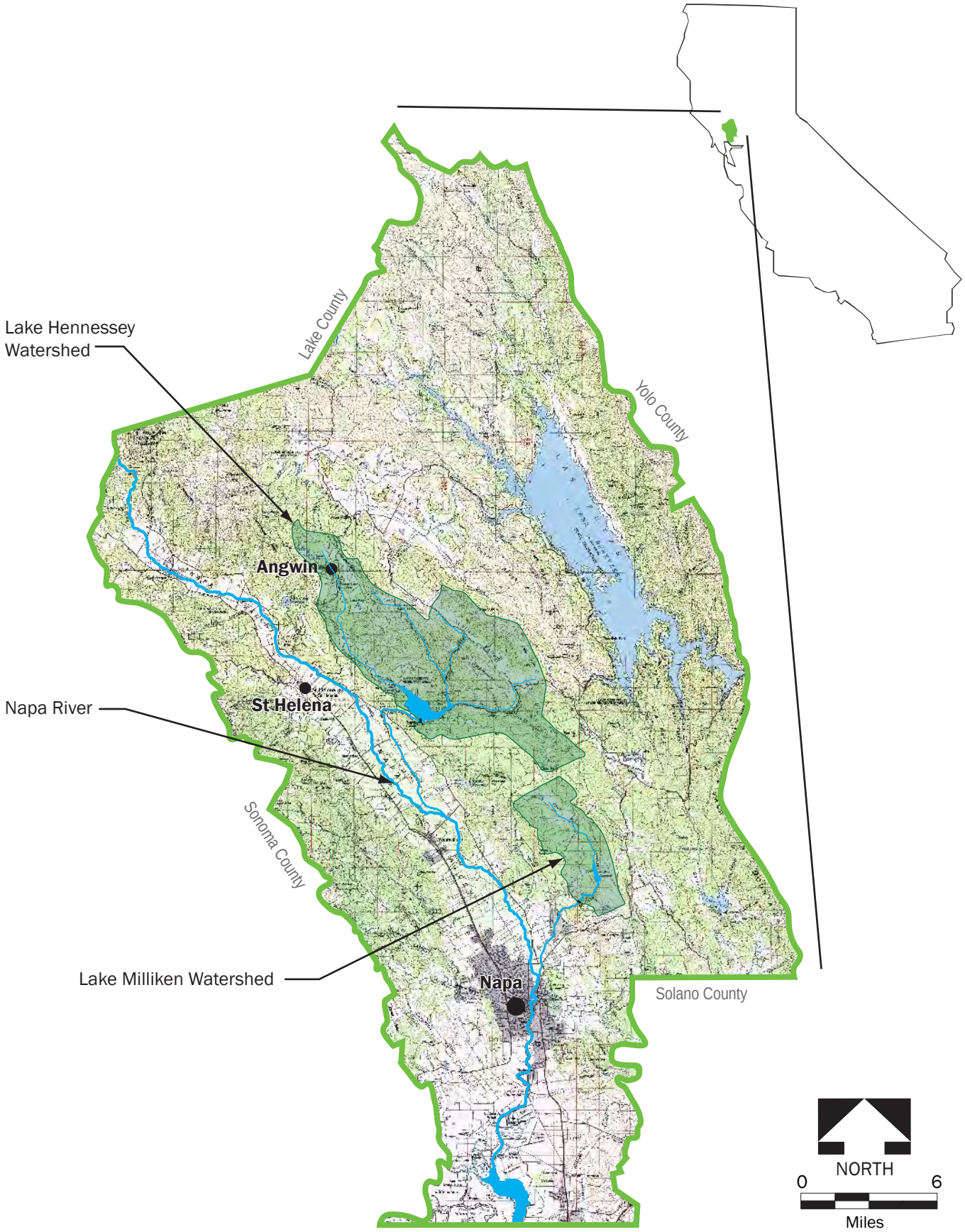
2.1 Lake Hennessey Watershed Description and Land Use

The Lake Hennessey watershed, located in central Napa County, consists of approximately 34,000 acres. The major land uses in the watershed are rural residential development and agriculture in the valleys and foothills, and undeveloped land in the steeper areas. One small town, Angwin, in the upper watershed, is located in the Howell Mountain area. Angwin has scattered residential areas, the Pacific Union College, a few commercial developments, and the Parrett Field Airport. There are no industries. Pacific Union College, a Seventh-Day Adventist liberal arts institution with about 1,500 students, occupies 150 acres in the town of Angwin. The college owns an additional 1,750 acres, which is primarily undeveloped agricultural and forestlands.

The City owns approximately 3,000 acres around and including the lake. Most of the remainder of the watershed is privately owned. The Angwin area is designated Rural Residential, and Chiles Valley as an Agricultural Resource in the Napa County Draft General Plan (Napa County Planning, Conservation, and Development Department, 2007). The remainder of the watershed is designated as Agriculture/Watershed and Open Space. Aside from a decreasing amount of cattle grazing, virtually all of the agricultural land is devoted to vineyards.

Lake Hennessey was formed in 1946 by the construction of Conn Dam on Conn Creek about 4 miles upstream of its confluence with the Napa River. Conn Creek, Chiles Creek, and Sage Creek are the primary streams that flow into Lake Hennessey, as shown on Figure 2-2. The creeks are intermittent, and are fed by rainfall during the wet season. The flow is reduced to less than 1 cubic foot per second (cfs) during the dry season. The current stream flow gauge at each creek does not measure flows above approximately 14 cfs. Figure 2-3 shows the flow in the three creeks in 2011; however, the data do not reflect peak winter flows. From 2001 to 2005, the peak flow into Lake Hennessey occurred on December 31, 2005, when the combined flow in the three tributaries was 5,200 cfs (Brown and Caldwell, 2007).

Lake Hennessey has a capacity of 31,500 acre-feet (ac-ft) and a safe yield of 5,000 acre-feet per year (AFY). The lake is generally at capacity during the wet season and is then slowly drawn down to its lowest level, typically in October of each year. Water is released from the lake to satisfy downstream agricultural demands and instream flow requirements in Conn Creek.



DATE	PROJECT	SITE	
9-17-12	143198	**Lake Hennessey and Lake Milliken Watershed Sanitary Survey, City of Napa, California**	**Figure 2-1**
Brown AND Caldwell		TITLE **Regional Map**	

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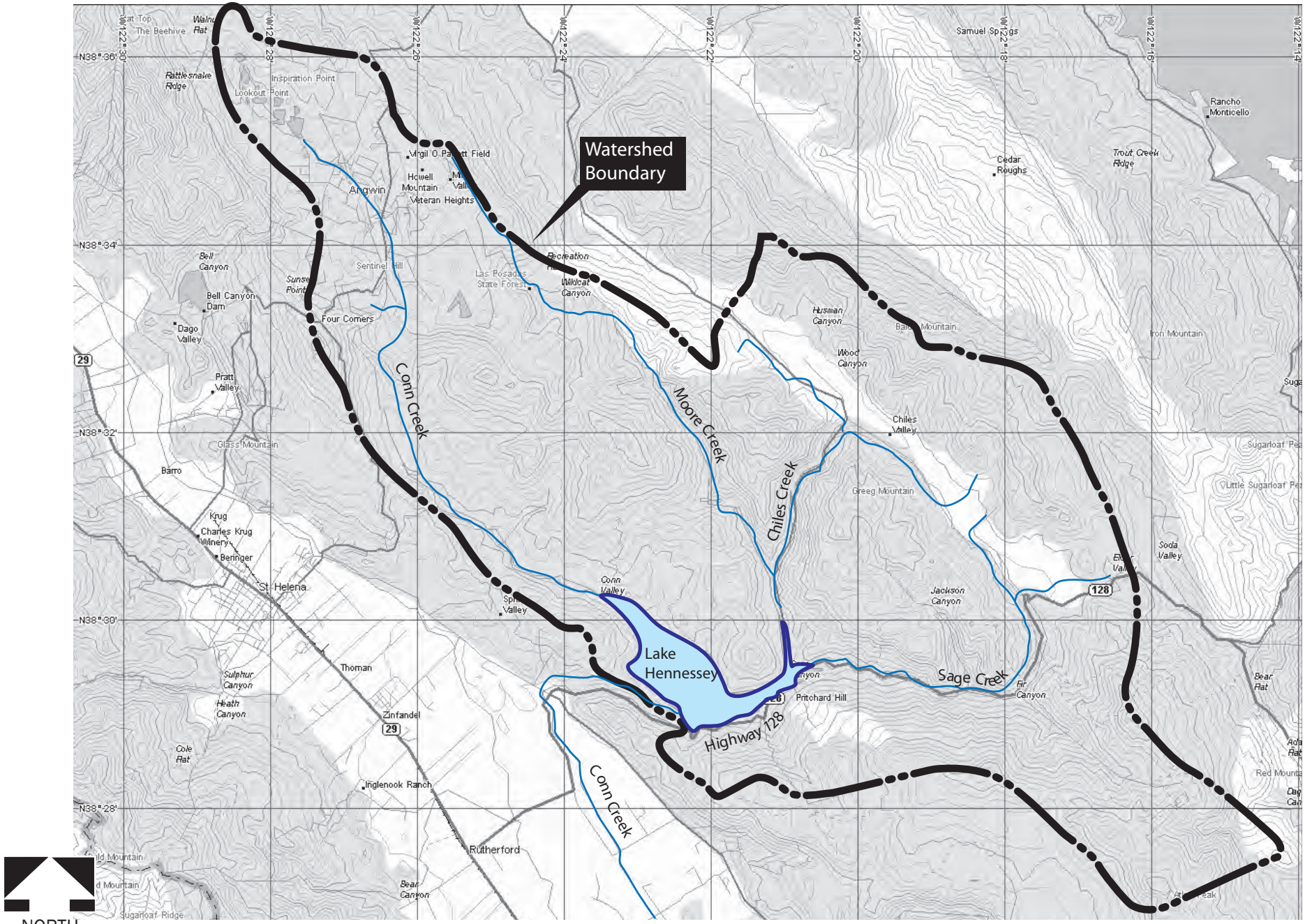


Source: TopoQuads, 1999 DeLorme

Brown AND Caldwell	DATE 9-17-12	SITE Lake Hennessey and Lake Milliken Watershed Sanitary Survey, City of Napa, California	Figure 2-2
	PROJECT 143198	TITLE Lake Hennessey Watershed	

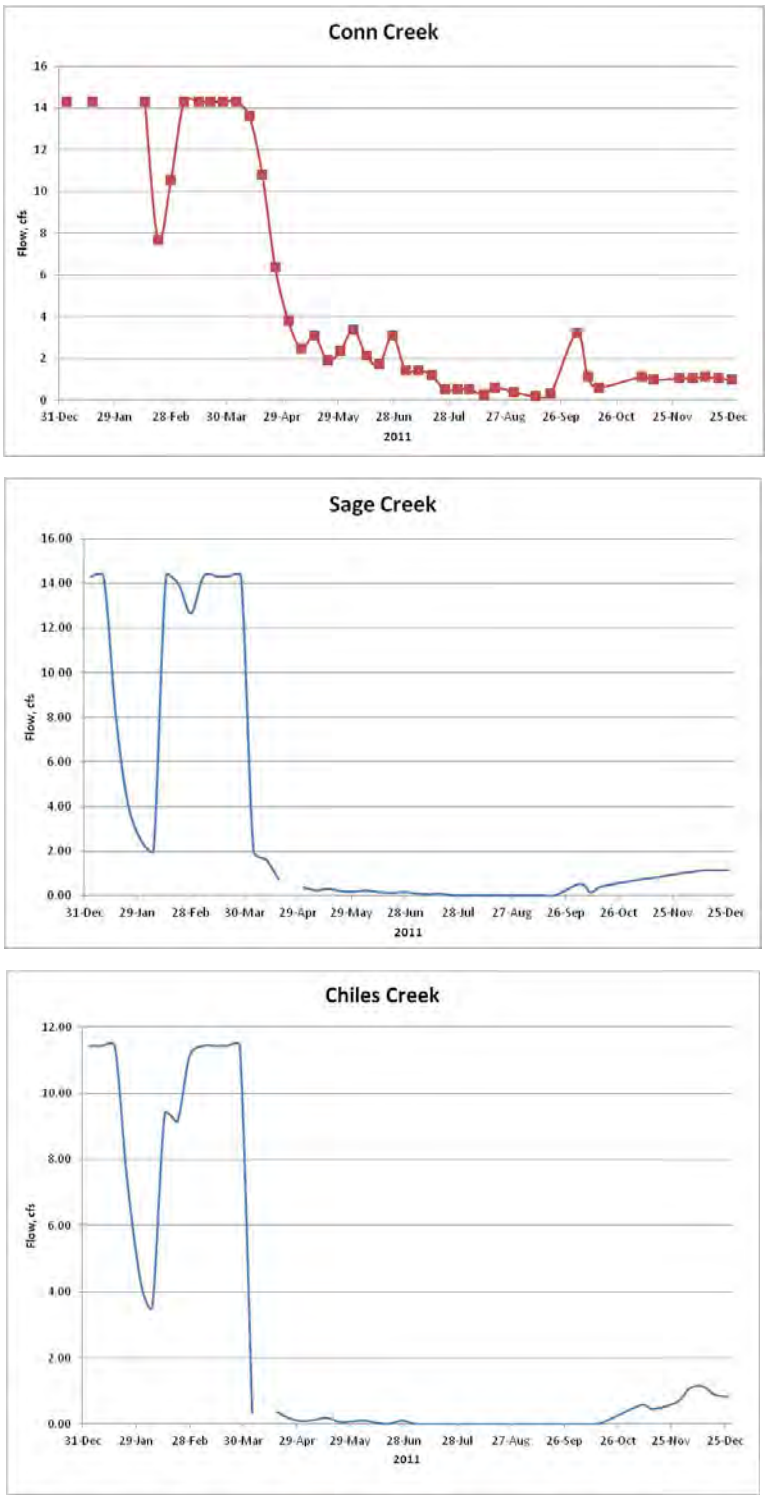


Figure 2-3. Flow in Tributaries to Lake Hennessey

The Conn transmission pipeline conveys water from the Hennessey WTP to the City of Napa. The first 1.5 miles lie above ground along the edge of Conn Creek. After crossing Conn Creek, the pipeline is buried and passes through easements along agricultural lands toward Highway 128. At Highway 128, it runs parallel to the highway within the right of way, and continues to the Napa distribution system in the area of the Eastside Reservoir. This 36-inch pipeline is about 20 miles long. It was built in 1948, and relined in 1974.

2.2 Lake Milliken Watershed Description and Land Use

The Lake Milliken watershed, located just south of the Lake Hennessey watershed, consists of approximately 6,200 acres. The watershed is largely undeveloped with only one major road, Atlas Peak Road, traversing it. The major land uses include rural residential development and agriculture in the valleys and foothills, and undeveloped land in the steeper areas. The City owns approximately 1,400 acres around the lake and Milliken Creek, and Lake Milliken itself. Most of the remainder of the watershed is privately owned. The watershed is designated "Agricultural Resource" or "Agriculture/Watershed and Open Space" in the Napa County General Plan (Napa County Planning, Conservation, and Development Department, 2008). Aside from a small and decreasing amount of cattle grazing, virtually all of the agricultural land is devoted to vineyards.

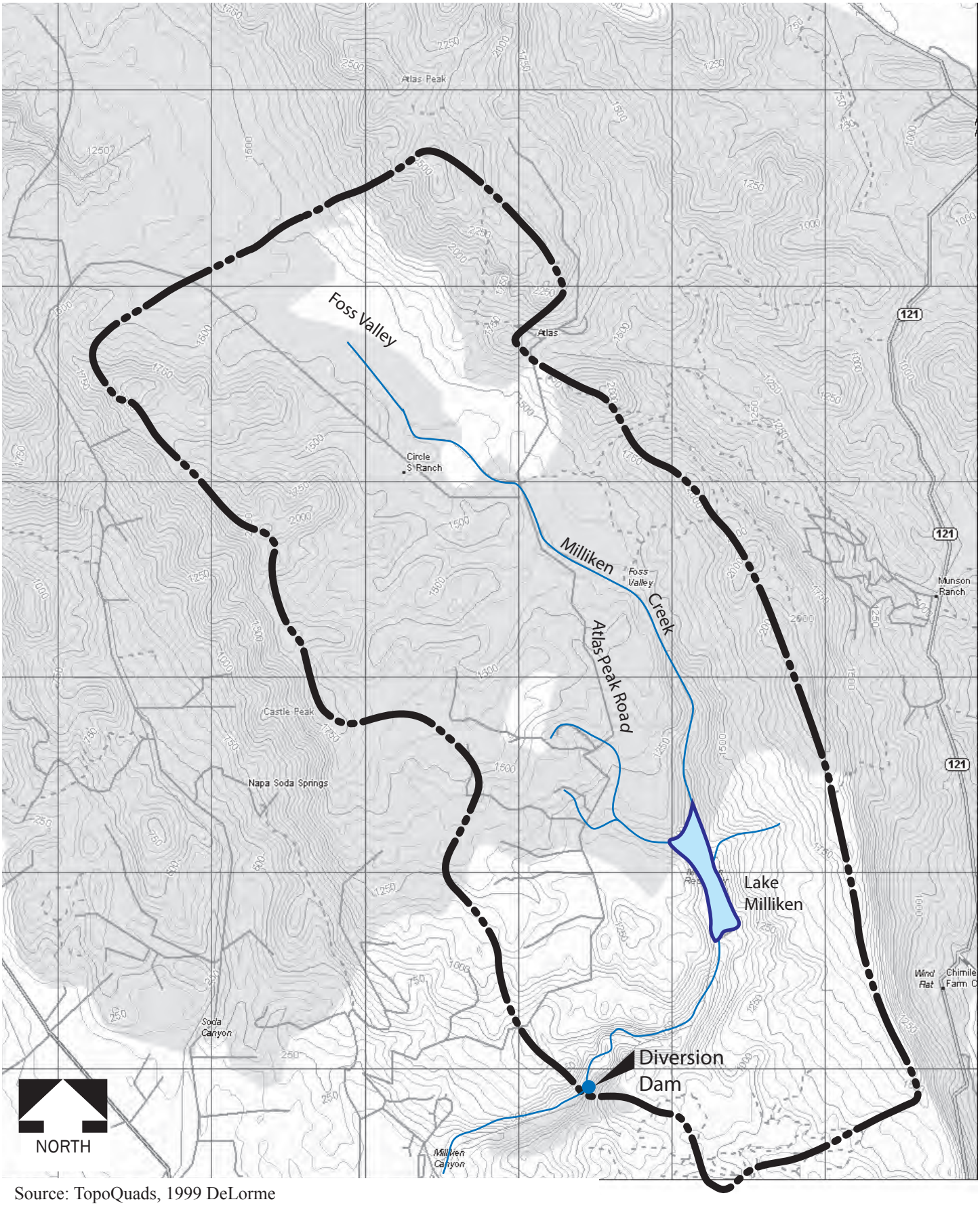
Lake Milliken was formed in 1923 by the construction of Milliken Dam on Milliken Creek. The only major tributary to the lake is Milliken Creek (see Figure 2-4). The creek is intermittent and is fed by rainfall during the wet season. Inflow to the lake drops to less than 1 cfs during the dry season. Lake Milliken has a capacity of approximately 2,000 ac-ft and a safe yield of 400 AFY. Because of concerns regarding dam safety, the reservoir is kept to a lower surface water level than the original design yielding an effective storage capacity of approximately 1,400 ac-ft. Water is released from the lake to satisfy downstream agricultural demands and instream flow requirements in Milliken Creek. Water released to Milliken Creek flows about 1.5 miles to a small diversion dam where is it diverted into a 16-inch diameter steel pipeline and carried 1 mile to the Milliken WTP. Flow at the diversion dam is generally between 0.5 and 2 cfs during the dry season.

2.3 Water Supply System

The City has three sources of water: Lake Hennessey, Lake Milliken, and the North Bay Aqueduct. Water from Lake Hennessey is treated at the Hennessey WTP, located near Conn Dam at Lake Hennessey. Lake Milliken water is treated at the Milliken WTP, located approximately 2.5 miles downstream of Lake Milliken on Milliken Creek. The North Bay Aqueduct water is treated at the Jamieson Canyon WTP. This sanitary survey covers the watersheds of Lake Hennessey and Lake Milliken. The watershed sanitary survey of the North Bay Aqueduct is conducted as part of the Sanitary Survey of the State Water Project conducted by the Department of Water Resources.

2.3.1 Service Area

The City provides drinking water from its three sources to the City of Napa, and the surrounding rural area through more than 25,200 active service connections and 480 standby fire connections. All customers are on water meters. The City serves a population of about 84,000 in the City of Napa and surrounding unincorporated areas. In addition, the City serves 16,000 in American Canyon, 6,500 in Calistoga and Yountville, and 7,500 in St. Helena on an intermittent basis. This water is provided under a "water wheeling agreement" for North Bay Aqueduct water. Service is also provided to American Canyon and to the Veterans Home in Yountville on an emergency basis and to St. Helena on a contract basis.



Source: TopoQuads, 1999 DeLorme

DATE	PROJECT	SITE	
9-17-12	143198	**Lake Hennessey and Lake Milliken Watershed Sanitary Survey, City of Napa, California**	**Figure 2-4**
Brown AND Caldwell		TITLE **Lake Milliken Watershed**	

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2.3.2 Facilities

The City has three water treatment plants that treat water from the three different sources. Water from Lake Hennessey is treated at the 20 million gallon per day (mgd) Hennessey WTP. Water from Lake Milliken is treated at the 5 mgd Milliken WTP. In addition, the City treats North Bay Aqueduct water at the 20 mgd Jamieson Canyon WTP. Dates of operation and actual dates vary based on demand. The schedule also must change due to treatment plant or pipeline maintenance or failures as well as water quality changes. The total treatment capacity is approximately 45 mgd. Since the source of water for the Jamieson Canyon WTP is the North Bay Aqueduct from Barker Slough, it is not described in this report on Lake Hennessey and Lake Milliken.

2.3.3 Hennessey Water Treatment Plant

Water is conveyed to the Hennessey WTP from the intake pump station fed by a gravity pipeline from Lake Hennessey located at the downstream face of Conn Dam. The water is pumped to the WTP, which is located about 2,000 feet northwest of the Conn Spillway. The Hennessey WTP began operation in 1981 and provides complete conventional treatment, including flash mixing, coagulation, flocculation, sedimentation, filtration, and disinfection. Treated water from a 5 mgd treated water reservoir is delivered to the City through the Conn transmission main. The WTP sludge is conveyed to three sludge basins that are adjacent to and above Lake Hennessey. After settling, the supernatant water is discharged to the lake and the sludge is periodically cleaned out. Since 2007, dried sludge from the holding ponds has been graded on-site or hauled off-site for disposal.

In May 2007, the City began applying PAK-27 to control algae in the lake, a sodium carbonate peroxyhydrate that breaks down into hydrogen peroxide and sodium carbonate in the water. The use of PAK-27 is covered under the City's general NPDES permit for application of aquatic pesticides. PAK-27 is applied once or twice a month when the plant is operational. The frequency of application of PAK-27 has more than doubled since 2007 to control algal growth. It is unclear if the reason for the increased frequency is due to the changing to a less-effective algal control product, or an increase in nutrients in the watershed.

2.3.4 Milliken Water Treatment Plant

Water is conveyed to the Milliken WTP by a gravity pipeline from the diversion dam on Milliken Creek. The Milliken WTP began operation in 1976. The plant has a capacity of 5 mgd; however, the maximum amount of water treated by the City is 3.3 mgd. The plant is a direct filtration plant with a contact/reaction tank and four horizontal, dual-media pressure filters, operated in parallel. Filter backwash water is pumped to a wash water tank. The sludge from the wash water tank is pumped to a sludge water tank and then conveyed to the sanitary wastewater system. The supernatant from the wash water tank is pumped back to the head of the plant. Sodium hypochlorite is used for disinfection. A pump station at the WTP pumps water through the treatment chain and into the 2 million gallon (mg) finished water storage tank, located adjacent to the plant. The treated water then leaves the storage tank and enters the distribution system.

The Milliken WTP was designed for a pristine water source. The plant is used only in the summer, when turbidities are lower. When the turbidity of the raw water is too high, the plant must be shut down; it does not treat water effectively at higher turbidities. Throughout the summer, roughly 80,000 gallons of raw water is used to backwash the filters, which is done once to three times a day. (Pers. Comm., Ms. Erin Farnand, City of Napa Water Division, October 2012).

In May 2007, the City began applying PAK-27 twice a week to control algae; however, PAK-27 is applied only at the diversion dam intake, not the reservoir.

2.3.5 Emergency Plans

The City has a water quality emergency notification plan for the municipal water system serving the City of Napa and the surrounding area. The plan outlines the procedures for notifying water users in the case of imminent danger to the health of the water users. Immediate and secondary actions that must be taken are described for both a system-wide problem and localized/isolable emergency. The plan includes notices to be issued in the event of bacteriological and chemical water quality emergencies.

In the event of a chlorination failure at the Hennessey WTP, alarms will sound and the plant will be shut down. The plant will be restarted upon completion of repair and testing of the system. If chlorination cannot be restored in a reasonable amount of time, i.e., before storage is exhausted, the Jamieson Canyon WTP will be started up to supply the system.

If a chlorination failure occurs at the Milliken WTP, alarms will sound, operators will be notified, and the plant will be shut down automatically. The plant will be restarted upon completion of repair and testing of the system. If chlorination cannot be restored in a reasonable amount of time, the Hennessey WTP or the Jamieson Canyon WTP will be relied upon for water supply. Because the Milliken WTP does not have sufficient capacity to meet system demands, it is not used as the sole source of water supply and barring an emergency, either the Hennessey or Jamieson Canyon WTPs would already be on-line.

3. POTENTIAL CONTAMINANT SOURCES IN THE WATERSHEDS

This section describes potential contaminants that were identified within the watersheds, the relative significance of these potential contaminant sources, anticipated growth within the watersheds, and projected changes in the sources of contaminants.

3.1 Survey Methods

Brown and Caldwell conducted this watershed sanitary survey by collecting and reviewing available information from government agencies and other stakeholders in the watershed. Brown and Caldwell and the City also conducted a field survey of the Lake Hennessey watershed on September 6, 2012, to identify the locations of planned trails. The field survey consisted of a driving and walking tour along shoreline and upland roads northeast of Lake Hennessey. Brown and Caldwell did not conduct a field survey of the Lake Milliken Watershed.

Information relating to potential and existing contaminant sources was obtained by researching documents and contacting agencies regarding specific facilities and programs within the watersheds, and investigating known impairments of surface water quality. Information was obtained from reports, maps, public agency file documents, personal interviews, telephone conversations, and official websites.

3.2 Potential Contaminant Sources in the Lake Hennessey Watershed

The information on potential contaminant sources is updated in this section and the significance of each source is reassessed from previous sanitary surveys based on the updated information.

3.2.1 Wastewater

There is one wastewater treatment facility located in the watershed is the Pacific Union College Wastewater Treatment Plant (WWTP), located in the town of Angwin in the upper part of Conn Valley. The WWTP serves the college and associated dormitories. The WWTP is located adjacent to Conn Creek; however, there is no discharge to the creek because all of the treated water is used for irrigation of grass and alfalfa fields adjacent to the treatment plant and near the Parrett Field Airport.

The WWTP treats approximately 6 to 7 million gallons (mg) per month with flows ranging from 0.1 mgd to 0.2 mgd. The plant capacity is 0.2 mgd. The treatment processes consist of a grit chamber, comminuter, bar screen, primary clarifier, trickling filter, secondary clarifier, disinfection, and four sequentially operated oxidation ponds. Sludge is treated in an open top holding tank/digester and then transferred to drying beds. The five ponds have a capacity of 6.7 mg. Most of the effluent from the fifth pond is pumped to a storage reservoir located uphill, near the airport, about one mile from the WWTP. The storage reservoir has a capacity of 57 mg.

Reclaimed water is pumped from the fourth oxidation pond and the storage reservoir and is used to irrigate about 112 acres of agricultural fields for fodder crop production. Reclaimed water is used for irrigation from

April 1 to October 30 each year. During the wet season all wastewater is stored in the ponds and the reservoir. The WWTP sludge is spread on 16 acres of agricultural land near the WWTP and 15 acres near the storage reservoir as a soil amendment during the dry season.

The Pacific Union College WWTP is regulated under California Regional Water Quality Control Board, San Francisco Bay Region (Regional Board) Order No 1991-0162 Water Reclamation Requirements. The limitations on use of reclaimed water contained in the order include no discharge to surface waters, irrigation only during the dry season, no irrigation during rain events that occur during the dry season, and all reclaimed water use areas must be at least 60 feet from the streams. The sludge spreading operations must be at least 100 feet from any stream or drainage ditch and can occur only during the dry season.

The most significant spills in the history of the plant occurred in February 1986 when there was 15 inches of rain in a single month, and in 1995 when over 1 MG of treated wastewater spilled into Conn Creek due to a leak in a pipeline between the WWTP and the storage reservoir. There have been no spills since 1997, when 10,000 gallons of treated wastewater ran off of one of the irrigated fields in July and 1,500 gallons of treated wastewater ran off of a field in August, with water spilling into Conn Creek in both instances. These incidents are described more fully in the 2007 Update.

The San Francisco Bay Regional Water Quality Control Board (SFRWQCB) has not recorded any violations since the 1997 incident described above (Pers. Comm., Mr. Blair Allen, SFRWQCB, September 2012). During the most recent inspection conducted by the Regional Board in 2011, the plant was well operated and no deficiencies were noted (Pers. Comm., Mr. Blair Allen, SFRWQCB, September 2012). The inspector has noted, however, that the plant's biosolids management plan permit requirements were established before the United States Environmental Protection Agency (USEPA) passed their 503 regulations. Therefore, the permit requires no more than tracking the operational process, not a detailed analysis of the sludge content that would be required today under either USEPA regulations or State Water Resources Control Board (SWRCB) orders. The inspector has planned to investigate whether the college is following the more recent requirements.

The County also inspects the WWTP, typically, every one to three years. No problems have been noted in the past five years (Pers. Comm., Mr. Sheldon Sapoznik, September 2012).

For the last decade, Pacific Union College has been attempting to sell a portion of their unused land, most recently for urban residential development. Many Angwin residents have consistently opposed these attempts, supported at elections by a majority of Napa County residents. Currently, the following Angwin General Plan Amendment initiative has been placed on the November 2012 county ballot:

> An initiative that will amend the Napa County General Plan to (1) re-designate certain lands in the Angwin area from "Urban Residential" to "Public Institutional" or "Agriculture, Watershed and Open Space," (2) prevent subdivision of lands designated "Public Institutional," and (3) permit modernization and expansion of a private sewage treatment facility in Angwin.

The measure is seeking to change the zoning of the WWTP lands so that the land cannot be developed, with the caveat that the land may still be used by the college for any facilities required for the WWTP.

Pacific Union College is still attempting to sell this land, and currently has two offers, one both residential (191 lots approved by the County) and agricultural, the other would result in strictly agricultural uses (Pers. Comm., Mr. Dale Withers, Pacific Union College, September 2012).

The WWTP is located close to Conn Creek, and is susceptible to flooding during an unusually high rainfall event. However, the WWTP has not had violations of their permit since 1997, and is well operated (Pers. Comm., Mr. Blair Allen, SFRWQCB, September 2012). The plant does not pose a significant risk to water

quality due to episodes of overflows during the dry season. The risk of overflows and increased nutrient loading to the lake contributing to algal blooms and increased TOC is increased during the wet seasons. If the City has to make operational changes and starts to take water from Lake Hennessey more often during the winter months, the WWTP could be a more significant potential source of contaminants.

3.2.2 Septic Tank Systems

With the exception of Pacific Union College in Angwin, the remainder of the watershed is served by septic tank/leachfield systems. Individual septic systems were not examined as part of this sanitary survey; however, Napa County Environmental Management Department staff was interviewed about potential problems. Angwin has had septic tank failures, although the rate is not greater than in other parts of the County with older systems (Pers. Comm., Mr. Sheldon Sapoznik, Napa County Environmental Management Department, September 2012). Most of the systems in Angwin are old and do not meet the current standards. Although the County has no evidence of impacts to Conn Creek, no study has been conducted to examine this issue. There are a number of houses immediately adjacent to the creek on very small lots, and it is likely that some of these septic systems are contributing contaminants to the creek.

The septic tank located closest to Lake Hennessey is the one at the Hennessey WTP. It meets County standards and is located outside of the watershed.

In recent years there has been increased residential development in the Sage Canyon area. All new development is required to meet the existing standards for septic tank systems contained in the Napa County Code, Title 13, Division 2, and have not affected groundwater or surface water quality (Pers. Comm., Mr. Sheldon Sapoznik, Napa County Environmental Management Department, September 2012). There have been no complaints or known failures of systems in Sage Canyon, Chiles Canyon, or the Conn Creek area (outside of Angwin). The lots in Sage Canyon are estate lots of 40 and 60 acres, often with wineries and associated vineyards.

The County requires property owners to repair or replace failing septic systems. The County does not conduct routine inspections of septic systems but they respond when complaints are filed. Given the large lot sizes in most of the watershed, it is unlikely that an adjacent property owner would be bothered by a failing septic system so it is up to individual property owners to identify and correct any problems. Since many of the parcels in Angwin are small there is not sufficient area to bring the older systems up to County standards when there are failures. County staff require property owners to comply with the County standards to the maximum extent possible given the constraints of the parcel size. Property owners are required to abate the nuisance, but are not required to upgrade their septic system. A failing septic system would primarily contribute nitrate and microbial contaminants to surface waters.

In 1980, Napa County voters approved the Slow Growth Initiative, which limits the number of new housing units to one percent annually. The number of septic systems in the watershed will increase over the next five years due to the current development trends in the watershed. Due to the restriction of one percent growth and the typically large lot sizes in the watershed, the number of new systems will be limited. In addition, all new systems are required to comply with current County standards. In 2008, the County rewrote their sewage ordinance to clarify their septic tank policies, but there was no substantive change to their policies (Pers. Comm., Mr. Sheldon Sapoznik, Napa County Environmental Management Department, September 2012). The issues that were clarified included setbacks, vertical separation to groundwater, and site requirements (e.g., soil types).

Failing and improperly designed septic tanks in Angwin are likely contributing microbial contaminants and nutrients to Conn Creek. The land in the area is rocky and fractured (Pers. Comm., Mr. Blair Allen, SFRWQCB, September 2012). Due to the distance from the lake (3 miles), the dilution capacity of Lake Hennessey, and the relatively small volume of wastes from the failing systems, they do not likely pose a

significant health threat to the water system, although they are likely contributing an unquantified amount of nutrients to the lake.

3.2.3 Urban Runoff

A limited amount of urban runoff enters the creeks that flow to Lake Hennessey. The Lake Hennessey watershed is largely undeveloped, with scattered areas of low density residential development along the major roads. The Town of Angwin does not have a stormwater collection system; runoff flows into Conn Creek. In addition to developed areas, roads in undeveloped areas are considered a source of urban runoff. Due to the limited amount of urban runoff that is contributed to the tributary streams, the loads of these contaminants to Lake Hennessey are likely to be quite small in comparison to the loading from agricultural lands and undeveloped areas of the watershed. Urban runoff does not pose a significant risk to the water quality of Lake Hennessey.

Several roads in the watershed are adjacent to the lake or its tributaries, including Highway 128 (Lake Hennessey and Sage Creek), Chiles and Pope Valley Road (Chiles Creek), and Conn Valley Road (Conn Creek). Runoff from roads and other impervious surfaces contains hydrocarbons, trace metals, suspended sediments, and microbial contaminants. Caltrans maintains Highway 128, and in 2011 rebuilt the road section, bank, and culvert near a sharp turn in the road near the lake because of erosion problems. A culvert improvement, whichis also intended to reduce erosion, is planned by Caltrans for late 2012. (Pers. Comm., Mr. Ken Wright, City of Napa Water Division, September 2012).

The City Water Division maintains the roads circling Lake Hennessey, which are required for maintenance and surveillance needs. The Water Division follows Napa County's Construction Site Runoff Control Requirements (Napa County Department of Public Works, 2006) when they are repairing or upgrading their roads. Erosion from these roads is acknowledged to be a source of sediment contribution to the lake (Pers. Comm., Mr. Ken Wright, City of Napa Water Division, September 2012).

Due to the low growth rate in the watershed there has not been a significant increase in urban runoff discharged to the streams that feed Lake Hennessey in the last five years. According to the census data, the population of Angwin decreased from 3,500 in 1990 to 3,148 in 2000. The population of unincorporated Napa County, which includes Angwin, increased by 0.7 percent from 2000 to 2010.

3.2.4 Recreational Use

Recreational use of the watershed and the lake has been fairly limited. With the exception of the area along Highway 128 and Chiles Canyon Road, the City property surrounding the lake is fenced and gated to prevent access by motorized vehicles. However, the property is accessible to hikers, bicyclists, and dogs on leashes via the City maintenance roads, and these uses are allowed by the City. Recreationists are only permitted to travel on the City's maintenance roads; for this reason, and because of the denseness of the brush vegetation, no informal trails have been started (Pers. Comm., Mr. Ken Wright, City of Napa Water Division, September 2012). The City does not allow horseback riding or camping. Signs are posted at all of the gates on the allowable uses of the City property. There are no public recreation areas in the Lake Hennessey watershed but unauthorized use for mountain biking and hiking infrequently occurs due to the large amount of open space in the watershed.

The City controls recreational use of the lake and does not allow body contact recreation. Fishing, small motorboats powered by outboard motors not exceeding 10 horsepower, rowboats, canoes, kayaks, and sailboats are allowed on the lake. There is a boat launch facility on the southeast shore of the lake. The boat launch contains a parking lot for about 20 vehicles and a permanent chemical toilet facility. Annual usage of the boat ramp facility is estimated to be about 2,500 to 3,000 people, approximately 500/month in the warmer months, and 100/month in the winter. Boat ramp usage has not changed significantly over the last

five year period (Pers. Comm., Mr. Ken Wright, City of Napa Water Division, September 2012). Pacific Union College uses the lake for kayaking once a week from April through mid-June. In addition, there is a fishing derby at the lake each year, usually at the end of April or early May.

The City requires all boat operators and fishermen to obtain an annual Fish and Boating Permit from the Lake Hennessey watershed keeper. Forty-five fishing permits and eighty-two boating permits were sold in 2011. No fishing is allowed within 2,000 feet of the intake tower and no fish can be cleaned or scaled in or near the lake. All boats are prevented from entering the area within 500 feet of the intake tower by ropes and buoys. The City's watershed keepers open and close the boat ramp and patrol the City property and escort unauthorized users off of City property.

3.2.4.1 Napa County Regional Park and Open Space District Trails

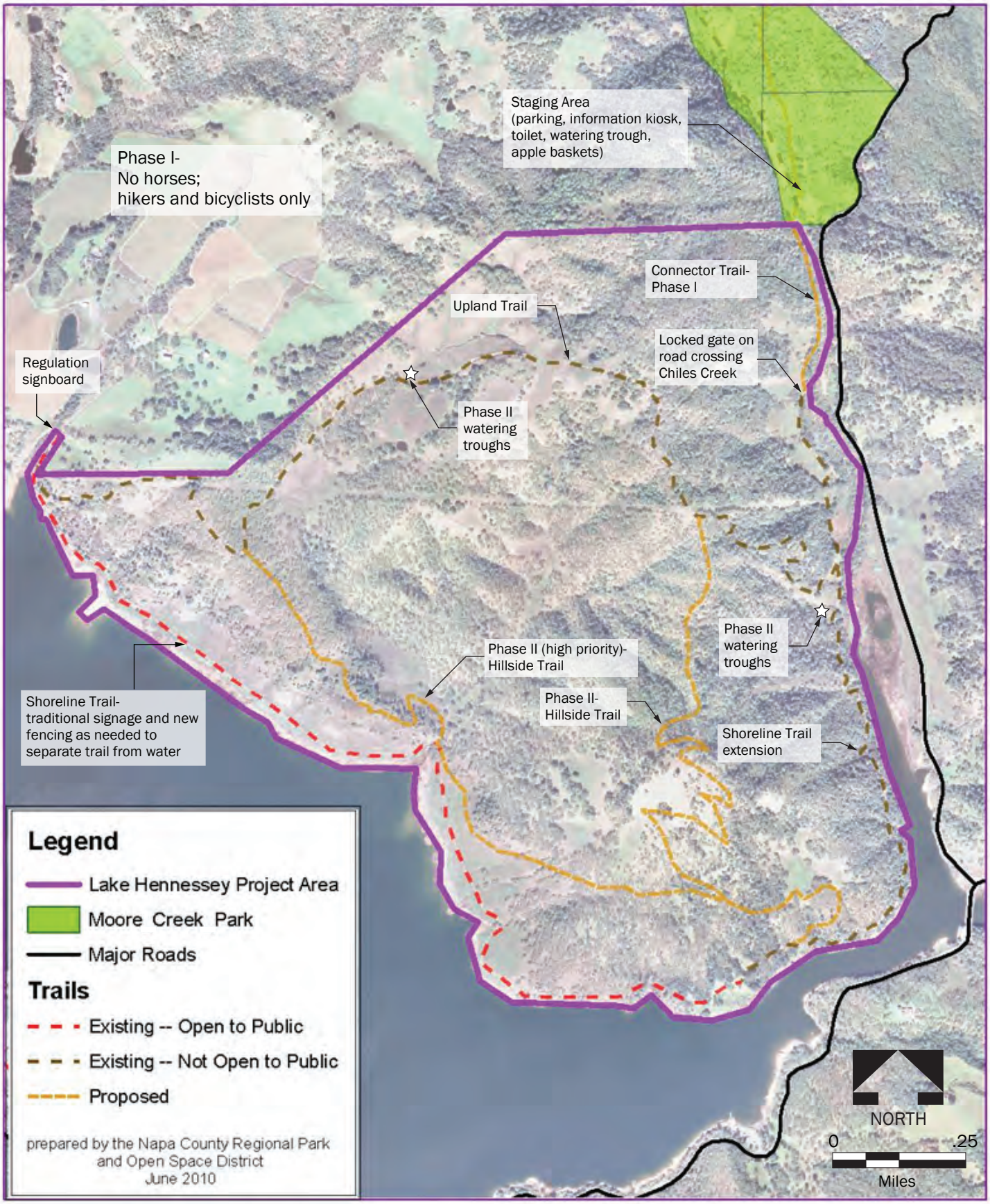
The Napa County Regional Park and Open Space District (NCRPOSD) is working to increase the number of trails in the county, including in the Lake Hennessey watershed (Pers. Comm., Mr. John Woodbury, NCRPOSD, September 2012). In particular, the NCRPOSD has pursued trail development on the land northeast of Lake Hennessey, where the trails have been open to the public, although little used (Figure 3-1). There are two trails on this land that are used both by the City to monitor the watershed and maintain facilities, as well as by a small number of recreationists: a shoreline trail that follows the perimeter of the lake, and an upland trail that roughly parallels the shoreline trail, but is located at the ridgetop. The NCRPOSD would create additional trails as part of their plan.

The NCRPOSD has prepared an Initial Study/Mitigated Negative Declaration, entitled Moore Creek Park, to improve, maintain, and operate recreational trails on City property north of Lake Hennessey (NCRPOSD, 2011). Moore Creek Park is adjacent to the proposed Lake Hennessey trails, and would be developed as a staging and access area to the trails. The proposal was approved by the Napa County Board of Supervisors in September 2012. The initial study describes the project as follows:

> Application to and adoption of a Use Permit by the County of Napa, to allow the District [NCRPOSD]-owned Moore Creek parcels to be improved and used as a public recreational facility, including trails for hiking, horseback riding and mountain bicycling, staging area accommodating up to 25 vehicles, and limited environmental camping; adoption of a land use agreement between the District and the City of Napa to allow the District to improve, maintain and operate non-motorized recreational trails on City property north of Lake Hennessey, and actions by the District to construct, maintain and operate the improvements on both District and City lands (NCRPOSD, 2011).

The NCRPOSD expects to implement Phase I in the spring of 2013; Phase I includes developing the Upland Trail and Shoreline Trail, including signage indicating the area is an important watershed area vital to the municipal water supply and bodily contact with the water is prohibited. Also part of Phase I would be the making of a new trail to connect Moore Creek Park to the Shoreline Trail. Other trails would be developed at a later date, including a 1.83 mile Hilltop Trail, and a 1.39 mile Hillside Trail. The latter will provide an alternative route for, and reduce usage on, the Shoreline Trail.

Although the NCRPOSD is coordinating with volunteers to maintain proper use of the trails, a concern of the City's is that staff will need to spend time monitoring recreational activities to prevent potentially contaminating activities. To allay these concerns, the City's agreement with NCRPOSD establishes (1) a $30,000 reserve fund established by NCRPOSD.If, upon notification by the City, NRCPOSD does not take corrective actions to clean up trash or repair trails in the watershed, the City can call on this reserve fund to be reimbursed for work performed or to hire persons to perform the work. In addition, a $6 million insurance policy is held to allow the City to purchase 6,000 Acre Feet of water in the event the water supply is compromised and unable to be treated to meet drinking water quality regulations. This scenario could occur, for example if a fire occurred in the watershed or other recreational use compromised the water supply for one or more years.



Source: Napa County Regional Park and Open Space District, 2010

DATE	PROJECT	SITE		
9-17-12	143198	Lake Hennessey and Lake Milliken Watershed Sanitary Survey, City of Napa, California		Figure 3-1
Brown AND Caldwell		TITLE	Recreational Trails Adjacent to Lake Hennessey Approved by City of Napa	

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The draft Development, Operations and Management Plan includes the following features to protect the watershed (NCRPOSD, 2011):

- The District will regularly and actively monitor public use, educate the public regarding appropriate activities, and promptly remove any trash and graffiti. District monitoring will be done by a combination of District staff, caretaker(s) residing at the Moore Creek Unit, and supervised volunteers.
- No hunting or shooting will be allowed.
- No smoking or fires will be permitted.
- Access from the Moore Creek Unit staging area to the Lake Hennessey Unit will be closed to the public during periods of extreme fire hazard, as determined by the County Fire Marshall, and as needed during and after rainstorms to prevent soil erosion and damage to trails.
- Motorized recreation will not be permitted; public access will be limited to hikers, mountain bicyclists and equestrians.
- The District will maintain a reserve fund equal to 10% of the construction cost of improvements within the Lake Hennessey Unit, for up to two years after construction, to be used to repair any construction defects. Subsequent maintenance costs and repairs will be budgeted through the District's annual budget process.
- The Plan will follow the principle of adaptive management. As such, it will be subject to periodic review by the District and the City, and be modified as needed to respond to changing conditions in order to ensure that water quality, public safety and other District and City objectives are fully met.

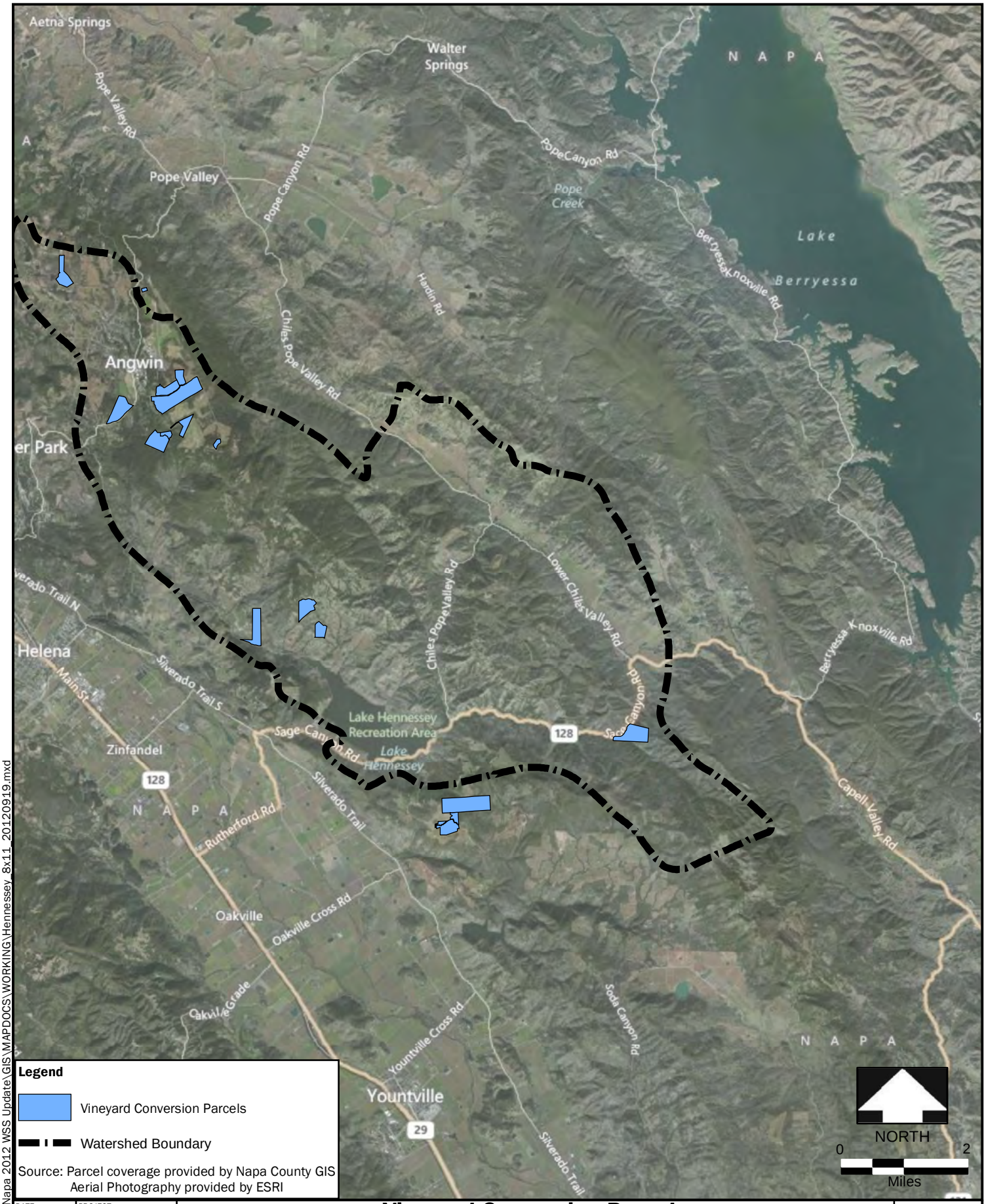
Although the Hennessey WTP is a conventional plant with coagulation, flocculation, sedimentation and filtration, the facilities are old and inefficient and cannot operate at the design capacity of 20 mgd for an extended period of time. At flow capacities of 17 mgd and higher, the filters have to be backwashed every two hours which is very inefficient and generates a large amount of spent backwash water for disposal. Additional backwash water could exceed the allowable discharge to the sludge ponds of 1.1 mgd. The sedimentation basin presently operates at a barely adequate level under current conditions. If raw water turbidity is further increased, these problems would be exacerbated and flow capacity would need to be reduced.

3.2.5 Agricultural Activities

Vineyards are the primary agricultural use of lands in the Lake Hennessey watershed. The only other identified agricultural crops are the fodder crops grown at Pacific Union College, and a few small orchards. The largest agricultural area is the Chiles Valley in the eastern portion of the watershed. Most of the valley floor is devoted to vineyards. Vineyards are also present in Elder Valley and in Conn Valley. Pacific Union College, which owns 1,890 acres in the Conn Creek subwatershed, does not have vineyards on their property because of the Seventh-day Adventist discouragement of the production or use of alcohol.

According to aerial photo counts prepared by the Napa County Planning and Community Development Department, the vineyard acreage in the Lake Hennessey watershed increased from 1,740 acres in 1993, to 2,362 acres in 2005. Recent vineyard conversions are mapped on Figure 3-2.

The downturn in the economy since 2008 has slowed the development of vineyards (Pers. Comm., Mr. Brian Bordona, Napa County Planning and Community Development Department, September 2012). The Agricultural Commissioner's Office also reports that vineyard development has continued, but at a slower pace (Pers. Comm., Mr. John Cooledge, Napa County Agricultural Commissioner's Office, November 2012).



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DATE	PROJECT	SITE
9-19-12	143198	**Vineyard Conversion Parcels Napa County, California**

Brown AND Caldwell

TITLE

Vineyard Conversion Parcels near Lake Hennessey Watershed

Figure 3-2

3.2.6 Pesticide/Herbicide Use

The top five pesticides used in Napa County in 2010, and the commodities on which they were applied are identified in Table 3-2 (DPR, 2012). Sulfur is the major pesticide used in Napa County; it is applied on grapes as a fungicide against powdery mildew. Sulfur is oxidized by bacteria and becomes sulfate, which does not adversely affect water quality (Napa County Resource Conservation District, 1996). A similar product, lime sulfur, is used to control fungi, bacteria and insects; it is the fifth most-used pesticide in the County. The other most commonly used pesticides in Napa County are mineral oil, refined petroleum distillates, and glyphosate (potassium salt). These pesticides are also used primarily on wine grapes.

Sulfur use has dropped significantly in the past five years in Napa County. New fungicides have become available that are have less of an impact on workers and the environment. Sulfur tends to drift on other agricultural crops (Pers. Comm., Mr. John Cooledge, Napa County Agricultural Commissioner's Office, November 2012).

Pesticide practices in the Lake Hennessey (or Lake Milliken) watershed are not known to vary from the remainder of Napa County (Pers. Comm., Mr. John Cooledge, Napa County Agricultural Commissioner's Office, November 2012). However, the Agricultural Commissioner's Office notes that, overall, there the vineyard industry makes an effort to be "green and sustainable." They use more scientific practices now than in the past to lower their use of pesticides. For example, the growers take insect counts to determine whether pre-plant fumigation is necessary. In the past, fumigation was a standard practice (Pers. Comm., Mr. John Cooledge, Napa County Agricultural Commissioner's Office, November 2012).

The Napa County Resource Conservation District (RCD) also reports that practices to protect water quality are becoming more widespread. Many vineyards are implementing management practices to decrease sediment runoff into the streams, such as improved roads and vegetated filter strips between the agricultural plots and adjacent streams. A primary impetus for these increased watershed management efforts is the impending enforcement of a total maximum daily load of sediment for the Napa River, which the RWQCB has determined is impaired for sediment (Pers. Comm., Ms. Leigh Sharp, Napa County RCD, November 2012).

Soil fumigants are injected into soils to sterilize them before planting, or when converting from other crops or grape varieties. It had been standard practice to fumigate for these reasons but, more recently, this practice has become much less common. Soil fumigation is now generally only done when an actual pest problem has been identified (Pers. Comm., Mr. John Cooledge, Napa County Agricultural Commissioner's Office, November 2012). This trend is also evidenced in the data. In 2005, 1,3-Dichloropropene, a soil fumigant, was the third most common pesticide used in Napa County; in 2010, it was no longer in the top five.

Table 3-2. 2010 Top Five Pesticides Used in Napa County

Pesticide	Commodity	Pounds	Acres
Sulfur	Grape, Wine	841,493	136,633
	Olive	1,992	203
	Grape	20	3
	Sulfur, Total	843,505	136,839
Mineral Oil	Grape, Wine	96,178	25,128
	Public Health	2,191	
	Peach	32	2
	Landscape Maintenance	9	
	Olive	1	19
	Mineral Oil, Total	98,410	25,149

Table 3-2. 2010 Top Five Pesticides Used in Napa County			
Pesticide	Commodity	Pounds	Acres
Petroleum Distillates refined	Grape, Wine	71,450	13,098
	Public Health	122	
	Landscape Maintenance	32	
	Peach	21	2
	N-Outdoor Plants in Containers	9	2
	All Other Sites		
	Petroleum Distillates refined, Total	71,634	13,102
Glyphosate, Isopropylamine Salt	Grape, Wine	26,767	18,157
	Landscape Maintenance	2,712	
	Rights of Way	1,646	
	Public Health	1,151	
	Uncultivated Ag	135	674
	All Other Sites	103	25
	Glyphosate, Isopropylamine Salt, Total	32,513	18,856
Lime-Sulfur	Grape, Wine	29,426	1,540
	Landscape Maintenance	4	
	Peach	1	
	Nectarine	1	
	Lime-Sulfur, Total	29,432	1,540

Source: California State Department of Pesticide Regulation, 2012

The trend towards using fewer pesticides on wine grapes and other crops in Napa County has continued (see Table 3-3). The number of organic farms in Napa County and the acres under production have doubled in the last five years.

Table 3-3. Organic Farming Trends in Napa County			
Crop	Year	No. of Farms	Production Acres
Winegrapes	2011	149	3,536
	2006	61	1,653
Olives	2011	20	55
	2006	9	32
Other Fruits and Vegetables	2011	13	18
	2006	15	40
Eggs and Honey	2011	2	NA
	2006	3	NA
Cut Flowers and Nursery Stock	2011	6	8
	2006	8	5
Totals	2011	161[a]	3,617
	2006	70[a]	1,809

Source: Napa County 2011 Agricultural Crop Report and Napa County 2006 Agricultural Crop Report.

[a] Some farms produce multiple commodities.

Weeds along the roads in the Lake Hennessey watershed are controlled by a combination of mowing and the use of Pro-Roundup (glyphosate, a post-emergent) and surflan (a pre-emergent). The City uses Aquamaster to

control weeds near the boat launch facility and right-of-ways in the winter and early spring. (Pers. Comm., Mr. Ken Wright, City of Napa Water Division, September 2012)

In May 2007, the City began applying PAK-27 to control algae in the lake, a sodium carbonate peroxyhydrate that breaks down into hydrogen peroxide and sodium carbonate in the water. PAK-27 is applied four times a month when the plant is operational. In 2008, the application amount increased from 550 pounds to 850 pounds per application, and the number of applications per year has steadily increased from 11 in 2007 to 26 in 2011. (Pers. Comm., Ms. Erin Farnand, City of Napa Water Division, October 2012)

Although the increased acreage devoted to vineyards would be expected to have increased pesticide use since the 2007 Update, the trend toward reduced pesticide use counteracts the growth in vineyard acreage. Sulfur was the top pesticide used in 2001, 2005, and 2010; however, its usage has decreased: 1,846,994 pounds were applied in 2005, and 841,493 pounds in 2010.

3.2.7 Grazing Animals

There are several areas of cattle grazing in the watershed of Lake Hennessey. The total number of cattle in all of Napa County is less than 1 percent of the value of total agricultural production in the county. There has been no significant change in the amount of cattle grazing in the County in the past five years (Pers. Comm., Mr. John Cooledge, November 2012). Cattle grazing is spread thinly throughout the unincorporated areas of the county, generally on hillsides unsuitable for vineyards, with most of the cattle production in the County lying in the Lake Berryessa watershed (Pers. Comm., Mr. John Cooledge, November 2012).

During the wet season, runoff from the areas that are grazed could potentially contain sediment due to trampling of the streambed by the cows and organic matter, nutrients, and pathogenic microorganisms from the manure. In addition, cows with access to the streams can directly deposit manure and its associated contaminants in the streams during the summer months.

The City does not allow cattle grazing on the City-owned property around Lake Hennessey. There is currently no other grazing immediately adjacent to the lake. The grazing that occurs in the upper watershed at Pacific Union College does not likely affect water quality due to the low density of animals and the distance from Lake Hennessey. The grazing animals in the lower watershed may be contributing nutrients, pathogens, and other contaminants to the lake; however, their numbers are small with respect to the size of the watershed. Although cattle grazing provides some fire control benefits, the negative consequences of cattle grazing, specifically, the nutrient, pathogen, and sediment contributions of cattle to the tributary water bodies, outweigh the potential fire control benefits.

Cattle grazing practices northeast of Lake Hennessey are expected to improve when the NCRPOSD trail plan is implemented (NCRPOSD, 2011):

> once the existing grazing lease within the Moore Creek Unit terminates, cattle grazing will be allowed to continue within the Moore Creek Unit, except that no grazing will be allowed in the northern two miles of the Unit (where it is not feasible to provide off-stream water for cattle, and which is marginal grazing land at best), and new fencing will be installed to keep cattle out of the lower one-half mile of the Unit. The duration and intensity of grazing will be based on best management practices developed in consultation with the Natural Resource Conservation Service. A key grazing objective will be to use grazing to control the risk of wildfire and the spread of invasive weeds.

3.2.8 Wild Animals

Much of the land in the Lake Hennessey watershed is undeveloped so there is a relatively large population of wild animals. According to the California Department of Fish and Game (CDFG), deer, black bear, coyotes, several types of rodents, and potentially muskrats are present in the watershed (CH2MHill, 1996). Deer are prevalent in the watershed. The City's Water Division staffs have also observed foxes, snakes, jackrabbits, turkeys, possum, and a variety of waterfowl. In addition to contributing sediment to the lakes, the large population of wild animals may be a source of pathogenic microorganisms. Birds, in particular, can be a significant source of pathogens to lakes because of the direct nature of their deposits. Birds are a particular concern if there is a large year round population of waterfowl (as opposed to a migratory bird population). As more of the watershed is converted to agricultural use, the populations of wild animals may decrease.

3.2.9 Hazardous Materials Storage

Pacific Union College and the Hennessey WTP store hazardous materials in aboveground tanks. At both facilities, the tanks are enclosed within secondary containment structures designed to hold at least 110 percent of the total capacity of the tanks. There are two locations in Angwin that have underground storage tanks that are regulated by the Napa County Environmental Management Department and there may be a number of unregulated farm tanks. The two regulated locations include one tank at the Parrett Field Airport, and four tanks at the Chevron gasoline station on Howell Mountain Road across from the college. The four tanks at the Chevron station were installed in 1989 and meet current standards. No new tanks have been installed in the watershed in the last five years, nor are there any leaking underground storage tanks (Pers. Comm., Mr. Jim Newman, Napa County Environmental Management Department, September 2012). Pacific Union College does not anticipate installing any new tanks within the next five years (Pers. Comm., Mr. Dale Withers, Pacific Union College, September 2012).

The storage of hazardous materials in regulated aboveground and underground tanks does not pose a risk to the water quality of Lake Hennessey because these regulated tanks have containment structures to prevent releases to the environment.

3.2.10 Hazardous Materials Spills and Traffic Accidents

Highway 128 traverses the southern shore of Lake Hennessey and then follows Sage Canyon for about 5 miles. It is the major route connecting Napa Valley to Lake Berryessa and is heavily traveled. A large spill of hazardous materials along Highway 128 near the intake tower could significantly impact the quality of the raw water pumped into the Hennessey WTP. Spills resulting from traffic accidents along this highway, and other spills in the watershed are reported to Cal EMA and the local Office of Emergency Services (OES) office.

In California, any significant release or threatened release of a hazardous material requires immediate reporting by the responsible person to 911 and the Cal EMA State Warning Center. The Cal EMA HazMat Section helps the reporting individual or agency to decide how to respond to a spill. The California Emergency Management Agency maintains a database on hazardous materials spills that can be accessed online (http://www.calema.ca.gov/HazardousMaterials/Pages/Spill-Release-Reporting.aspx). According to the database, there are no spills identified that involved illegal drug activity in the watershed areas during from 2006 to 2012. The watershed keepers are not aware of any spills within the watershed (Pers. Comm., Mr. Ken Wright, City of Napa Water Division, September 2012)

The City is notified of hazardous materials spills or other significant events by the Napa County Public Works Department. The County Public Works Department is made aware of incidents by any of various agencies that may first encounter the problem, based on the agencies' jurisdictions, the location of the incident, and the nature of the incident. The County may be notified by the sheriff's dispatch center, CDFG, Caltrans, or

by their own road maintenance or flood control staff. The Napa County Office of Emergency Services coordinates various agencies who respond to a spill of hazardous materials. Doug Calhoun, Environmental Health Supervisor, Napa County Planning, Building and Environmental Services Department, then notifies the City Water Division if the incident takes place in the City's watersheds. The following staff are then contacted, typically in this order:

- Mr. Ken Wright, Watershed Supervisor
- Ms. Erin Farnand, Water Quality Manager
- Ms. Joy Eldredge, Water General Manager

As the population of Napa Valley increases, the result is more traffic on Highway 128 and more potential for spills of hazardous materials. With increased agricultural use of the watershed there may be an increase in the transport of pesticides and herbicides on Highway 128 and the other major roads that generally follow the creeks that drain into the lake.

3.2.11 Unauthorized Activity

There is occasional unauthorized recreational use of the lake and the City property near the lake. According to the City, they occasionally find illegal dumping, but the items are immediately removed. Only infrequently have transients been observed in the watershed (who often leave trash). Litter and other potentially contaminating activities generally occur near Highway 128, where traffic is considerably higher than other roads near the lake. (Pers. Comm., Mr. Ken Wright, City of Napa Water Division, September 2012).

The City's watershed keepers prepare brief incident reports when they observe unauthorized activities. A Watershed Incident Report form is presented in Appendix A. Typical incidents include: being out on the lake past dusk; operating a boat on the lake that is larger than the size limit; and entering the water (either to swim or to launch a boat) (Pers. Comm., Mr. Ken Wright, City of Napa Water Division, September 2012).

With the anticipated significant increase in the use of the public trails northeast of Lake Hennessey, changes are anticipated in unauthorized activities in the next five years. The current very low use of public trails within the watershed will increase considerably, and the trails will also be available for use by equestrians and mountain bikers. The Shoreline Trail, which often approaches within 20 feet of the lake, is of particular concern. Hikers, horses, or bicyclists may create unauthorized trails from the Shoreline Trail to reach the lake, increasing the likelihood of erosion as well as unauthorized water body contact recreation by people and animals. The attraction to people and animals of entering the lake on a hot day, combined with infrequent patrols, may result in occasional body contact, as well as animal defecation even closer to the lake than the trail. Increased recreational use of the newly developed trails is likely to increase unauthorized use of maintenance roads, which will not have been improved for higher usage, that are not open to the public.

Improper recreational uses, such as trail cutting, would result in increased erosion and the introduction of sediments into the lake. Body contact recreation and the non-removal of animal wastes would result in the introduction of pathogens into the lake.

3.2.12 Fires

Much of the Lake Hennessey watershed is undeveloped and covered with dense brush which makes it very susceptible to wildfires during the dry months. The watershed is categorized as a high fire hazard area according to the California Department of Forestry and Fire Protection (CALFIRE). CALFIRE has primary responsibility for wildland fires and the County has primary responsibility for structural fires. Both agencies usually respond to fires in the watershed. The last major fires in the watershed occurred in the 1980s. There have been no significant fires in the last five years (Pers. Comm., Mr. Tom Knecht, CALFIRE, November 2012).

In the past, to help prevent or control a fire, the City has worked with CDF to clear brush on its property and burn it in a controlled burn area. Currently, the City has continued this effort alone, or with the help of the California Conservation Corps (Pers. Comm., Mr. Ken Wright, City of Napa Water Division, September 2012).

CALFIRE conducts basic fire suppression repair, which is the repair of environmental damage caused during the fire fighting process, which includes revegetation, placement of hay bales, and other measures. Although brush clearing could result in increased sediment loads to the lakes in the wet season following the activity, a significant fire in the watershed would result in intense loading of sediment and other contaminants to the lake.

There is a grant funded program that has been in place for the last decade called Napa Fire Wise. This program serves as an educational tool for the residents in Napa County to bring the awareness of how to prevent wildland fires. One program incentive encourages residents to gather up loose wood and debris within defensible space. Once the debris is gathered, supervised inmates provide a free chipping service to residents. The chipping service is sponsored by the Napa County Fire Department and through the Napa Fire Wise Program.

Although there is a low probability of occurrence, a large fire in the watershed could be a significant source of contaminants and organic loading to the Hennessey WTP. Large portions of the watershed are relatively inaccessible, are heavily vegetated, and have steep slopes. A wildfire could burn a large portion of the watershed before it could be controlled. This could result in severe erosion for several years after the fire.

3.2.13 Geologic Hazards

The landslide potential in most of the Lake Hennessey watershed is ranked as low to moderate (Napa County Planning Department, 2008). The following areas are vulnerable to landslides: Route 128 at Lake Hennessey, Chiles and Pope Valley Road north of Chiles Grist Mill Site, and Howell Mountain Road between Angwin and the Silverado Trail. Landslides have closed Highway 128 in Sage Canyon in the past.

The City Water Division maintains the roads adjacent to Lake Hennessey, which are required for maintenance and surveillance needs. The Water Division follows Napa County's Construction Site Runoff Control Requirements (Napa County Department of Public Works, 2006) when they are repairing or upgrading their roads. The City had problems with erosion of the dirt road that goes around the shoreline of the lake. Over ten years ago, the City constructed drainage ditches along the road and culverts under the road to route the storm drainage away from the road and convey it to the lake. As a result, the amount of road erosion was greatly reduced, but it did not resolve the erosion issues caused by the road. In addition, the City has a routine maintenance program to clear rocks from the drainage ditches to prevent them from overflowing. Erosion from these roads is acknowledged to be a major source of sediment contribution to the lake; however, the City is continually improving the worst sections (Pers. Comm., Mr. Ken Wright, City of Napa Water Division, September 2012).

There are several inactive earthquake faults in the watershed but the nearest active faults are the West Napa Fault, 5 miles southwest of the dam, the Green Valley Fault, 12 miles southeast of the dam, and the Cordelia Fault, 13 miles southeast of the dam.

Landslides and earthquakes could result in increased sediment loads to the lake. Other contaminants associated with the sediment, such as organic carbon and nutrients, would also increase in the raw water supply as a result of an earthquake or landslide.

A landslide in Sage Canyon near Lake Hennessey could be a significant source of sediment to the lake and result in high turbidity in the raw water. Landslides generally occur during the winter months when the

ground is saturated due to heavy rains. The City infrequently relies on Lake Hennessey as a water supply source during the winter, so a landslide generated by saturated soils is less likely to affect the City's water supply. A landslide generated by an earthquake could occur at any time and could potentially impact the quality of Lake Hennessey water. A large earthquake along one of the faults could potentially create problems for the water supply system and result in disruptions in service, although this is unlikely based on past history.

3.2.14 Water Treatment Plant Discharge

The three sludge ponds for the Hennessey WTP are located adjacent to the shoreline of the lake. The solids are removed by settling and the water is discharged directly to the lake about one mile from the intake tower. This discharge is done under a National Pollutant Discharge Elimination System (NPDES) permit. Storm drainage is routed around the sludge basins to prevent overflows to the lake. The dried sludge is removed from the basins to an off-site location as needed. There have been no changes in the operation of the sludge basins in the last five years, and there are no changes planned (Pers. Comm., Mr. Ken Wright, City of Napa Water Division, September 2012). Due to the small volume, the quality of the discharge and the distance from the lake, the discharge of supernatant from the sludge basins does not adversely affect water quality at the intake.

3.2.15 Contaminant Sources Not Present in the Watershed

The Lake Hennessey watershed does not contain any highly concentrated animal facilities, mines, solid waste disposal facilities, or hazardous waste disposal facilities. There is no logging in the watershed.

3.3 Potential Contaminant Sources in the Lake Milliken Watershed

Information on potential contaminant sources in the Lake Milliken watershed is updated in this section, and the significance of each source is reassessed from previous sanitary surveys based on the updated information.

3.3.1 Septic Tanks

All wastewater generated in the watershed is treated in septic tanks and leachfields. Individual septic systems were not examined as part of this sanitary survey; however, Napa County Environmental Management Department staff was interviewed about potential problems. All new septic systems in the Lake Milliken watershed are required to comply with current County standards. Because the soils are rocky, engineered septic systems are often required by the County. There have been no reported problems with the septic tanks in the Lake Milliken watershed (Pers. Comm., Mr. Sheldon Sapoznik, Napa County Environmental Management Department, September 2012).

The County requires property owners to repair or replace failing septic systems. The County does not conduct routine inspections of septic systems but they respond when complaints are filed. Given the large lot sizes in the watershed, it is unlikely that an adjacent property owner would be bothered by a failing septic system so it is up to individual property owners to identify and correct any problems. A failing septic system would primarily contribute nitrate and microbial contaminants to surface waters.

The small number of septic systems in the watershed, their distance from the Milliken WTP intake, and the apparent lack of septic system failures suggest that their impact on raw water quality at the intake is insignificant.

3.3.2 Recreational Use

There are no developed recreation areas in the watershed. Most of the private property in the watershed is fenced and "No Trespassing" signs are posted along Atlas Peak Road, the only public access in the watershed. The City does not allow recreation in the portion of the watershed that they own. The City property is fenced and no trespassing signs are posted. The City's watershed keeper patrols City property regularly and occasionally encounters trespassing hunters, mountain bikers, and hikers. Several times per year the watershed keeper finds people swimming in Milliken Creek below the dam. All trespassers are asked to leave and, if necessary, escorted off of City property.

The level of unauthorized recreational use of the watershed has not changed in the last five years (Pers. Comm., Mr. Ken Wright, City of Napa Water Division, September 2012).

The Bay Area Ridge Trail Council, a group that seeks to establish a ridge line trail that rings the San Francisco Bay, had previously proposed a route in Napa County that lies within the Lake Milliken watershed. Because of the greater obstacles to establishing this trail in the Lake Milliken watershed, the efforts to expand trails in Napa County switched to Lake Hennessey. While the Lake Milliken watershed has no existing public trails, the Lake Hennessey watershed already had this established use. In addition, the Lake Milliken watershed has more private property, and an older treatment plant that would have greater difficulty treating higher levels of turbidity should that result from trail development and use. The Milliken WTP is a direct filtration plant without the benefit of solids sedimentation ahead of the filters. Any additional raw water turbidity with associated increase in coagulant chemical dosages would increase the solids loading directly on the filters and cause shorter filter runs and potential filtered water quality deterioration. The filters are especially vulnerable because they are pressure filters.

The NCRPOSD has not abandoned its plans to develop trails in the Lake Milliken watershed, however. The plan is to learn from the establishment of trails at Lake Hennessey, and to monitor any resulting problems. At that point, the NCRPOSD will propose a trail plan for Lake Milliken. This plan would be proposed no earlier than in 3-5 years.

3.3.3 Agricultural Activities

Vineyards are the primary agricultural use of lands in the Lake Milliken watershed. According to aerial photo counts prepared by the Napa County Planning and Community Development Department, the vineyard acreage increased from 368 acres in the Lake Milliken watershed in 1993, to 432 acres in 2005. There are several small vineyards along Atlas Peak Road and a vineyard on the upper slopes of the hills above Lake Milliken. There is also an area of about 280 acres of vineyards in the upper portion of Foss Valley that is designated Agricultural Resource on the Land Use Element map of the Napa County General Plan (Napa County Planning Department, 2008). There is one vineyard downstream of Lake Milliken that drains to Milliken Creek.

The 1600-acre Circle S Ranch lies near the headwaters of Milliken Creek, a seasonal creek that flows from the northwest to the southeast corners of the property. Historically, the property was a cattle ranch, and more recently, the property had been leased for cattle grazing. However, the property was sold shortly before the 2007 Update, and the new owner, Premier Pacific Vineyards, is working with the County to operate as a vineyard. More detailed information about the future vineyard plans can be found in the 2007 Update.

The vineyard conversion was approved by Napa County in December 2011, but the conversion has not begun. (Pers. Comm., Mr. Brian Bordona, Napa County Planning and Community Development Department, September 2012).

No applications for vineyard conversions in the Lake Milliken watershed are currently pending. Vineyard development has presumably slowed because of the economy (Pers. Comm., Mr. Brian Bordona, Napa County Planning and Community Development Department, September 2012). One recent vineyard conversion in the Lake Milliken watershed is mapped on Figure 3-3.

Although vineyards occupy the greatest amount of developed land in the watershed, most of the vineyards are some distance from the intake and upstream of Lake Milliken. As discussed in Chapter 4, the City only collects water quality data during the summer months when the Milliken WTP is operating so the quality during the winter months is not known. Based on the current extent of vineyards in the watershed and the limited water quality data, it appears that vineyards have not adversely affected Lake Milliken.

3.3.4 Pesticide/Herbicide Use

The discussion of pesticide/herbicide use is primarily on a county-wide basis. Please refer to Section 3.3.6, Pesticide/Herbicide Use for Lake Hennessey, for the county-wide discussion.

PAK-27 has been applied at the diversion dam twice a week since 2007. The quantity applied varies from 10 pounds to 25 pounds per application, depending upon the extent of algae present near the intake (Pers. Comm., Ms. Erin Farnand, City of Napa Water Division, October 2012).

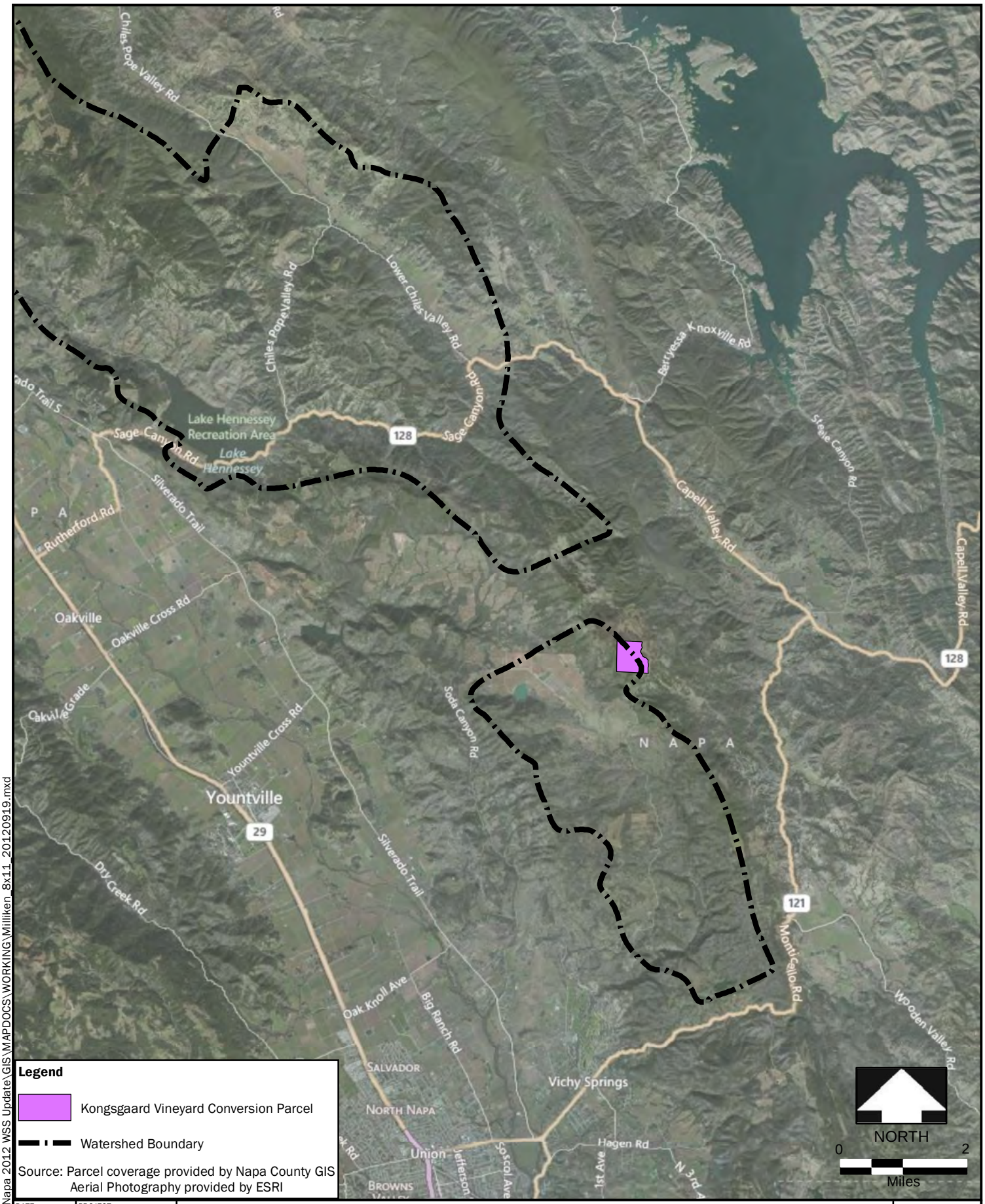
Weeds along the roads in the Lake Milliken watershed are controlled by a combination of mowing and the use of Pro-Roundup (glyphosate, a post-emergent) and surflan (a pre-emergent) (Pers. Comm., Mr. Ken Wright, City of Napa Water Division, September 2012).

3.3.5 Grazing Animals

The conversion of the 1600-acre Circle S Ranch from a cattle ranch to a vineyard will significantly reduce the number of cattle in the watershed. Circle S Ranch cattle have unrestricted access to Milliken Creek and all tributaries on the property. Upon implementation of the Circle S Ranch Erosion Control Plan for development of the property into a vineyard, the cattle would be removed. Riparian areas that have been overgrazed by cattle would be restored. As discussed in Section 3.3.3, the vineyard conversion has not yet begun.

3.3.6 Wild Animals

Much of the land in the Lake Milliken watershed is undeveloped so there is a relatively large population of wild animals. According to CDFG, deer, black bear, coyotes, several types of rodents, and potentially muskrats are present in the watershed (CH2MHill, 1996). Deer are prevalent in the area around the lake. The City's Water Division staff have also observed foxes, snakes, jackrabbits, turkeys, possum, and a variety of waterfowl. In addition to contributing sediment to the lakes, the large population of wild animals may be a source of pathogenic microorganisms. Birds, in particular, can be a significant source of pathogens to lakes because of the direct nature of their deposits. Birds are a particular concern if there is a large year round population of waterfowl (as opposed to a migratory bird population).



Legend

Kongsgaard Vineyard Conversion Parcel

Watershed Boundary

Source: Parcel coverage provided by Napa County GIS
Aerial Photography provided by ESRI

DATE	PROJECT	SITE
9-19-12	143198	**Vineyard Conversion Parcels Napa County, California**

Brown AND Caldwell

TITLE

Vineyard Conversion Parcels near Lake Milliken Watershed

Figure 3-3

P:\43000\143198 - Napa 2012 WSS Update\GIS\MAPDOCS\WORKING\Milliken_8x11_20120919.mxd

Due to the relatively low level of human activity in this watershed, the wild animal population may be the most significant, although minor source of microbial contaminants to the reach in the reach between Lake Milliken and the diversion dam, particularly in the summer months when there is little or no runoff to carry contaminants into Milliken Creek.

3.3.7 Hazardous Materials Storage

The Circle S Ranch proposed vineyard operations would include storage of pesticides, including herbicides, fungicides, insecticides, and nematicides, as well as diesel and gasoline fuels. Some of these chemicals are stored on-site currently for existing operations. All petroleum products are stored in compliant aboveground storage tanks located in or directly adjacent to a shop at the existing main ranch complex. Pesticides would be stored in a locked metal shipping container in the vicinity of the shop. The shop is located off of the existing driveway, approximately 250 feet from the nearest stream and approximately 1,250 feet from the nearest wetland.

Two trash pits southwest of the ranch buildings were identified in a Phase I Site Assessment (ATC Associates, 2005). The areas were identified, excavated, sorted, tested, removed and properly disposed of. A 2 mile radius search of state, federal, and local hazardous materials database identified no records of leaking, spills, or any other type of contamination. However, two above ground storage tanks were identified at the project site: a 550-gallon regular fuel tank and a 1,000 gallon unleaded fuel tank (Environmental Data Resources, 2007). With the proposed project, these tanks would continue to be used and use would increase with vineyard farming activities.

No new tanks have been installed in the watershed in the last five years, nor are there any leaking underground storage tanks (Pers. Comm., Mr. Jim Newman, Napa County Environmental Management Department, September 2012).

The storage of hazardous materials in aboveground and underground tanks does not pose a risk to the water quality of Lake Milliken because all of the regulated tanks in the watershed are compliant with current regulations.

3.3.8 Hazardous Materials Spills and Traffic Accidents

Atlas Peak Road is the only major road traversing the Lake Milliken watershed. The road dead ends at Atlas Peak, so it is used mainly by residents and their guests. It is at least 0.5 mile from Lake Milliken and Milliken Creek downstream of the lake, although it runs along Milliken Creek and crosses the creek in the upper watershed. Spills resulting from traffic accidents along this highway, and other spills in the watershed are reported to Cal EMA and the local OES office.

In California, any significant release or threatened release of a hazardous material requires immediate reporting by the responsible person to 911 and the Cal EMA State Warning Center. The Cal EMA HazMat Section helps the reporting individual or agency to decide how to respond to a spill. The California Emergency Management Agency maintains a database on hazardous materials spills that can be accessed online (http://www.calema.ca.gov/HazardousMaterials/Pages/Spill-Release-Reporting.aspx). According to the database, there are no spills identified that involved illegal drug activity in the watershed areas during from 2006 to 2012. The watershed keepers are not aware of any spills within the watershed (Pers. Comm., Mr. Ken Wright, City of Napa Water Division, September 2012).

The City is notified of hazardous materials spills or other significant events by the Napa County Public Works Department. The County Public Works Department is made aware of incidents by any of various agencies that may first encounter the problem, based on the agencies' jurisdictions, the location of the incident, and the nature of the incident. The County may be notified by the sheriff's dispatch center, CDFG, Caltrans, or

by their own road maintenance or flood control staff. The Napa County Office of Emergency Services coordinates various agencies who respond to a spill of hazardous materials. Doug Calhoun, Environmental Health Supervisor, Napa County Planning, Building and Environmental Services Department, then notifies the City Water Division if the incident takes place in the City's watersheds. The following staff are then contacted, typically in this order:

- Mr. Ken Wright, Watershed Supervisor
- Ms. Erin Farnand, Water Quality Manager
- Ms. Joy Eldredge, Water General Manager

There has not been a significant change in traffic accidents or spills since the 2007 Update. With increased agricultural use of the watershed there is likely to be an increase in the transport of pesticides and herbicides on Atlas Peak Road. Due to the distance of Atlas Peak Road from the lake and Milliken Creek downstream of the lake and the past history of no spills in the watershed, spills of hazardous materials are not considered a significant source of contaminants to Lake Milliken.

3.3.9 Unauthorized Activity

Unauthorized recreational use of the lake is rare. Because of its distance from populated areas, and the limited access to areas near the lake, the City has not had problems with illegal dumping of trash or with transients (Pers. Comm., Mr. Ken Wright, City of Napa Water Division, September 2012).

Two years ago the Napa County Sheriff's Office found a marijuana farm in the watershed above Lake Milliken. After the removal of the operation, the City removed the remaining trash, including drip tubing that had been used for irrigation. No hazardous materials were found (Pers. Comm., Mr. Ken Wright, City of Napa Water Division, September 2012).

There have been no changes in the watershed as a result of unauthorized activities since the 2007 Update was conducted. No changes are anticipated in unauthorized activities in the next five years; however, trail development in the watershed could increase occurrences after that time. The current level of unauthorized activities, including occasional recreational swimming, represents an insignificant source of contaminants and, therefore, a low water quality risk to the lake.

3.3.10 Fire

Much of the Lake Milliken watershed is undeveloped and covered with dense brush which makes it very susceptible to wildfires during the dry months. The watershed is categorized as a high fire hazard area according to CALFIRE. CALFIRE has primary responsibility for wildland fires and the County has primary responsibility for structural fires. Both agencies usually respond to fires in the watershed. The last major fire in the watershed was the Atlas Peak fire which occurred in 1981. There have been no significant fires in the last five years (Pers. Comm., Mr. Tom Knecht, CALFIRE, November 2012).

In the past, to help prevent or control a fire, the City has worked with CDF to clear brush on its property and burn it in a controlled burn area. Currently, the City has continued this effort alone, or with the help of the California Conservation Corps. (Pers. Comm., Mr. Ken Wright, City of Napa Water Division, September 2012).

CALFIRE fire suppression repair and the County's Napa Fire Wise program were described under Lake Hennessey. No changes are anticipated in the manner in which the City protects their property from fires or in the fire response methods.

A large fire in the watershed could be a significant source of contaminants to the Milliken WTP. Large portions of the watershed are relatively inaccessible, are heavily vegetated, and have steep slopes. A wildfire could burn a large portion of the watershed before it could be controlled, as evidenced by the Atlas Peak fire. This could result in severe erosion for several years after the fire.

3.3.11 Geologic Hazards

The landslide occurrence in the Lake Milliken watershed is ranked as negligible to low (Napa County Planning Department, 2008). Small landslides occasionally occur along the dirt road that connects the check dam on Milliken Creek with the Milliken WTP.

There are no earthquake faults in the watershed but the Green Valley Fault is about two miles to the south and the West Napa Fault is about five miles west of Lake Milliken (Napa County Planning Department, 2008).

Landslides and earthquakes could result in increased sediment loads to the lake. Other contaminants associated with the sediment, such as organic carbon and nutrients, would also increase in the raw water supply as a result of an earthquake or landslide.

The City Water Division maintains the roads adjacent to Lake Milliken, which are required for maintenance and surveillance needs. The Water Division follows Napa County's Construction Site Runoff Control Requirements (Napa County Department of Public Works, 2006) when they are repairing or upgrading their roads. Erosion from these roads is acknowledged to be a major source of sediment contribution to the lake; however, the City is continually improving the worst sections (Pers. Comm., Mr. Ken Wright, City of Napa Water Division, September 2012).

There have been no changes in the potential for landslides or earthquakes to affect water quality since the 2007 Update. It is not possible to predict the level of geologic hazards in the next five years; however, it is unlikely that there will be a landslide that will affect water quality due to the low landslide occurrence rating in the watershed. The City has continued to improve erosion control for the City roads near the lake as major repairs are needed.

Landslides are not significant sources of contaminants in the watershed. A large earthquake along one of the faults could potentially create problems for the water supply system and result in disruptions in service, although this is unlikely based on past history. Erosion from the maintenance roads near the lake contributes sediment to the lake, which results in increased turbidity and treatment concerns at the Lake Milliken water treatment plant.

3.3.12 Contaminant Sources Not Present in the Watershed

The Lake Milliken watershed does not contain any urban areas, concentrated animal facilities, mines, solid waste disposal facilities, or hazardous waste disposal facilities. There is no logging or use of reclaimed water in the watershed.

3.4 Anticipated Growth within the Watershed

Most of the land within the watershed is devoted to agricultural uses or is undeveloped. Residential, commercial, and industrial growth within the watershed is limited, and major changes in land use are not anticipated by the Napa County Planning, Conservation and Development Department (Pers. Comm., Mr. Brian Bordona, September 2012). The 1980 Slow Growth Initiative, which limited growth in the county to 1 percent annually, was reaffirmed in the 2008 General Plan Update for the duration of the General Plan (2030). Rebuilding additions occur, but do not exceed a 1 percent annual rate.

In the Lake Hennessey watershed, there is some growth in the Sage Canyon area. Large lot subdivisions are in the process of being developed as 10-acre estates. A proposal to build 191 units of affordable housing in Angwin was approved, and there is currently an offer to Pacific Union College to build 191 units of housing on college property that is for sale.

In the Lake Milliken watershed, there is some small sporadic development, and growth is expected to remain slow. Typical activities in the watershed are small wineries remodeling or adding to their facilities. The conversion of the Circle S Ranch from cattle grazing to vineyards is the largest ongoing project. The project was approved in 2011, but no vineyards have been developed yet.

The 2,300-acre Walt Ranch vineyard development project, which is located primarily in the Lake Berryessa watershed (Capell Creek), also has over one hundred acres within the Milliken Creek watershed, east of Foss Valley. Sixty-five vineyard blocks are proposed for development within areas with slopes greater than five percent. There will be a total of 356 net acres of vineyard (Analytical Environmental Services 2012). The vineyard areas have a somewhat higher concentration in the Milliken Creek watershed. Vineyard development began in 2006.

Also mentioned in the General Plan as part of the County's Recreation Vision, which gives an indication of the County's direction regarding trail development, are the following policies:

- coordinating the voluntary sale or donation of open space lands or easements by willing owners and partnering with other agenices including the new Napa County Regional Park and Open Space District
- expanding parks and trails into a network of off-road bicycle and pedestrian paths connecting population centers in incorporated and unincorporated areas to parks and regional trails such as the Bay Area Ridge Trail.

4. WATER QUALITY

The purpose of this chapter is to identify changes in raw water quality that may impact the ability of the City to meet current and anticipated regulations. An additional goal is to identify water quality changes that may indicate deterioration of the source waters. This chapter is divided into four sections: (1) a regulatory review, (2) an evaluation of raw and finished water quality data, (3) an evaluation of the City's ability to meet Surface Water Treatment Rule requirements, and (4) recommended monitoring improvements.

4.1 Overview of Federal and State Regulations

The U.S. Environmental Protection Agency (US EPA) is responsible for developing and implementing drinking water regulations under the federal Safe Drinking Water Act (SDWA) of 1974. The California Department of Public Health (CDPH) Office of Drinking Water has been delegated the authority to implement drinking water regulations within the state. The state either adopts the federal regulations or develops its own regulations with more stringent standards; for nearly all regulated drinking water contaminants, the state has adopted the federal regulations.

The following sections summarize the federal and state requirements associated with surface water and distribution systems. State requirements are only identified when they are more stringent than the corresponding federal regulations.

4.1.1 Federal Regulations

Federal water quality regulations are summarized in Table 4-1. The most recently promulgated federal regulations relevant to the City are the Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR) and the Stage 2 Disinfectants/ Disinfection By-Products (D/DBP) Rule. These regulations augment the previously promulgated regulations, the Interim Enhanced Surface Water Treatment Rule (IESWTR), the Long Term 1 Enhanced Surface Water Treatment Rule (LT1ESWTR), and the Stage 1 Disinfectants/Disinfection By-Products Rule. The goal of the new rules is to provide a high level of protection against microbial contaminants, while further limiting the production of potentially carcinogenic disinfection by-products (DBPs).

Table 4-1. Summary of US EPA Water Quality Regulations

Regulation	Major Requirements
National Primary Drinking Water Regulations	• Currently set for 92 contaminants, including turbidity, 8 microorganisms, 4 radionuclides, 19 inorganic contaminants, and 60 organic contaminants. • 83 of the contaminants have maximum contaminant levels (MCLs) and maximum contaminant level goals (MCLGs), with treatment technique requirements for the remaining 9. • 15 additional contaminants have secondary (aesthetic) standards.
Total Trihalomethanes Rule *Promulgated in 1979*	• Established an MCL of 100 µg/L for the sum of four trihalomethanes (THMs): chloroform, bromodichloromethane, dibromochloromethane, and bromoform. • Compliance determined as a running annual average (RAA) of quarterly samples.
Surface Water Treatment Rule *Promulgated in 1989*	• Requires that a detectable disinfectant residual be present in all portions of the distribution system (heterotrophic plate count [HPC] less than 500 colony forming units [CFU]/mL equivalent to a detectable residual). • Requires 3-log *Giardia* inactivation/removal. Conventional systems receive a 2.5-log credit and direct filtration systems receive a 2-log credit for meeting filter effluent turbidity requirements. Remaining requirements must be met through disinfection. • Requires 4-log virus inactivation/removal. Conventional systems receive a 2-log credit and direct filtration systems receive a 1-log credit for meeting filter effluent turbidity requirements. Remaining requirements must be met through disinfection. • Requires combined filter effluent turbidity not exceed 0.5 NTU (nephelometric turbidity units) in more than 5 percent of samples each month.
Total Coliform Rule *Promulgated in 1989*	• Requires that less than 5 percent of distribution samples collected each month be positive for total coliform. • Requires a detectable disinfectant residual at all points in the distribution system (HPC less than 500 CFU/mL considered equivalent to a detectable residual).
Interim Enhanced Surface Water Treatment Rule (IESWTR) *Promulgated in 1998*	• Establishes an MCLG of zero for *Cryptosporidium.* • Requires combined effluent turbidity of less than 0.3 NTU in 95 percent of samples collected each month. • Establishes requirements for individual filter effluent turbidities, with associated requirements for a Comprehensive Performance Evaluation of underperforming filters. • Requires that new finished water reservoirs be covered. • Requires sanitary surveys at three year intervals. • Requires disinfection benchmarking.
Stage 1 Disinfectants/ Disinfection By-Products (D/DBP) Rule *Promulgated in 1998*	• Establishes MCLs for the following disinfection by-products (DBPs): THMs (80 µg/L), haloacetic acids [HAAs] (60 µ/L), bromate (10 µg/L) and chlorite (1 mg/L). THM and HAA compliance is based on an RAA of distribution system samples. • Establishes maximum residual disinfectant levels (MRDLs) for the following disinfectants: free chlorine (4 mg/L), chloramines (4 mg/L), and chlorine dioxide (0.8 mg/L). Compliance based on an average of distribution system samples. • Establishes enhanced coagulation requirements requiring total organic carbon (TOC) removals based on raw water TOC and alkalinity. Purpose is to optimize removal of DBP precursors.
Modified Lead and Copper Rule *Promulgated in 2000*	• Maintains MCLGs (0 mg/L for lead and 1.3 mg/L for copper) and action levels [ALs] (0.015 mg/L for lead and 1.3 mg/L for copper) established in the 1991 Lead and Copper Rule. • Compliance requires that less than 10 percent of distribution system samples exceed action levels. • Establishes additional requirements, including demonstration of optimal corrosion control, lead service line replacements, public education, monitoring, analytical methods, etc.

Table 4-1. Summary of US EPA Water Quality Regulations	
Regulation	Major Requirements
Arsenic Rule *Promulgated in 2001*	• Establishes an MCL of 10 µg/L for arsenic.
Filter Backwash Recycle Rule *Promulgated in 2001*	• Requires that all recycle streams be returned prior to or at the point of primary coagulant addition. • Requires that information on recycle streams be provided to the California Department of Public Health (CDPH) for evaluation.
Long-term 1 Enhanced Surface Water Treatment Rule (LT1ESWTR) *Promulgated in 2002*	• Extended requirements of the IESWTR to utilities serving less than 10,000 persons.
Long-term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR) *Promulgated in 2006*	• Assigns utilities to one of four "bins" based on raw water *Cryptosporidium* concentrations. • Each bin has associated requirements for additional *Cryptosporidium* treatment. • Includes a toolbox of options for receiving *Cryptosporidium* reduction credits, including watershed control, disinfection, and filtration. • Bin assignment is based on the average of the 12 consecutive highest months within a 2-year period of quarterly *Cryptosporidium* samples.
Stage 2 D/DBP Rule *Promulgated in 2006*	• Does not change the MRDLs or MCLs established in the Stage 1 Rule. • Requires an initial distribution system evaluation (IDSE) to identify sites with high DBP levels. • Systems with no samples with THM/HAA levels exceeding 40/30 µg/L can apply for an IDSE waiver. • Compliance schedule is based on population of the public water system. • 6 to 8 years following promulgation, requires compliance with 80 µg/L THM and 60 µg/L HAA based on a location running annual average (LRAA) at each site.

4.1.2 State Regulations

CDPH implements drinking water regulations within the state. CDPH regulations are per the State Safe Drinking Water Act and Related Laws, referred to as the "blue book." The most recent updated version of the blue book was published in January 2012.

CDPH regulations relevant to water purveyors are summarized in Table 4-2. Only regulations and requirements that are in excess of federal requirements are mentioned. Table 4-2 also includes requirements under the Cryptosporidium Action Plan (CAP), which was implemented to promote protection of public health through the optimization of the performance of water treatment plants. The CDPH was directed to implement the CAP through Section 116360 of the California Health and Safety Code, which was passed by the legislature in 1995. Since 1995, federal rules have been adopted to address *Cryptosporidium* (e.g., the ESWTR, Long Term 1 ESWTR, and Long Term 2 ESWTR) and, therefore, CAP requirements may be of only historical interest (CDPH 2009).

Table 4-2. Summary of CDPH Water Quality Regulations

Regulation	Major Requirements
State Primary Drinking Water Standards	• State MCLs are more stringent than federal levels for 32 contaminants. • The state also has notification levels (NLs) for 30 chemicals. NLs are health-based standards for contaminants without a current MCL. Exceedance may require public notification or switching to an alternative source.
Cryptosporidium Action Plan *Established in 1995*	• Sedimentation/clarification basin effluent turbidity of 1 to 2 NTU. • Combined filter effluent turbidity <0.1 NTU. • Reclaimed backwash water turbidity <2 NTU. • Filter effluent turbidity after filter backwash or filter-to-waste <0.3 NTU. • Recycle flows limited to 10 percent of influent.

4.2 Constituents of Concern to Water Purveyors

The purpose of this section is to summarize the water quality constituents specifically of concern to the City.

4.2.1 Microbiological Water Quality

One major function of water treatment is to remove or inactivate pathogenic organisms. The primary sources of microbiological contaminants are grazing and wild animals, wastewater treatment and septic spills, and to a lesser degree, body-contact recreation within surface water sources. Pathogen concentrations are reduced through a combination of removal by filtration processes and chemical disinfection. Chemical oxidants may also provide other benefits in addition to disinfection, including the destruction of compounds that cause taste and odor problems.

Both state and federal regulations are focused on the removal of four major pathogens/pathogen groups: coliform bacteria, *Giardia*, viruses and *Cryptosporidium*. For three of the pathogen groups, removal requirements are dependent on the level of microbial contamination of the source water. Turbidity is also used as a surrogate for microbial water quality and is discussed below.

Coliform Bacteria

Coliform bacteria are used as an indicator of microbial contamination. Coliform bacteria are directly regulated under the Total Coliform Rule, which requires that less than 5 percent of distribution system samples collected each month test positive for the presence of coliform bacteria. Positive samples require additional action, including further testing for fecal coliform, as well as collection of additional distribution system samples.

Source water total coliform levels are also used by the CDPH to determine *Giardia* and virus removal requirements through treatment, as described in the following section.

***Giardia* and Viruses**

Giardia and viruses are regulated under the California SWTR; removal requirements are based on source water total coliform levels, as shown in Table 4-3. Systems using conventional treatment that meet filter effluent turbidity requirements receive treatment credits of 2.5-log for *Giardia* and 2-log for viruses. Credits for direct filtration systems are 2.0-log *Giardia* and 1-log virus. Credits for alternative filtration technologies are determined by CDPH.

Table 4-3. Reduction Requirements for *Giardia* and Viruses

Median monthly total coliform concentrations (MPN/100 mL)	*Giardia* cyst log reduction requirements	Virus log reduction requirements
< 1,000	3	4
> 1,000 – 10,000	4	5
>10,000 – 100,000	5	6

Cryptosporidium

Reduction of *Cryptosporidium* is regulated under the recently promulgated LT2ESWTR. Requirements under this rule may not yet be in effect, but source water monitoring is underway for systems serving more than 50,000 persons. Source water monitoring for *Cryptosporidium* was required by April 2008 for systems serving between 10,000 and 49,999 persons. For filtered systems serving less than 10,000 persons, sampling for *E. coli* was required by October 2008. Systems that did not complete *E. coli* monitoring, or detect high levels, were required to initiate *Cryptosporidium* monitoring by April 2010.

As shown in Table 4-4, utilities will be assigned to one of four "bins" according to average levels of *Cryptosporidium* in their source water. The bin assignments have associated treatment requirements ranging from no additional treatment to a required 2.5 logs. For Lake Hennessey, bin assignment will be based on the average of the 12 consecutive highest months within a 2-year period. The Milliken WTP operates less than 6 months per year so different LT2ESWTR rules apply. The treatment requirements listed in Table 4-4 will apply to the water purveyors if a conventional or direct treatment process is used. Requirements for alternative filtration technologies will be determined by CDPH.

Table 4-4. Bin Assignment for Cryptosporidium Reduction Requirements

Bin number	Average Cryptosporidium concentration	Additional treatment requirementsa
1	<0.075/L	No additional treatment
2	≥ 0.075/L and < 1.0/L	1-log additional treatment
3	≥ 1.0/L and < 3.0/L	2-log additional treatmentb
4	≥ 3.0/L	2.5-log additional treatmentb

[a] *For conventional treatment systems in full compliance with the SWTR, IESWTR, and LT1ESWTR*

[b] *Utilities falling under Bins 3 or 4 must meet 1.0 log of the required treatment using ozone, UV, membranes, bag filtration, cartridge filtration, or bank filtration.*

A unique aspect of *Cryptosporidium* regulation under the LT2ESWTR is that utilities can achieve "credits" for prevention, removal or inactivation through a number of pathways. Credits of potential interest to the City are summarized in Table 4-5.

Table 4-5. Microbial Toolbox for Cryptosporidium Treatment Credits	
Toolbox option	**Cryptosporidium treatment credit**
Source protection and management toolbox options	
Watershed control program	• 0.5-log credit for state-approved program comprising required elements, annual program status report to state, and regular watershed survey.
Alternative source/intake management	• No prescribed credit. Utilities may conduct simultaneous monitoring for treatment bin classification at alternative intake locations or under alternative intake management strategies.
Prefiltration toolbox options	
Presedimentation basin with coagulation	• 0.5-log credit during any month that presedimentation basins achieve a monthly mean reduction of 0.5-log or greater in turbidity or alternative state-approved performance criteria. Basins must be operated continuously with coagulant addition and all flows must pass through basins.
Bank filtration	• 0.5-log credit for 25-foot setback; 1.0 log credit for 50-ft setback; horizontal and vertical wells only; aquifer must be unconsolidated sand containing at least 10 percent fines (as defined by rule); average turbidity in wells must be less than 1 NTU. Systems using existing wells followed by filtration must monitor the well effluent to determine bin classification and are not eligible for additional credit.
Treatment performance toolbox options	
Combined filter performance	• 0.5-log credit for combined filter effluent turbidity less than or equal to 0.15 NTU in at least 95 percent of measurements each month.
Individual filter performance	• 0.5-log credit (in addition to 0.5-log combined filter effluent credit) if individual filter effluent turbidity is less than or equal to 0.15 NTU in at least 95 percent of samples each month in each filter and is never greater than 0.3 NTU in two consecutive measurements in any filter.
Demonstration of performance	• Credit awarded to unit process or treatment train based on a demonstration to the state with a state-approved protocol.
Additional filtration toolbox options	
Bag and cartridge filters	• Up to 2.0-log credit with demonstration of at least 1-log greater removal in a challenge test when used singly. Up to 2.5-log credit with demonstration of at least 0.5-log greater removal in a challenge test when used in series.
Membrane filtration	• Log credit equivalent to removal efficiency demonstration in challenge test for device if supported by direct integrity testing.
Second stage filtration	• 0.5-log credit for second separate granular media filtration stage if treatment train includes coagulation prior to first filter.
Inactivation toolbox options	
Chlorine dioxide	• Log credit based on measured contact time (CT) in relation to CT table.
Ozone	• Log credit based on measured CT in relation to CT table.
UV	• Log credit based on validated UV dose in relation to UV dose table; reactor validation testing required to establish UV dose and associated operating conditions.

Turbidity

Turbidity is a concern in drinking water because it can reduce the effectiveness of disinfection by shielding microorganisms. It is also used as a surrogate measure for potential pathogenic contamination and as a measure of filtration performance.

The IESWTR included new requirements for filtered water turbidities. In particular, it introduced monitoring of individual filter effluents, rather than just combined filter effluent. The rule requires that individual filter effluent turbidities not be greater than 1.0 NTU in any two consecutive samples at any time, or greater than 0.3 NTU after the filter has been in operation for 4 hours. Individual filters exceeding these standards are

subject to a Comprehensive Filter Evaluation. The rule also requires that combined filter effluent turbidities be less than 0.3 NTU in 95 percent of samples collected each month.

4.2.2 Disinfectants and Disinfection By-Products

Disinfection by-products (DBPs) are produced through the reaction of chemical disinfectants with natural organic matter (NOM) present in the source water. DBPs are a concern due to a number of confirmed or suspected health effects, including increased rates of cancer, miscarriages and developmental defects.

The maximum contaminant levels (MCLs) for DBPs are summarized in Table 4-6. All values are from the US EPA Stage 1 and 2 D/DBP Rules, which will supersede previous DBP regulations. The CDPH version of the Stage 1 Rule did not alter the MCLs from the US EPA rule. Though CDPH has the option of implementing more stringent standards than the US EPA Stage 2 Rule, such standards are not anticipated. Compliance schedules are presented on Table 4-7 and Table 4-8.

Table 4-6. US EPA Stage 1/2 D/DBP Disinfectants and Disinfection by-Product Limits

Disinfectants By-Products	
DBP	**Maximum contaminant level**
Trihalomethanes	80 µg/L
Haloacetic acids	60 µg/L
Disinfectants	
Disinfectant	**Maximum residual disinfectant level**
Chlorine	4 mg/L
Chloramines	4 mg/L

Table 4-7. Stage 2 Disinfectants and Disinfection By-Products Rule Compliance Schedule for Systems Serving 100,000 people or more

Category	Deadline
Monitoring plan or waiver submittal	October 1, 2006
Monitoring completion	September 30, 2008
Final IDSE report submittal	January 1, 2009
Compliance with rule requirements	January 2013

Table 4-8. Stage 2 Disinfectants and Disinfection By-Products Rule Compliance Schedule for Systems Serving 10,000 people or less

Category	Deadline
Monitoring plan or waiver submittal	April 1, 2008
Monitoring completion	March 31, 2010
Final IDSE report submittal	July 1, 2010
Compliance with rule requirements	July 2014

The two DBPs of greatest concern to the City of Napa will be THMs and HAAs, which are formed through the interaction of chlorine with NOM in the source water. Under the Stage 2 Rule, both THMs and HAAs are regulated based on samples collected at a number of locations throughout the distribution system. Compliance is based on a locational running annual average (LRAA) of quarterly samples collected at each of the sample locations.

Total Organic Carbon Reduction Requirements

Under Stage 1 D/DBPR, water systems that use surface water or ground water under the direct influence of surface water and used conventional filtration treatment are required to remove specified percentages of organic materials, measured as total organic carbon (TOC), which may react with disinfectants to form DBPs. The enhanced coagulation requirements are relevant to conventional water treatment plants only; as such, only Hennessey WTP will be affected. The percent of TOC removal ranges from 15 to 50 percent depending on the source water alkalinity (Table 4-9). Compliance with the TOC removal requirement shown in Table 4-6 for Stage 1 D/DBPR was calculated based on system-wide running annual TOC average.

Under Stage 2 D/DBPR, TOC removal requirements described in Table 4-9 are provided as alternative compliance criteria. Reduced total trihalomethanes (TTHM) and HAA5 monitoring options are offered if the source water TOC running annual average prior to any treatment is less than or equal to 4 mg/L, source water alkalinity is less than 60 mg/L as CaCO3 and the system is achieving TTHM <40 µg/L and HAA5 <30 µg/L.

Table 4-9. TOC Removal Percentages from Stage 1 Disinfectants and Disinfection By-Products Rule[1]

Source Water TOC (mg/L)	Source Water Alkalinity (mg/L as $CaCO_3$)		
	0 to 60	>60 to 120	>120
>2.0 to 4.0	35%	25%	15%
>4.0 to 8.0	45%	35%	25%
>8.0	50%	40%	30%

Source: http://water.epa.gov/lawsregs/rulesregs/sdwa/mdbp/upload/2001_05_23_mdbp_qrg_st1.pdf

[1] TOC removal calculated based on system-wide running annual TOC average

4.2.3 Chemical Contaminants

Chemical contaminants are regulated under the National Primary Drinking Water Regulations. These regulations currently include 87 contaminants, including 16 inorganic, 53 organic chemicals, and 4 radionuclides. In addition to the primary standards, secondary standards based on aesthetics have been established for 15 additional parameters. They are established only as guidelines to assist public water systems in managing their drinking water for aesthetic considerations, such as taste, color and odor and are not considered to present a risk to human health at the SMCL.

For the federal and state primary and secondary drinking water standards, each contaminant generally has a maximum contaminant level (MCL): the highest level of the contaminant allowed in drinking water. Some contaminants have a treatment technology requirement in lieu of or in addition to the MCL. In some cases, CDPH has established regulatory levels that are more stringent than the federal requirements. A number of the contaminants are associated with agriculture, including pesticides and herbicides.

The state also establishes health-based NLs for selected emerging contaminants for which MCLs have not yet been established. Detection of contaminant levels that exceed the NL may require utilities to take further action, such as public notification or switching to an alternative source.

4.2.4 Emerging Contaminants

The purpose of this section is to identify chemical and microbial contaminants that are not currently regulated, but may be regulated in the future. Two major sources of information are the US EPA's Contaminant Candidate List (CCL) and Information Collection Rule. Additional contaminants have been identified by the CDPH.

CCL 1 was published in 1998 and included 10 microbial, 6 inorganic, and 50 chemical contaminants. The purpose of the CCL is to identify contaminants not yet subject to regulation but that are known or anticipated to occur in public water systems, and may require future regulation under the SDWA. The CCL classified contaminants as either being ready for regulatory determination, or in need of further research pertaining to one or more of the following: health effects, treatability, analytical methods, and occurrence. CCL 2 was published in 2005 and includes the contaminants on CCL 1 for which a regulatory determination was not made. CCL 2 does not include the 9 CCL 1 contaminants for which sufficient information existed to determine that National Primary Drinking Water Regulations need not be developed. These include 1 microbial, and 8 chemical contaminants. In October 2009, USEPA published the final CCL3 list which included 104 chemical contaminants and 12 microbial contaminants. The list includes, among others, pesticides, biological toxins, disinfection byproducts, chemicals, and waterborne pathogens.

Contaminants requiring further information on occurrence have been monitored under the Unregulated Contaminant Monitoring Rule (UCMR). The first cycle of the rule (UCMR 1) was promulgated in 1999 and included a list of 34 contaminants. The contaminants were divided into three lists according to the availability of analytical methods, as shown in Table 4-10. All of the List 1 contaminants, and 13 of the 15 List 2 contaminants were monitored by selected utilities for a 12-month period between 2001 and 2003. The method for *Aeromonas* was released in May 2002, with monitoring conducted in 2003.

The second cycle of the rule (UCMR 2) was published in 2007. The UCMR 2 contaminant list is divided into two sub-lists: List 1 Assessment Monitoring chemical contaminants and List 2 Screening Survey chemical contaminants, as presented in Table 4-11. The Assessment Monitoring chemical contaminants are those which have established analytical methods and the Screening Survey chemical contaminants are those for which analytical methods have recently been developed and the associated technologies may not be in wide use. The Assessment Monitoring contaminants include two pesticides, five flame retardants, and three explosives. The Screening Survey contaminants include acetanilide pesticide parent compounds and their degradation products and nitrosamines. All PWSs serving more than 10,000 people and a subset of those serving 10,000 or fewer are required to monitor for the List 1 (Assessment Monitoring) contaminants. All PWSs serving greater than 100,000 people and subsets of those serving 10,001 to 100,000 and 10,000 or fewer are required to monitor for the List 2 (Screening Survey) contaminants. PWSs selected to monitor as part of the representative subsets of smaller systems will be notified in writing by their state or EPA. UCMR 2 requires four consecutive quarterly rounds of sampling at the entry points to the distribution system between 2008 and 2010.

The third cycle of the rule (UCMR 3) was published in 2012. The UCMR 3 contaminant list is divided into three sub-lists: List 1 Assessment Monitoring chemical contaminants, List 2 Screening Survey chemical contaminants and List 3 Pre-Screen Testing chemical contaminants, as presented in Table 4-12. The Assessment Monitoring chemical contaminants are those which have established analytical methods; the Screening Survey chemical contaminants are those for which analytical methods have recently been developed and the associated technologies may not be in wide use; and the Pre-Screen Testing uses newer method technologies not as commonly used by drinking water laboratories. The Assessment Monitoring contaminants include seven volatile organic compounds, one synthetic organic compound, six metals, one oxyhalide anion and six perfluorinatec compounds. The Screening Survey contaminants include seven hormones. The Pre-Screen Testing chemical contaminants include two viruses. All PWSs serving more than 10,000 people and a subset of those serving 10,000 or fewer are required to monitor for the List 1 (Assessment Monitoring) contaminants. All PWSs serving greater than 100,000 people and subsets of those serving 10,001 to 100,000 and 10,000 or fewer are required to monitor for the List 2 (Screening Survey) contaminants. A subset of those serving 1,000 people or fewer is required to monitor for the List 3 (Pre-Screening Survey) contaminants. PWSs selected to monitor as part of the representative subsets of smaller systems will be notified in writing by their state or EPA. UCMR 3 requires four consecutive quarterly rounds of sampling at the entry points to the distribution system between 2013 and 2015.

Many of the contaminants monitored under the UCMR were identified in the Information Collection Rule (ICR), which was promulgated in May 1996. The purpose of the ICR is to collect occurrence and treatment information to help evaluate the need for possible changes to the current SWTR and evaluate the need for future regulation of disinfectants and DBPs. The data were published in December 1999.

Table 4-10. UCMR 1 Monitoring List

List 1 Contaminants with sufficient analytical methods available	List 2 Contaminants with analytical method requiring further refinement	List 3 Contaminants with method under development
2,4-dinitrotoluene	2,3-diphenylhydrazine	Lead-210
2,6-dinitrotoluene	2-methyl-phenol	Polonium-210
Acetochlor	2,4-dichlorophenol	Cyanobacteria
DCPA mono-acid degradate	2,4-dinitrophenol	Echoviruses
2,2'-DDE	2,4,6-trichlorophenol	Coxsackieviruses
EPTC	Diazinon	*Helicobacter pylori*
Molinate	Disulfoton	Microsporidia
MTBE	Diuron	Caliciviruses
Nitrobenzene	Fonofos	Adenoviruses
Perchlorate	Linuron	
Terbacil	Nitrobenzene	
	Prometon	
	Terbufos	
	Aeromonas	
	Alachlor ESA	
	RDX	

Table 4-11. UCMR 2 Monitoring List

List 1 Assessment Monitoring	List 2 Screening Survey
Dimethoate Terbufos sulfone 2,2',4,4'-tetrabromodiphenyl ether (BDE-47) 2,2',4,4',5-pentabromodiphenyl ether (BDE-99) 2,2',4,4',5,5'-hexabromobiphenyl (HBB) 2,2',4,4',5,5'-hexabromodiphenyl ether (BDE-153) 2,2',4,4',6-pentabromodiphenyl ether (BDE-100) 1,3-dinitrobenzene 2,4,6-trinitrotoluene (TNT) Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	Acetochlor Alachlor Metolachlor Acetochlor ethane sulfonic acid (ESA) Acetochlor oxanilic acid (OA) Alachlor ethane sulfonic acid (ESA) Alachlor oxanilic acid (OA) Metolachlor ethane sulfonic acid (ESA) Metolachlor oxanilic acid (OA) N-nitroso-diethylamine (NDEA) N-nitroso-dimethylamine (NDMA) N-nitroso-di-n-butylamine (NDBA) N-nitroso-di-n-propylamine (NDPA) N-nitroso-methylethylamine (NMEA) N-nitroso-pyrrolidine (NPYR)

Table 4-12. UCMR 3 Monitoring List

List 1 Assessment Monitoring	List 2 Screening Survey	List 3 Pre-Screen Testing
1,2,3-trichloropropane		
1,3-butadiene		
chloromethane (methyl chloride)		
1,1-dichloroethane		
bromomethane (methyl bromide)		
chlorodifluoromethane (HCFC-22)		
bromochloromethane (halon 1011)		
1,4-dioxane	17-β-estradiol	
vanadium	17-α-ethynylestradiol (ethinyl estradiol)	
molybdenum	16-α-hydroxyestradiol (estriol)	enteroviruses
cobalt	equilin	noroviruses
strontium	estrone	
chromium[a]	testosterone	
chromium-6	4-androstene-3,17-dione	
chlorate		
perfluorooctanesulfonate acid (PFOS)		
perfluorooctanoic acid (PFOA)		
perfluorononanoic acid (PFNA)		
perfluorohexanesulfonic acid (PFHxS)		
perfluoroheptanoic acid (PFHpA)		
perfluorobutanesulfonic acid (PFBS)		

[a] *Monitoring for total chromium–in conjunction with UCMR 3 Assessment Monitoring–is required under the authority provided in Section 1445(a)(1)(A) of SDWA.*

The CDPH has also identified a number of constituents of concern. The state required monitoring of an additional nine chemical constituents, effective January 2001. Monitoring was to be completed by December 31, 2003. The chemicals were as follows: boron, chromium-6, dichlorodifluoromethane, ethlyl tertiary butyl ether, perchlorate, tertiary amyl methyl ether, tertiary butyl alcohol, 1,2,3-trichloropropane, and vanadium. CDPH has also identified a number of chemicals of "current interest," consisting of: arsenic, chromium-6, manganese, MTBE, nitrate and nitrite, NDMA and other nitrosamines, perchlorate, and 1,2,3-trichloropropane.

Also among the emerging contaminants are pharmaceuticals and personal care products, industrial chemicals present at low concentrations, and chemicals that may affect hormone status, referred to as "endocrine disruptors."

MTBE has been of particular interest to the public. The current health-based state MCL for MTBE is 13 μg/L, with a secondary standard of 5 μg/L due to taste and odor concerns. CDPH has not reported any detections of MTBE above the detection limit, 3 μg/L, in drinking water sources in Napa County.

4.3 Review of Water Quality Data

The 2007 Update presented and analyzed data collected from Lakes Hennessey and Milliken from 2001 through 2005. This Sanitary Survey update presents data collected from 2006 through 2011. The data are analyzed for effects on treatment and regulatory requirements and any degradation or improvement to water quality over the past five years.

4.3.1 Monitoring Program

Most water quality parameters are monitored weekly at the treatment plants. Weekly and monthly average values are presented for 2006 through 2011. All regulated contaminants are monitored at least once per quarter when the treatment plants are operating. Monitoring has been conducted upstream of the treatment plants since 2011. Parameters monitored are:

- temperature
- dissolved oxygen
- alkalinity
- pH
- turbidity
- hardness
- calcium
- chloride
- total dissolved solids
- conductivity
- iron
- manganese
- copper

The average values for 2011 for each creek are presented in Table 4-13. Total dissolved solids and turbidity values for each creek are graphed in Figures 4-1 and 4-2.

Table 4-13. Average of Weekly Monitoring in Conn, Sage, and Chiles Creeks in 2011

Parameter	Conn Creek	Sage Creek	Chiles Creek
Temperature, degrees C	14.8	15.2	15.5
Dissolved oxygen, mg/L	8.1	9.2	8.6
Alkalinity, mg/L	101.2	312.9	216.8
pH, units	7.7	8.4	8.1
Turbidity, NTU	6.3	2.7	2.5
Hardness, mg/L	96.5	316.0	228.7
Calcium, mg/L	44.6	93.8	72.0
Chloride, mg/L	15.7	21.4	18.9
Total dissolved solids, mg/L	195.1	507.9	384.5
Conductivity µS, cm	215.5	549.6	421.7
Iron, mg/L	0.1	0.1	0.0
Manganese, mg/L	0.0	0.3	0.0
Copper, mg/L	0.0	0.0	0.0

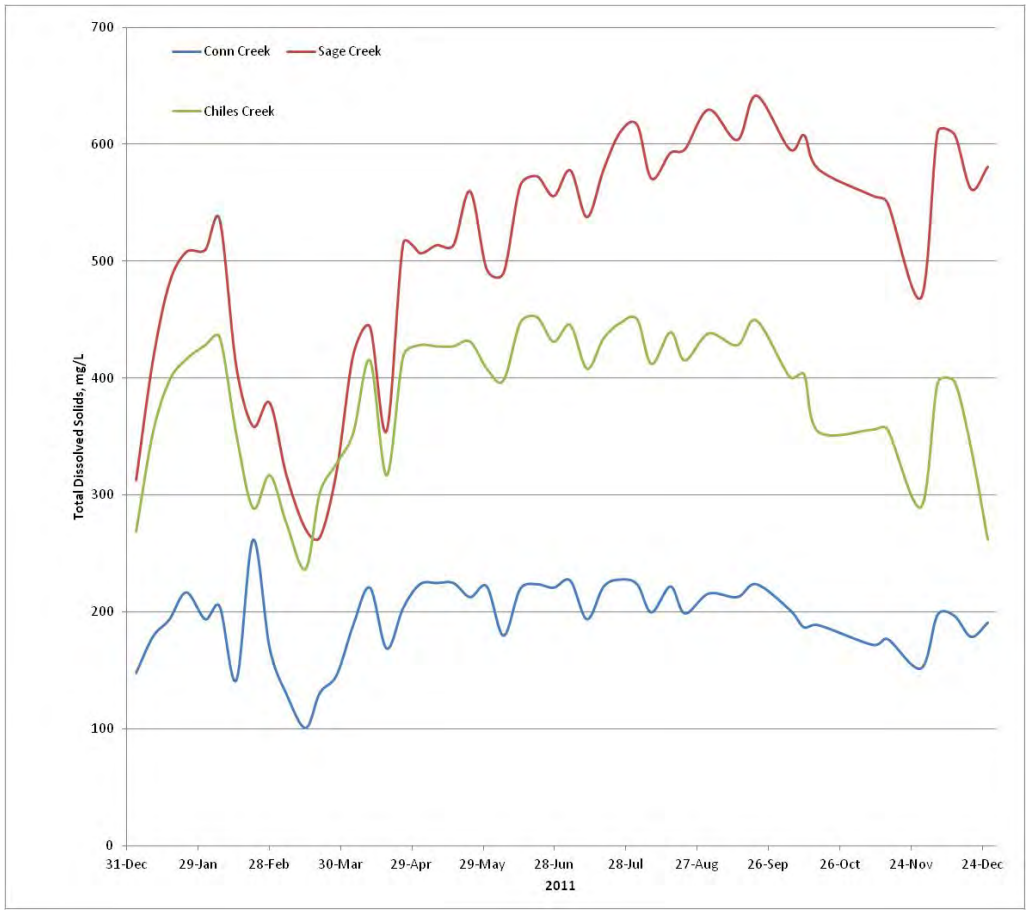


Figure 4-1. Total Dissolved Solids in Lake Hennessey Tributaries

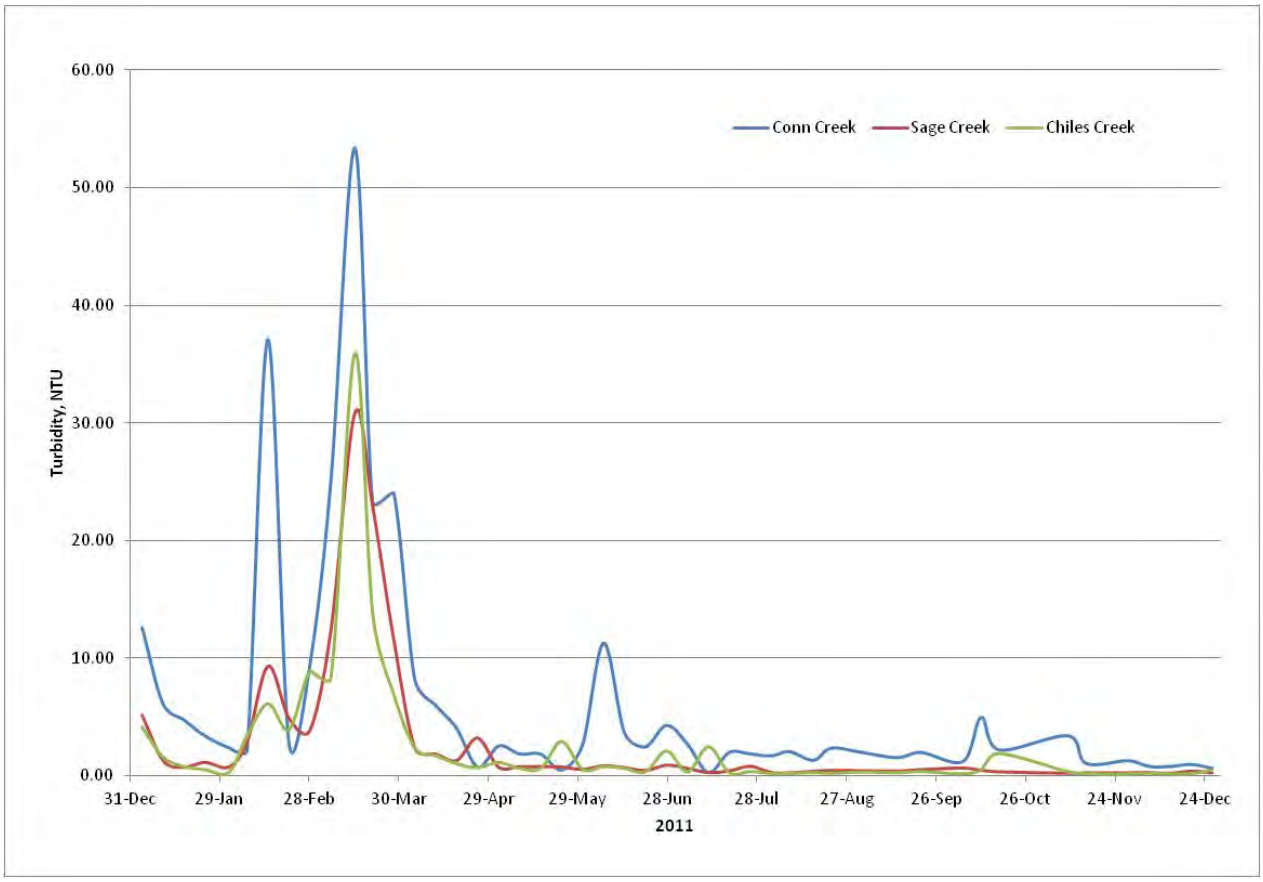
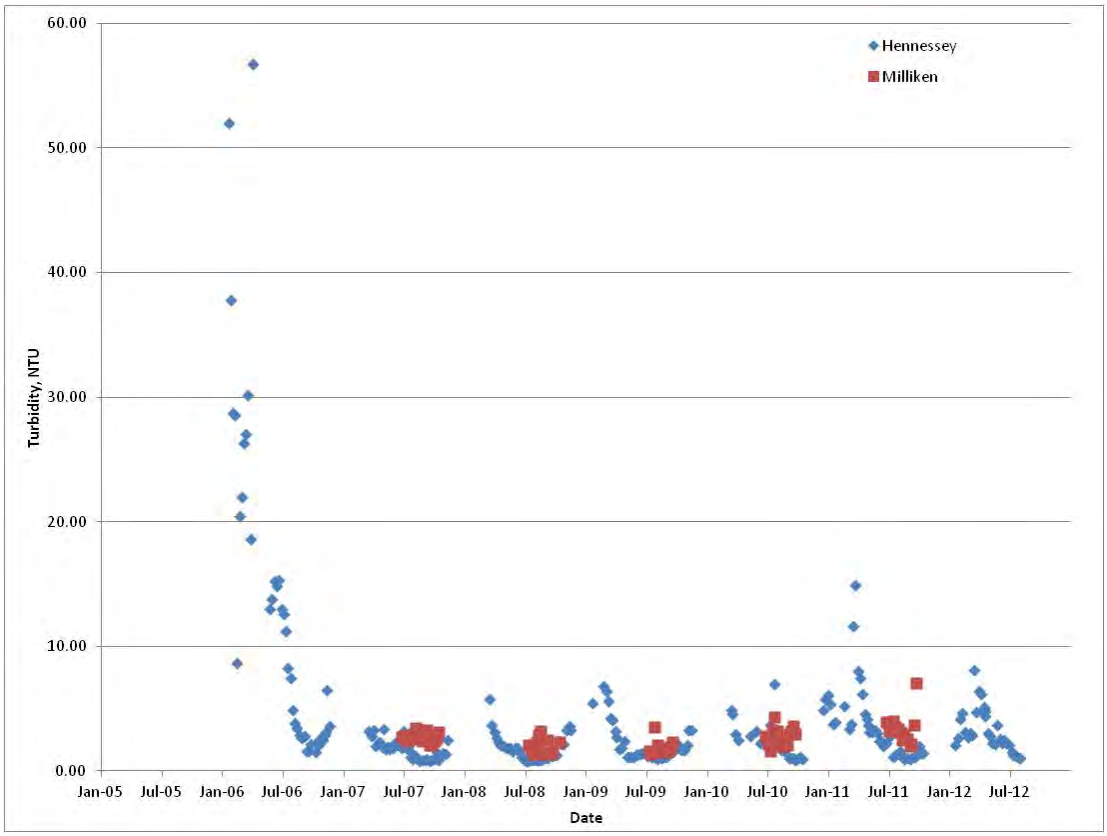


Figure 4-2. Turbidity in Lake Hennessey Tributaries

4.3.2 Raw Water Quality

Turbidity

Raw water turbidity at Hennessey and Milliken WTPs are presented on Figure 4-3. The data are from weekly grab samples during the months of operation for each plant. The turbidity at Hennessey ranged from 1 to 144 NTU and averaged 5.7 NTU (the three highest values for Lake Hennessey, ranging from 100 to 144 NTU, and each occuring in January 2006, are not graphed in Figure 4-3). The turbidity at Milliken ranged from 1 to 7 NTU and averaged 3.6 NTU. Most of the values greater than 4 NTU at Hennessey occurred during the winter months when runoff transports sediments into the lake. Milliken does not operate in the winter when raw water turbidity levels are too high to be treated effectively. While turbidity values have been decreasing at Milliken for the past decade, turbidity values for Hennessey have increased slightly, although they are still significantly less than those reported in the 1996 to 2000 data when the mean value was 11 NTU.

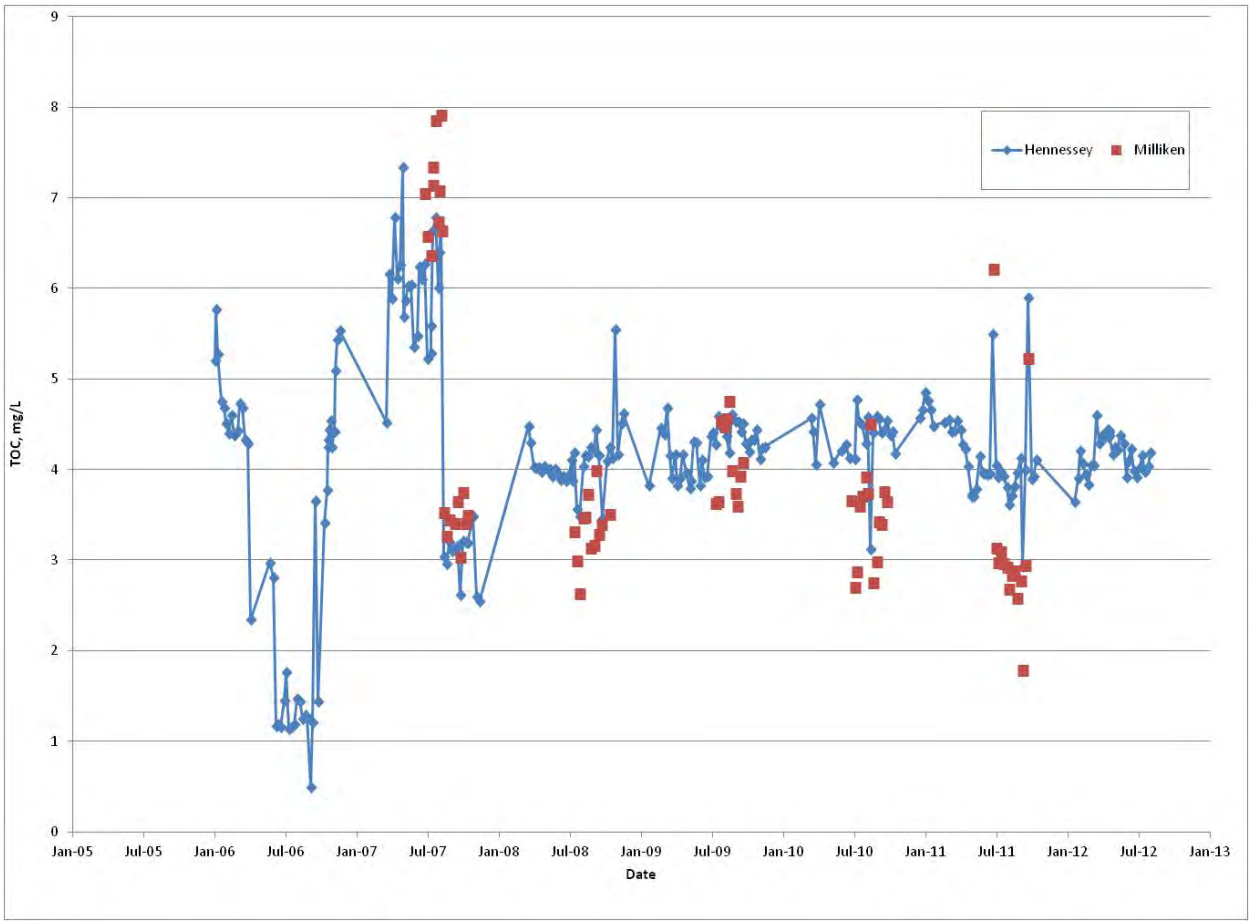


Notes: The three highest values for Lake Hennessey, ranging from 100 to 144 NTU, and each occuring in January 2006, are not graphed in Figure 4-1. Milliken data are presented for the plant's operational months: July to the second week of October.

Figure 4-3. Weekly Turbidity Values at Hennessey and Milliken Water Treatment Plants

Organic Carbon

Values of raw water total organic carbon at the Hennessey and Milliken WTPs are presented on Figure 4-4. TOC at Hennessey ranged from 0.5 to 7.3 mg/L and averaged 4.2 mg/L. TOC at Milliken ranged from 1.8 to 7.9 mg/L and averaged 4.0 mg/L. The average data for Hennessey and Milliken are lower than the values reported in the 2007 Update; the 2007 Update TOC averages for Hennessey and Milliken were 12 mg/L and 5.6 mg/L, respectively.

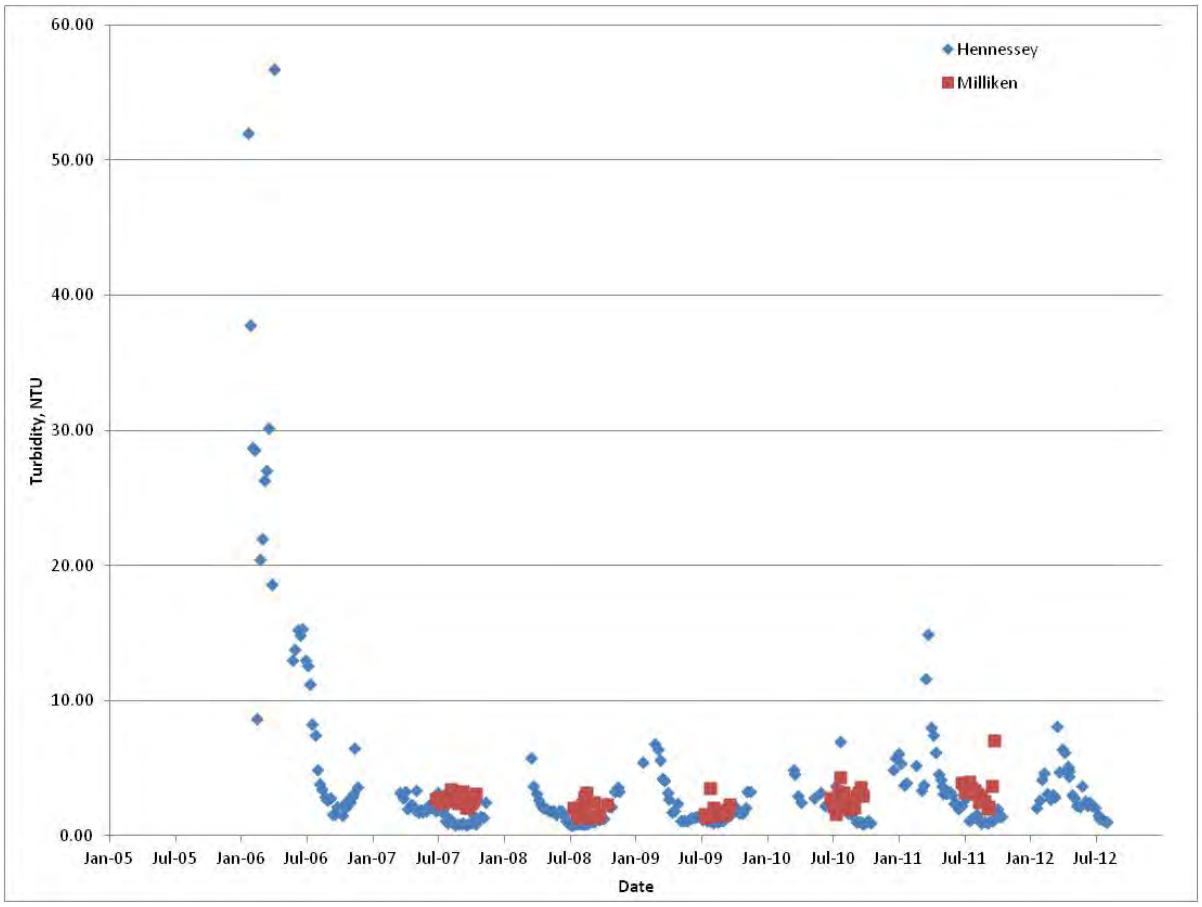


Note: Milliken data are presented for the plant's operational months: July to the second week of October.

Figure 4-4. Weekly Total Organic Carbon Values at Hennessey and Milliken Water Treatment Plants

Total Dissolved Solids

Monthly average total dissolved solids (TDS) are presented on Figure 4-5. Monthly average TDS at Hennessey ranged from 121 to 329 mg/L and averaged 226 mg/L. TDS data were only available for 2011 for Milliken, with monthly averages ranging from 54 to 66 mg/L, and the average, 62 mg/L. Values are significantly below the secondary standard for TDS of 500 mg/L and are consistent with the data reported in the 2007 Update.

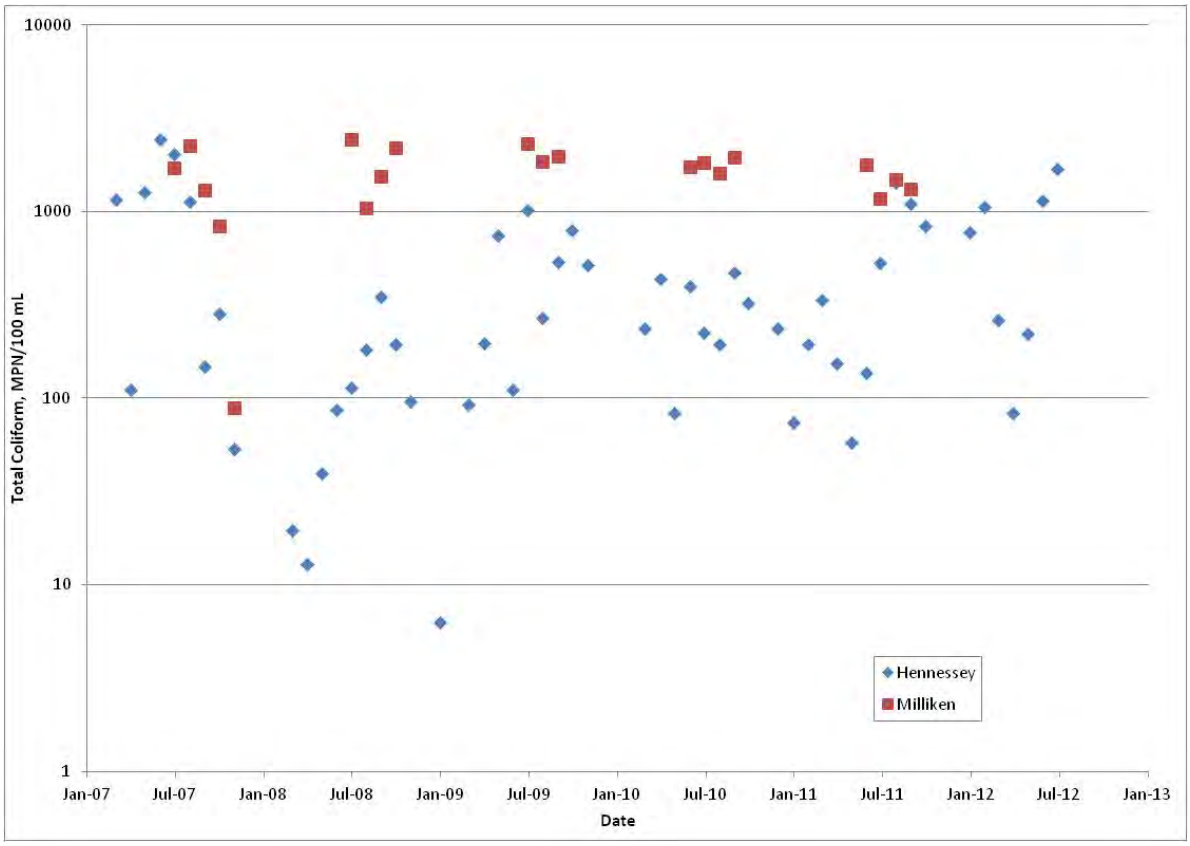


Note: Milliken data are presented for the plant's operational months: July to the second week of October.

Figure 4-5. Monthly Average Total Dissolved Solids at Hennessey and Milliken Water Treatment Plants

Microbiology

Weekly values of total coliform bacteria at Hennessey and Milliken WTPs are presented on Figure 4-6. Approximately nine months of monthly sampling of total coliform was conducted from 2007 to 2012 at Hennessey, and four months of monthly sampling was conducted from 2007 to 2011 at Milliken. Hennessey's total coliform values were generally below 1,000 MPN/100 mL, but peaked above 1,000 MPN/100 mL in four of six years of sampling. Total coliform levels at Hennessey ranged from 6 to 2,420 MPN/100 mL. Milliken's total coliform values are consistently above 1,000 MPN/100 mL, ranging from 88 to 2,420 MPN/100 mL. The median value at Hennessey was 235 MPN/100 mL compared with 1,717 MPN/100 mL at Milliken. Consistent with the three previous watershed sanitary surveys, the total coliform levels at Milliken are considerably higher than the total coliform levels at Hennessey.



Note: Milliken data are presented for the plant's operational months: July to the second week of October.

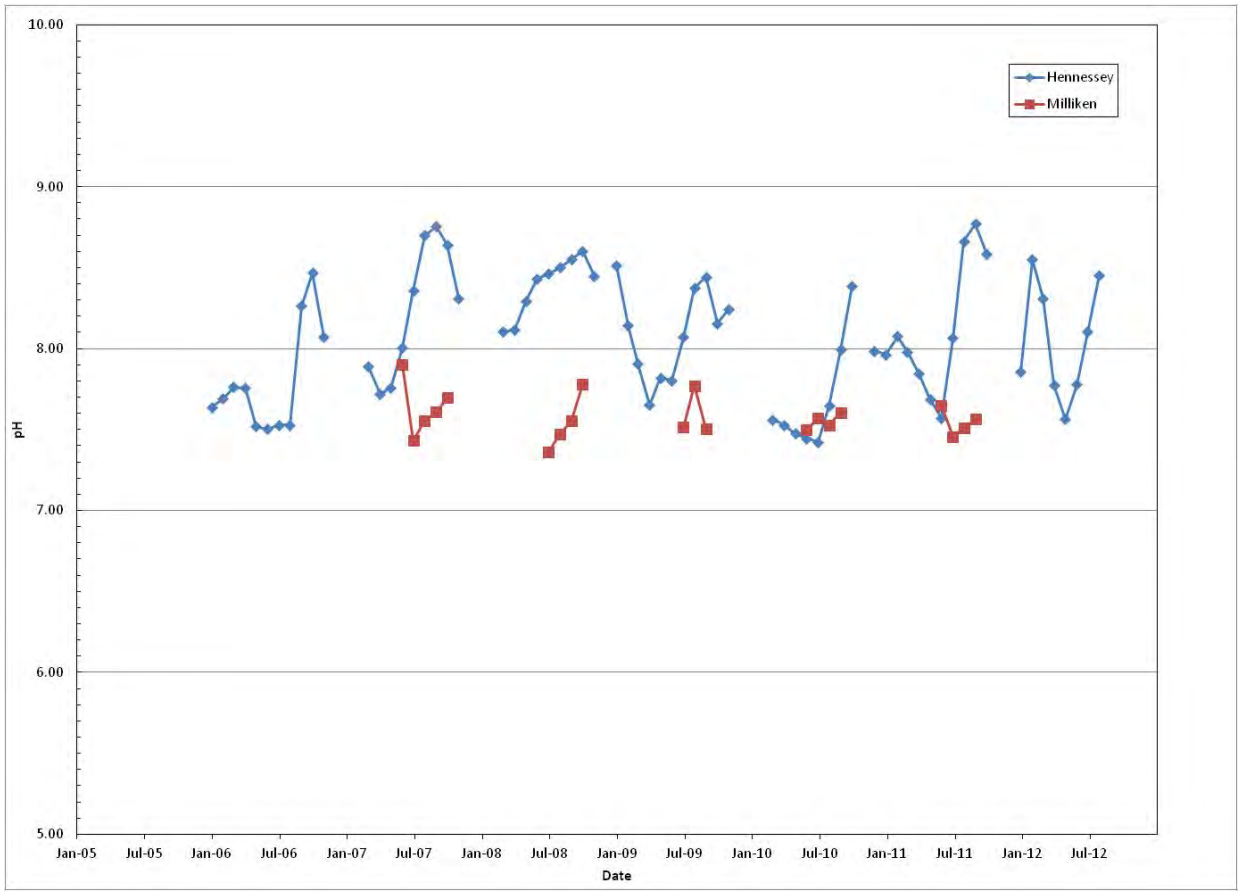
Figure 4-6. Total Coliform at Hennessey and Milliken Water Treatment Plants

Nutrients

Nutrient samples were analyzed quarterly at Hennessey from 2007 to 2011, and at Milliken from 2006 to 2011. Only ammonia was detected at either location, both in July 2008. Ammonia was detected at a concentration of 0.160 mg/L at Hennessey and 0.270 mg/L at Milliken.

pH

Monthly average pH is presented on Figure 4-7. pH is neutral ranging from 7.42 to 8.77 at Hennessey and 7.36 to 7.90 at Milliken. Peak pHs at Hennessey occur in the fall from September to November, with Milliken following a similar, if less pronounced trend. The minimum and maximum pH values at Hennessey have increased since the 2007 Update.



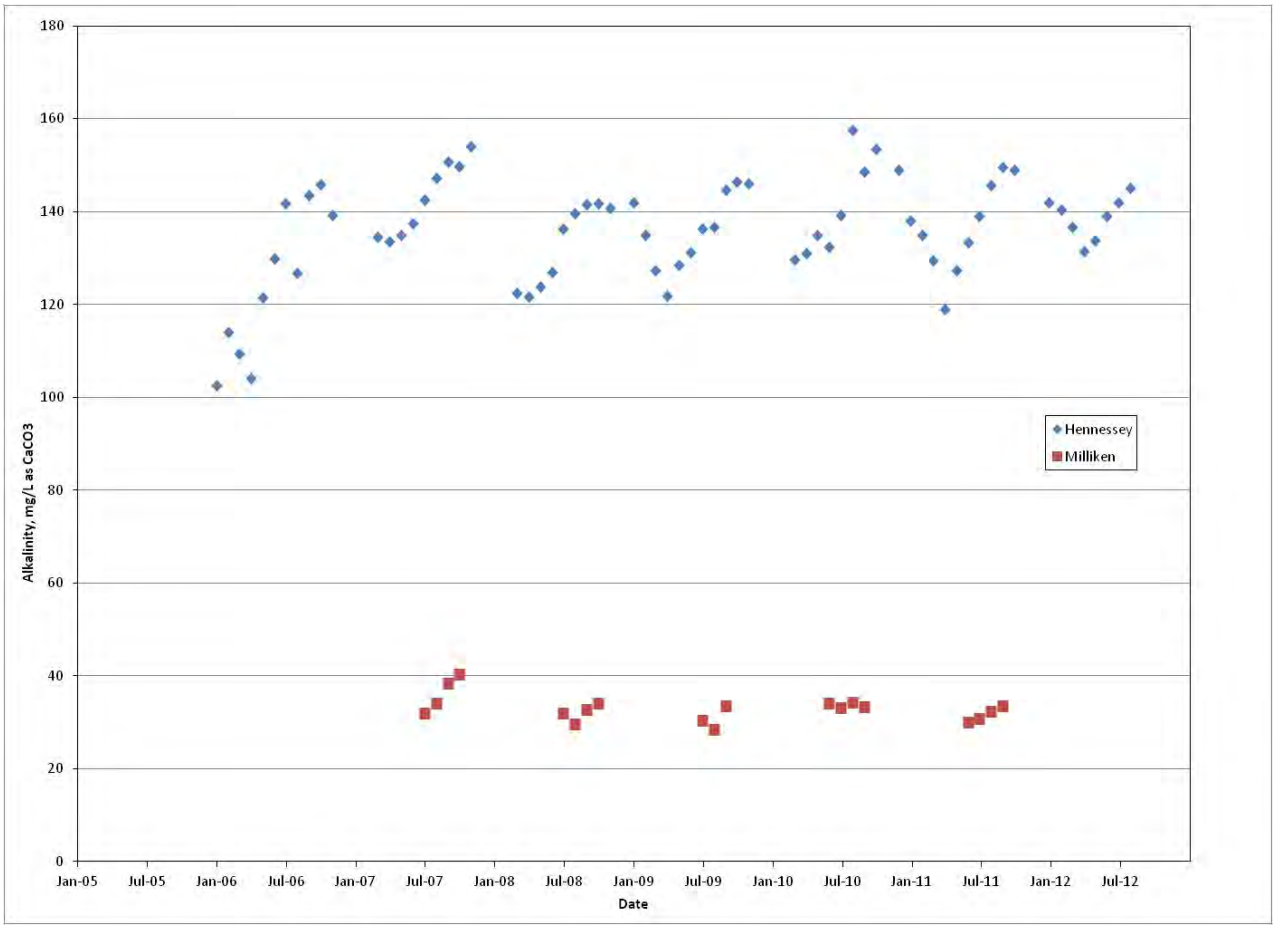
Note: Milliken data are presented for the plant's operational months: July to the second week of October.

Figure 4-7. Monthly Average pH at Hennessey and Milliken Water Treatment Plants

Alkalinity and Hardness

Monthly average alkalinity at Hennessey and Milliken WTPs are presented on Figure 4-8. Alkalinity generally increases from winter through summer. Alkalinity at Hennessey ranged from 103 to 158 mg/L as $CaCO_3$ and averaged 136 mg/L as $CaCO_3$. At Milliken, monthly average alkalinity ranged from 28 to 40 mg/L as $CaCO_3$ and averaged 33 mg/L as $CaCO_3$. The alkalinity at Hennessey and Milliken is very consistent with the 2007 Update.

Hardness at Hennessey ranged from 110 to 160 mg/L as CaCO3 and averaged 140 mg/L as CaCO3. These values indicate the water is moderately hard. Total hardness at Milliken ranged from 19 to 45 mg/L as CaCO3 and averaged 29 mg/L as CaCO3. These values indicate the raw water at Milliken is soft. Hardness values are consistent with the previous sanitary survey update.



Note: Milliken data are presented for the plant's operational months: July to the second week of October.

Figure 4-8. Monthly Average Alkalinity at Hennessey and Milliken Water Treatment Plants

Metals

Monthly average concentrations of metals were provided from the plant water quality reports. Detected concentrations are presented in Table 4-14; concentrations which exceed the EPA Secondary Standard are discussed below.

Manganese was detected at Milliken in three of six samples at 0.01 mg/L. The EPA Secondary Standard for manganese is 0.05 mg/L and the California Notification Level is 0.5 mg/L. At Hennessey, manganese was detected in 5 of 7 samples ranging from 0.03 to 0.25 mg/L with an average of 0.09 mg/L. Two concentrations at Hennessey were above the EPA secondary standard.

Iron concentrations ranged from <0.12 to 0.16 mg/L at Hennessey. The average concentration was 0.14 mg/L. The EPA Secondary Standard for iron is 0.3 mg/L. Iron concentrations are typically higher at Milliken than at Hennessey. At Milliken iron ranged from 0.23 to 0.74 mg/L with an average of 0.43 mg/L. Two iron concentrations at Milliken were greater than the Secondary Standard. There is no California Notification Level for iron.

Table 4-14. Detected Regulated Contaminants

Parameter	Milliken						Hennessey							MCL	DLR	UNITS
	07/05/06	07/16/07	07/16/08	08/05/09	07/14/10	07/06/11	07/05/06	09/06/06	07/16/07	07/09/08	08/05/09	07/14/10	07/06/11			
Inorganics																
total hardness	45	29	26	19	29	25			160	150	110	140	140			mg/L
calcium	9.6	6.2	5.3	4.4	5.8	5.2			22.0	19.0	16.0	19.0	19.0			mg/L
magnesium	5.1	3.3	3.1	2.1	3.5	2.9			25.0	24.0	18.0	23.0	23.0			mg/L
sodium	18.0	6.8	6.8	4.7	7.2	5.8	8.0	9.7	12.0	12.0	8.7	10.0	9.7			mg/L
potassium	2.9	1.7	1.9	1.4	1.5	1.4	1.2	1.4	1.7	1.7	1.6	1.5	1.5			mg/L
total alkalinity	50	32	29	30	34	30			140	130	140	130	130			mg/L
bicarbonate	50	32	29	30	41	30			140	130	140	130	130			mg/L
sulfate	10.0	32.0	2.8	2.8	2.6	2.2			18.0	18.0	17.0	16.0	14.0	250/500/600	0.5	mg/L
chloride	25.0	2.7	4.3	4.6	5.0	4.1			5.9	6.4	7.0	7.0	5.7	250/500/600		mg/L
nitrate (as NO_3)	ND	5.50	ND	ND	ND	ND			ND	ND	ND	< 2.0	ND	45.00	2.0	mg/L
fluoride	ND	ND	0.10	ND	0.12	ND			0.10	0.13	0.11	0.15	ND	2.00	0.1	mg/L
pH	6.54	7.53	7.35	7.59	7.69	7.56			8.13	8.17	8.27	7.26	7.43			units
specific conductance	178	87	83	71	91	81			310	300	320	340	290	900/1600/2200		umho/cm
TDS	121	77	80	84	85	76			190	160	180	190	170	500/1000/1500		mg/L
Turbidity	0.5	2.4	2.2	2.4	1.2	2.8			1.4	0.7	1.2	1.9	2.0	5.0		NTU
MBAS	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	< 0.5	ND	0.5		mg/L
aluminum	ND	0.20	0.18	0.019	0.093	0.25	0.12	ND	0.09	ND	ND	ND	ND	1	0.05	mg/L
arsenic	ND	ND	ND	ND	ND	ND	0.002	ND	ND	ND	ND	ND	ND	0.010	0.002	mg/L
iron	ND	0.74	0.23	0.32	ND	0.24	0.16	ND	0.12	ND	ND	ND	0.15	0.30	0.10	mg/L
lead	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND		0.005	mg/L
manganese	ND	0.010	0.011	ND	ND	0.011	0.021	0.10	0.025	ND	ND	0.053	0.25	0.050	0.02	mg/L
Organics																
simazine (princep)					0.1	0.09				ND						µg/L
Aesthetics																
Color	16	ND	ND	15	ND	ND			ND	ND	ND	5	ND	15		units
Odor	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	1	1	3	1.0	TON

Note: Blank cells indicate parameter was not sampled on that date.

Radioactivity

Radionuclides were monitored in 2007 at both Hennessey and Milliken. The samples did not detect radionuclides; therefore, the City received a 9-year waiver from sampling for radioactivity.

Other Regulated Contaminants

Each quarter that the plant is in operation the raw water is tested for regulated contaminants. Data for one quarter of 2006 through 2011 were provided. Table 4-15 presents the results for contaminants and parameters that were detected but not previously discussed in this section.

One organic compound was detected in the raw water at Milliken: simazine was detected in July of 2010 at 0.10 μg/L and in July of 2011 at 0.10 μg/L. Color exceeded the US EPA secondary standard at Milliken; it was detected at 16 units, just above the US EPA secondary standard for color of 15.

4.4 Evaluation of Ability to Meet Safe Drinking Water Act Requirements

Iron, manganese and color were the only contaminants identified as a concern in the raw water because they occasionally exceeded the secondary standards. With the current treatment technology, there are currently no concerns for the finished water not meeting the maximum contaminant levels and secondary standards in the current operation months.

The SWTR sets minimum requirements of 3-log removal and/or inactivation of *Giardia* and 4-log removal and/or inactivation of viruses for source waters which are of reasonably high quality. Levels of total coliform bacteria are used as a surrogate measure for the microbial quality of source waters. Source waters with median monthly total coliform levels exceeding 1,000 MPN/100 mL may be subject to additional *Giardia* and virus removal/activation requirements by CDPH, as presented in Table 4-3. Median monthly coliform levels for the Hennessey and Milliken WTPs are presented on Figure 4-6. Levels at both plants are greater than 1,000 MPN/100 mL in some months, therefore removal and/or inactivation requirements vary from month to month between 3-log removal of *Giardia* and 4-log removal of viruses and 4-log removal of *Giardia* and 5-log removal of viruses.

To satisfy LT2ESWTR requirements, the City conducted monthly *Cryptosporidium, Giardia,* and *E. coli* monitoring at Hennessey from April to October 2007, from April to November 2008, and March 2009. The City conducted monthly or twice monthly *Cryptosporidium* and *E. coli* monitoring from July to November 2007, and from August to October 2008. There were no detections of *Cryptosporidium* or *Giardia*. *E. coli* was detected in 7 of 16 samples at Hennessey, ranging from 1.0 to 5.2, with an average of 1.9 MPN/100 mL. *E. coli* was detected in 6 of 12 samples at Milliken, ranging from 1.0 to 22.1, with an average of 11.9 MPN/100 mL.

Although the Hennessey WTP is a conventional plant with coagulation, flocculation, sedimentation and filtration, the facilities are old and inefficient and cannot operate at the design capacity of 20 mgd for an extended period of time. At flow capacities of 17 mgd and higher, the filters have to be backwashed every two hours which is very inefficient and generates a large amount of spent backwash water for disposal. Additional backwash water could exceed the allowable discharge to the sludge ponds of 1.1 mgd. The sedimentation basin presently operates at a barely adequate level under current conditions. If raw water turbidity is further increased, these problems would be exacerbated and flow capacity would need to be reduced.

Increased recreational use can be expected to increase unauthorized recreational uses, such as body contact recreation and the non-removal of animal wastes that would result in the introduction of pathogens into the lake.

4.5 Recommended Monitoring Improvements

Two of the recommendations made in the 2007 Update, which have yet to be made, would yield key potential water quality improvements, and are repeated below.

1. A Hennessey Contaminant Load Study was recommended in both the 2001 and 2007 Updates. Although tributary monitoring takes place, several key parameters are not tested. The samples should be analyzed for TOC, total phosphorus, soluble orthophosphate, total nitrogen, ammonia, nitrate, total coliform, and fecal coliform. The combination of high TOC, a DBP precursor, and high total coliform densities requiring additional *Giardia* and virus reduction requirements in the raw water may contribute to elevated DBP concentrations in the finished water and difficulties meeting the Stage 2 D/DBP Rule requirements. A contaminant load study will help the City identify the source of nutrients leading to algae growth, TOC, and coliform bacteria in the lake. If necessary, targeted watershed management activities may then be enacted to improve the raw water quality in the lake. Samples should be collected from Conn Creek, Chiles Creek, and Sage Creek once a month during the dry season when flow in the tributaries is low. During the wet season, weekly sampling is recommended. In addition, the City should target several storm events and collect samples under storm conditions. Corresponding samples should be collected from the raw water entering the Hennessey WTP.
2. A Milliken Coliform Study would help identify the source of elevated total coliform densities in the raw water at Milliken WTP. If the coliform source is traced to cattle grazing in the upstream watershed, best management practices may be enacted to protect the stream from coliform loadings. Samples should be collected from Milliken Creek as it enters the lake, from the creek just downstream of the dam, and from the creek at the diversion dam and analyzed for total and fecal coliform and turbidity. Samples should be collected weekly during the summer months when the Milliken WTP is operating. In addition, samples should be collected weekly during two to three months of the wet season, ideally January to March, when flows in the creek are generally highest. Although the Milliken WTP does not currently have the capability to meet water quality regulations during the winter months, the winter sampling is needed to characterize the source of coliform bacteria. These data should allow the City to determine if the source of the coliform is upstream or downstream of the lake.

5. WATERSHED CONTROL AND MANAGEMENT PRACTICES

The protection of water quality in the state is primarily the responsibility of the State Water Resources Control Board (SWRCB) and the RWQCB, under both federal and state laws. With regard to land in the watershed that is privately held, implementation of existing water quality regulations is critical to protecting the watersheds. The City itself owns a considerable amount of land surrounding Lake Hennessey and Lake Milliken, and can directly control activities on this property.

5.1 City of Napa Water Division Watershed Management Practices

The City Water Division follows the best management practices required by Napa County's Construction Site Runoff Control Requirements (Napa County Department of Public Works, 2006). The roads near Lake Hennessey and Lake Milliken were constructed prior to the development of improved erosion control techniques. When they are repairing or upgrading their roads, the City follows the County's construction site runoff control requirements (Napa County, 2006).

Specific watershed management practices implemented in each watershed are described below.

5.1.1 Lake Hennessey

Of the 33,687 acres of the watershed, 2,821 acres contiguous to the reservoir are owned by the City. The City does not allow grazing in the portion of the watershed owned by the City. Recreational use of the watershed and the lake has been fairly limited; recreational use of the trails will increase in 2013. The City controls recreational use of the lake and does not allow body contact recreation. Fishing, small motorboats powered by outboard motors not exceeding 10 horsepower, rowboats, canoes, kayaks, and sailboats are allowed on the lake. There is a boat launch facility on the southeast shore of the lake. The City requires all boat operators and fishermen to obtain an annual Fish and Boating Permit from the Lake Hennessey watershed keeper. No fishing is allowed within 2000 feet of the intake tower and no fish can be cleaned or scaled in or near the lake. All boats are prevented from entering the area within 500 feet of the intake tower by ropes and buoys. The City's watershed keepers open and close the boat ramp and patrol the City property and escort unauthorized users off of City property. There is no public access to the south shore of the reservoir.

With the exception of the area along Highway 128 and Chiles Canyon Road, the City property surrounding the lake is fenced and gated to prevent access by motorized vehicles. The property is accessible to hikers, bicyclists, and dogs on leash and this use is allowed by the City. The City does not allow horseback riding or camping. Signs are posted at all of the gates on the allowable uses of the City property.

The City has two full-time employees that live on-site as caretakers at Lake Hennessey, who each spend one-quarter of their time patrolling the watershed, monitoring the boat launch, handling permits, removing brush, doing road maintenance, and removing trash.

5.1.2 Lake Milliken

Of the 6,190 acres of the watershed, 1,437 acres contiguous to the reservoir are owned by the City, and are closed to the public. The City does not allow grazing or recreational activities on City property, or recreational use of the lake, including body contact or non-body contact recreation. There are no developed recreation areas in the watershed. Most of the private property in the watershed is fenced and "No Trespassing" signs are posted along Atlas Peak Road, the only public access in the watershed. The City does not allow recreation in the portion of the watershed that they own. The City property is fenced and no trespassing signs are posted. A caretaker lives on-site at Lake Milliken, whose responsibilities include: reading the dam elevation, patrolling the watershed and doing miscellaneous activities that are required, such as brush removal, road maintenance, etc.

5.2 Recommended Control Measures

In general, the City of Napa Water Division should study the extent to which current activities are discharging contaminants into the reservoir, and should document the extent of current use of the roads/trails and the state of the roads/trails through photographs, and by maintaining a record of Watershed Incident Reports, so that a comparison can be made after the recreational trails are developed.

1. The additional recreational activities in the Lake Hennessey watershed could significantly increase the risk to the WTP. Allowing public recreational access to the City's water supply watersheds should be done in conjunction with development of a watershed management plan which evaluates the risks, plans for mitigating existing or likely water quality consequences, and develops an optimum plan for this shared use.
2. The increased usage of the recreational trails can be expected to result in increased erosion, resulting in higher turbidity and organic loading to Lake Hennessey. Evaluating changes in these parameters between the water quality data reported in this 2012 Update and that recorded over the next five years should be the focus of the subsequent watershed sanitary survey.
3. The City should document the current physical condition of the Lake Hennessey watershed in the vicinity of the planned recreational trails. Documentation should include photographs of the following areas: trail locations currently subject to erosion; sites along the shoreline that are easily accessible to recreationists or accompanying animals from the recreational trail; and, sites along the trail that are easily accessible to recreationists to use as short-cuts, detours, vistas, or other non-trail activities. The City should also record the current number of users, the types of uses, unauthorized uses, and encroachments onto maintenance roads that are not open to the public.

   Although the City currently prepares Watershed Incident Reports to record unauthorized uses of the lake or lands, an accurate depiction of the changes in use would require a consistent methodology. For example, patrolling the trail area from dawn to dusk on a weekday and a weekend during the same season and weather conditions, before and after the trails are developed.
4. The City should maintain their current practice of not allowing cattle grazing on City property in the watersheds of Lake Hennessey and Lake Milliken.
5. It is recognized that funding is a challenge, but the City should work towards establishing funds to implement a policy of purchasing privately held lands within the watershed. Gaining control of the lands is an effective method of preventing the long-term degradation of water quality.
6. The biological health of the food chain should be examined to determine if certain species can be introduced to reduce phosphorus and other constituents that support the growth of algae and coliform bacteria as well as reduce TOC.

6. CONCLUSIONS AND RECOMMENDATIONS

Watershed sanitary surveys of the Lake Hennessey and Lake Milliken watersheds have been conducted every five years since 1996 to identify the potential sources of contaminants to the Hennessey Water Treatment Plant and the Milliken Water Treatment Plant. This watershed sanitary survey update has identified few changes to land uses and potential contaminant sources from the previous watershed sanitary surveys.

Conclusions regarding the potential sources of contaminants, projected changes in the source of contaminants in the next five years, water quality compliance, and watershed management practices are presented in this section.

6.1 Conclusions

6.1.1 Potential Sources of Contaminants

The Lake Hennessey watershed is largely undeveloped. The most significant potential sources of contaminants in the watershed are the Pacific Union College Wastewater Treatment Plant, older septic tank systems, vineyards, grazing, spills of hazardous materials along Highway 128 near the lake, wildfires, and erosion from the City's maintenance roads around Lake Hennessey. The Lake Milliken watershed is undeveloped, and contains few potential contaminants sources, the most significant of which are grazing animals, wild animals, wildfires, and erosion from the City's maintenance roads around Lake Milliken. Tables 6-1 and 6-2 provide a summary of the relative significance of the potential contaminant sources for each watershed.

Table 6-1. Significance of Potential Contaminant Sources in the Lake Hennessey Watershed

Potential Contaminant Source	Potential to Impact Water Quality	Comments
Wastewater Treatment Facilities/Reclaimed Water Use	Medium	The most potential to adversely affect water quality is in winter months when storage capacity can be exceeded or plant flooded. Accidental spills during the dry season may reach lake if spill is large.
Septic Systems	Medium	Old and failing septic tanks near Conn Creek and elsewhere may be contributing contaminants to the lake because of small lot sizes and fractured soils. The extent of the problem is not easily quantified.
Urban Runoff	Low	The watershed is relatively undeveloped.
Recreational Use	Medium	Existing level of usage is low and body contact recreation is not allowed in the lake; however, the increased usage of the land near the lake by hikers, equestrians, and bicyclists will greatly increase the level of use.
Agricultural Crop Land Use	Medium	Drainage from vineyards may be a source of nutrients, and conversion to vineyards continues, although at a relatively slow pace.
Pesticide/Herbicide Use	Low	Pesticides and herbicides are primarily used on vineyards, and the types used on vineyards do not adversely affect water quality. Pesticide use has decreased by half since the 2007 Update.
Grazing Animals	Low	Direct access to creeks is a concern, however the number of cattle are low compared to the size of the watershed.

Table 6-1. Significance of Potential Contaminant Sources in the Lake Hennessey Watershed

Potential Contaminant Source	Potential to Impact Water Quality	Comments
Wild Animals	Low	Compared to other sources in the watershed, wild animals are likely an insignificant source of contaminants.
Hazardous Materials Storage	Low	All of the tanks have containment structures.
Hazardous Materials Spills and Traffic Accidents	Low/Medium	Because of the proximity of Highway 128 to the lake, a hazardous materials spill could be catastrophic.
Unauthorized Activity	Low/Medium	There is little unauthorized use of City property, or illegal dumping, due to the vigilance of City staff; this is also expected to change with the increased recreational usage.
Fires	Medium	The watershed is ranked as a high fire hazard area. A large fire could have a severe and lasting impact on water quality.
Geologic Hazards	Medium	The City maintenance roads are contributing considerable sediment to the lake. There is a low probability of occurrence of an earthquake. A landslide in Sage Canyon could have immediate short-term impact on water quality but not long-term impacts.
Water Treatment Plant Discharge	Low	The discharge from the sludge basins is low volume and located one mile from the intake.

Table 6-2. Significance of Potential Contaminant Sources in the Lake Milliken Watershed

Potential Contaminant Source	Potential to Impact Water Quality	Comments
Septic Systems	Low	There are few septic tanks in the watershed, and none are near the intake to the Milliken WTP.
Recreational Use	Low	Existing level of usage is low and body contact recreation is not allowed in the lake.
Agricultural Crop Land Use	Medium	Although drainage from vineyards may be a source of nutrients, most vineyards are located a significant distance from the intake, and there is no evidence of water quality impacts.
Pesticide/Herbicide Use	Low	Pesticides and herbicides are primarily used on vineyards, and the types used on vineyards do not adversely affect water quality.
Grazing Animals	Low	There is no grazing around the lake, but there is cattle grazing upstream of the lake. Milliken Creek flows through pasture and the animals have direct access to the creek.
Wild Animals	Low/Medium	Because of the undeveloped nature of the watershed, wild animals, including birds may be the most significant source of microbial contaminants.
Hazardous Materials Storage	Low	The Circle S Ranch tanks have containment structures.
Hazardous Materials Spills and Traffic Accidents	Low/Medium	Because of the distance of Atlas Peak Road to the lake, and the light traffic on this deadend road, a hazardous materials spill is unlikely, and would likely be contained before reaching the lake.
Unauthorized Activity	Low	There is little unauthorized use of City property, or illegal dumping, due to the vigilance of City staff and the remoteness of the watershed.
Fires	Medium	The watershed is ranked as a high fire hazard area. A large fire could have severe and lasting impact on water quality.
Geologic Hazards	Medium	The City maintenance roads are contributing considerable sediment to the lake. There is a low probability of occurrence of an earthquake or landslide.

6.1.2 Water Quality Compliance and Concerns

Overall, the water quality data results are similar to that presented in the previous City of Napa watershed sanitary surveys. However, the increase in recreational use in the Lake Hennessey watershed that has been approved by the City of Napa is anticipated to have a measurable impact on the influent water quality monitoring data. In particular, the increased usage of the recreational trails, by hikers, bicyclists, dogs, and horses, can be expected to result in increased erosion, resulting in higher turbidity and organic loading to Lake Hennessey.

Increased raw water turbidity levels are a particular concern because, although the Hennessey WTP is a fully conventional treatment plant, the facilities are old and inefficient and cannot operate at the design capacity of 20 mgd for an extended period of time. At flow capacities of 17 mgd and higher, the filters have to be backwashed every two hours which is very inefficient and generates a large amount of spent backwash water for disposal. Addditional backwash water could exceed the allowable discharge to the sludge ponds of 1.1 mgd. The sedimentation basin currently operates at a barely adequate level under current conditions. If raw water turbidity is further increased, these problems would be exacerbated and flow capacity would need to be reduced.

The Milliken WTP is also an older treatment plant that would have great difficulty treating higher levels of turbidity that might result if trails are developed in the Milliken watershed. The Milliken WTP is a direct filtration plant without the benefit of solids sedimentation ahead of the filters. Any additional raw water turbidity with associated increase in coagulant chemical dosages would increase the solids loading directly on the filters and cause shorter filter runs and potential filtered water quality deterioration. The filters are especially vulnerable because they are pressure filters.

The water quality monitoring conducted on the raw water supplies for the Hennessey WTP and the Milliken WTP show that the primary maximum contaminant levels (MCLs) are not exceeded in the untreated water. The concentrations of iron, manganese, turbidity, and color in the untreated water occasionally exceed the secondary MCLs. All treated water is below the MCL.

The five-year average total organic carbon (TOC) concentrations in for the Hennessey WTP reported in the 2007 Update were exceedingly high: 12 mg/L. The 2001-2005 average for the Milliken WTP was 5-6 mg/L. The 2006-2012 averages are 4.2 mg/L for the Hennessey WTP, and 4.0 mg/L for the Milliken WTP.

With regard to pathogen removal requirements, the total coliform densities are consistent with the data presented in the three previous watershed sanitary surveys. Monthly median total coliform densities at Milliken are usually greater than 1,000 most probable number (MPN)/100 milliliter (mL) and at Hennessey are occasionally greater than 1,000 MPN/100 mL. Therefore, removal/reduction requirements vary between 3-log *Giardia* and 4-log virus and 4-log *Giardia* and 5-log virus reduction/inactivation.

6.1.3 Watershed Control and Management Practices

Historically, the City's ownership of large amounts of land in each watershed has enabled them to limit and control activities near the lakes. However, the increasing interest by recreational groups, both local and regional, in accessing the City's drinking water supply watersheds has recently led to the approval of trail development in the Lake Hennessey watershed. The prohibition against grazing and the previously extremely limited recreational use of the watershed has enabled the City to manage the properties with limited resources. The expansion of recreational uses within the watershed, adjacent to Lake Hennessey, may demand a commensurate increase in management of the watershed from the low level that has been conducted by the City up to this time. Currently, the City has the equivalent of one half-time staff patrolling the Lake Hennessey watershed.

In recent years, an increased interest in organic farming, combined with a State Water Resources Control Board focus on nonpoint sources, and specifically, agricultural sources of contamination, has resulted in significant changes in agricultural practices in the watersheds, including a decreased use of pesticides and herbicides. These trends have continued, resulting in 1 million fewer pounds, a 50 percent decrease, of pestcides being applied in Napa County from 2005 to 2010. The number and acreage of organic farms have doubled from 2006 to 2011. These trends are expected to continue.

6.2 Recommendations

In general, the City of Napa Water Division should study the extent to which current activities are discharging contaminants into the reservoir, and should document the extent of current use of the roads/trails and the state of the roads/trails through photographs, and by maintaining a record of Watershed Incident Reports, so that a comparison can be made after the recreational trails are developed.

1. The additional recreational activities in the Lake Hennessey watershed could significantly increase the risk to the WTP. Allowing public recreational access to the City's water supply watersheds should be done in conjunction with development of a watershed management plan which evaluates the risks, plans for mitigating existing or likely water quality consequences, and develops an optimum plan for this shared use.
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3. The City should document the current physical condition of the Lake Hennessey watershed in the vicinity of the planned recreational trails. Documentation should include photographs of the following areas: trail locations currently subject to erosion; sites along the shoreline that are easily accessible to recreationists or accompanying animals from the recreational trail; and, sites along the trail that are easily accessible to recreationists to use as short-cuts, detours, vistas, or other non-trail activities. The City should also record the current number of users, the types of uses, unauthorized uses, and encroachments onto maintenance roads that are not open to the public.

   Although the City currently prepares Watershed Incident Reports to record unauthorized uses of the lake or lands, an accurate depiction of the changes in use would require a consistent methodology. For example, patrolling the trail area from dawn to dusk on a weekday and a weekend during the same season and weather conditions, before and after the trails are developed.
4. The City should maintain their current practice of not allowing cattle grazing on City property in the watersheds of Lake Hennessey and Lake Milliken.
5. It is recognized that funding is a challenge, but the City should work towards establishing funds to implement a policy of purchasing privately held lands within the watershed. Gaining control of the lands is an effective method of preventing the long-term degradation of water quality.
6. The biological health of the food chain should be examined to determine if certain species can be introduced to reduce phosphorus and other constituents that support the growth of algae and coliform bacteria as well as reduce TOC.
7. A Hennessey Contaminant Load Study was recommended in both the 2001 and 2007 Updates. Although tributary monitoring takes place, several key parameters are not tested. The samples should be analyzed for TOC, total phosphorus, soluble orthophosphate, total nitrogen, ammonia, nitrate, total coliform, and fecal coliform. The combination of high TOC, a disinfection by-product (DBP) precursor, and high total coliform densities requiring additional *Giardia* and virus reduction requirements in the raw water may contribute to elevated DBP concentrations in the finished water and difficulties meeting the Stage 2 Disinfectants/Disinfection By-Products (D/DBP) Rule requirements. A contaminant load study will help the City identify the source of nutrients leading to algae growth, TOC, and coliform bacteria in the lake. If

necessary, targeted watershed management activities may then be enacted to improve the raw water quality in the lake. Samples should be collected from Conn Creek, Chiles Creek, and Sage Creek once a month during the dry season when flow in the tributaries is low. During the wet season, weekly sampling is recommended. In addition, the City should target several storm events and collect samples under storm conditions. Corresponding samples should be collected from the raw water entering the Hennessey WTP.

8. A Milliken Coliform Study would help identify the source of elevated total coliform densities in the raw water at Milliken WTP. If the coliform source is traced to cattle grazing in the upstream watershed, best management practices may be enacted to protect the stream from coliform loadings. Samples should be collected from Milliken Creek as it enters the lake, from the creek just downstream of the dam, and from the creek at the diversion dam and analyzed for total and fecal coliform and turbidity. Samples should be collected weekly during the summer months when the Milliken WTP is operating. In addition, samples should be collected weekly during two to three months of the wet season, ideally January to March, when flows in the creek are generally highest. Although the Milliken WTP does not currently have the capability to meet water quality regulations during the winter months, the winter sampling is needed to characterize the source of coliform bacteria. These data should allow the City to determine if the source of the coliform is upstream or downstream of the lake.

7. REFERENCES

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Personal Communication. Mr. Brian Bordona, Supervising Planner, Napa County Department of Conservation, Development and Planning, September 2012.

Personal Communication. Mr. Doug Calhoun, Napa County Public Works Department, November 2012.

Personal Communication.Mr. John Cooledge, Napa County Agricultural Commissioner's Office, November 2012.

Personal Communication. Ms. Erin Farnand, Water Quality Manager, City of Napa Water Division, August and September 2012.

Personal Communication. Mr. Bill Johnson, San Francisco Regional Water Quality Control Board, September 2012.

Personal Communication. Mr. Tom Knecht, CalFire/Napa County Fire Department, November 2012.

Personal Communication. Mr. Rick Marshall, Napa County Public Works Department, September 2012.

Personal Communication. Mr. Sheldon Sapoznik, Napa County Environmental Management Department, September 2012.

Personal Communication. Mr. Jim Newman, Napa County Environmental Management Department, September 2012.

Personal Communication. Ms. Leigh Sharp, Napa County Resource Conservation District, November 2012.

Personal Communication. Ms. Dee Swanhuyser, North Bay Trail Director, Bay Area Ridge Trail Council, May 2007 and July 2012.

Personal Communication. Mr. Dale Withers, Supervisor of Plant Services, Pacific Union College, May and September 2012.

Personal Communication. Mr. John Woodbury, Napa County Regional Park and Open Space District, September 2012.

Personal Communication. Mr. Ken Wright, Watershed Supervisor, City of Napa Water Division, August and September 2012.

8. LIMITATIONS

Report Limitations

This document was prepared solely for the City of Napa (City) in accordance with professional standards at the time the services were performed and in accordance with the contract between the City and Brown and Caldwell dated August 6, 2012. This document is governed by the specific scope of work authorized by the City; 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 the City and other parties and, unless otherwise expressly indicated, have made no independent investigation as to the validity, completeness, or accuracy of such information.

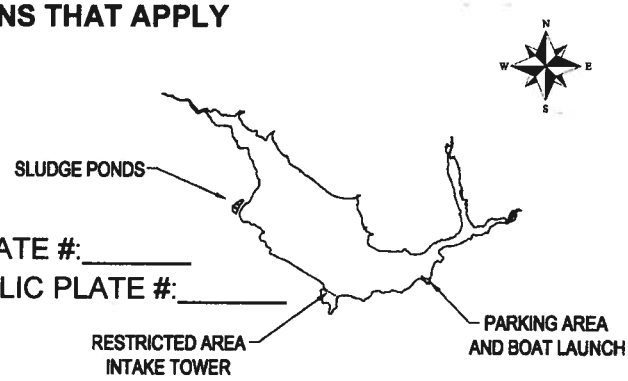
APPENDIX A: WATERSHED INCIDENT REPORT

WATERSHED INCIDENT REPORT

NAME OF REPORT TAKER:_____

DATE:_____ TIME:_____ am/ pm TEMPERATURE:_____
NAME OF PERSONS INVOLVED:_____
NUMBER OF PERSONS:___

CIRCLE THE FOLLOWING VIOLATIONS THAT APPLY



CONTACT WITH WATER BODILY / DOG N/A
HIKER DOG N/A
LITTERING YES N/A
BICYCLE YES N/A
MOTOR VEHICLE MAKE:_____ MODEL:_____LIC PLATE #:_____
WATERCRAFT MAKE:_____ MODEL:_____LIC PLATE #:_____
WATERCRAFT SIZE IN (hP) 10 & UNDER ABOVE 10
PERMIT STICKER #:_____
DESCRIPTION_____

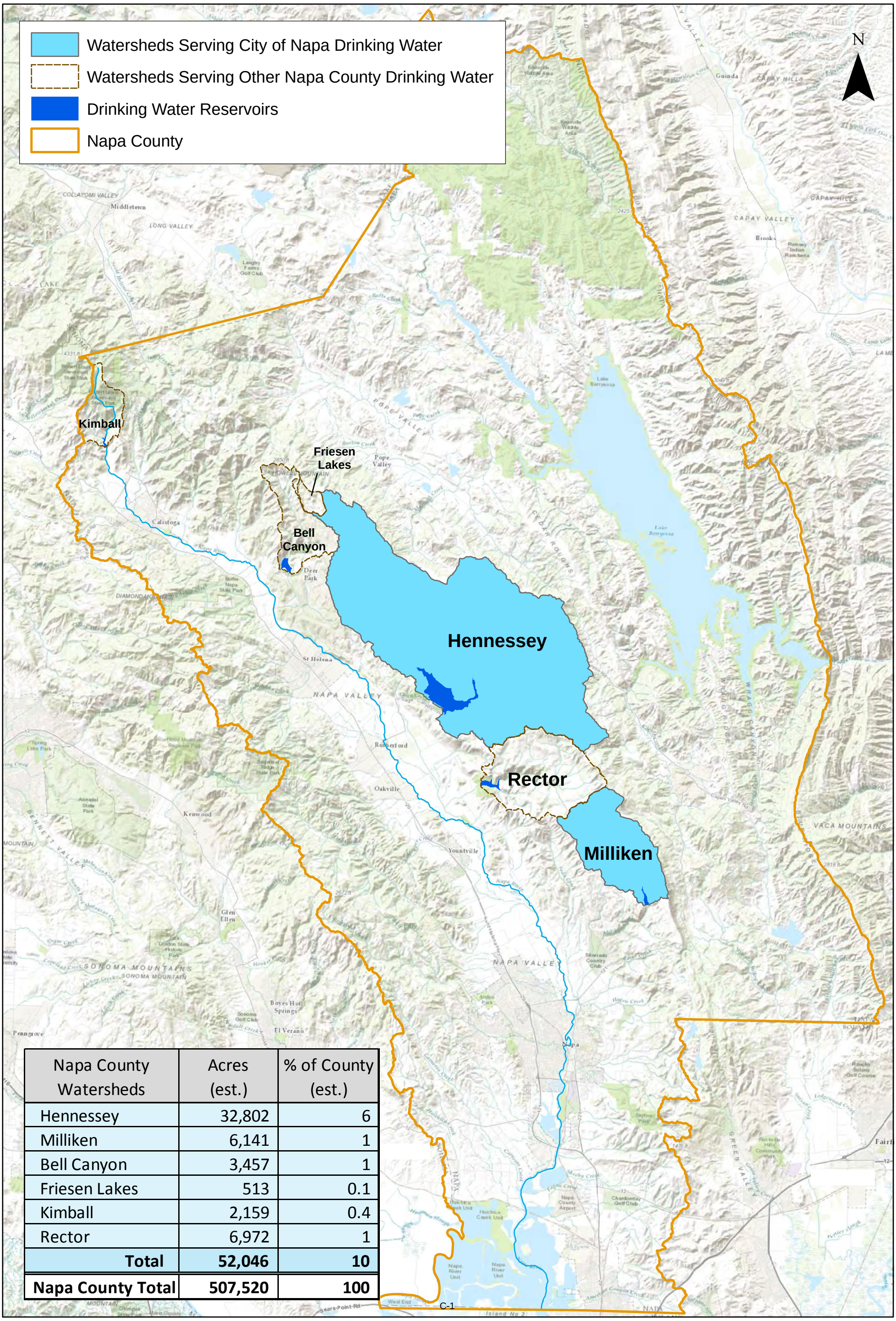
_____

12.16.030 -Unlawful activities designated: YOU ARE CITED FOR VIOLATION OF COUNTY ORDINANCE NO 1157 § 1, 1999: prior code § 9002
12.16.040- Boat operation-Fishing and boating permit: YOU ARE CITED FOR VIOLATION OF COUNTY ORDINANCE NO 1157 §§2, 3,, 1999; Ord. 719 § 1, 1982: prior code § 9003

C. Exhibit C Map of Existing and Potential Land Use In Hennessey and Milliken Watersheds

(Pages C1-C3)

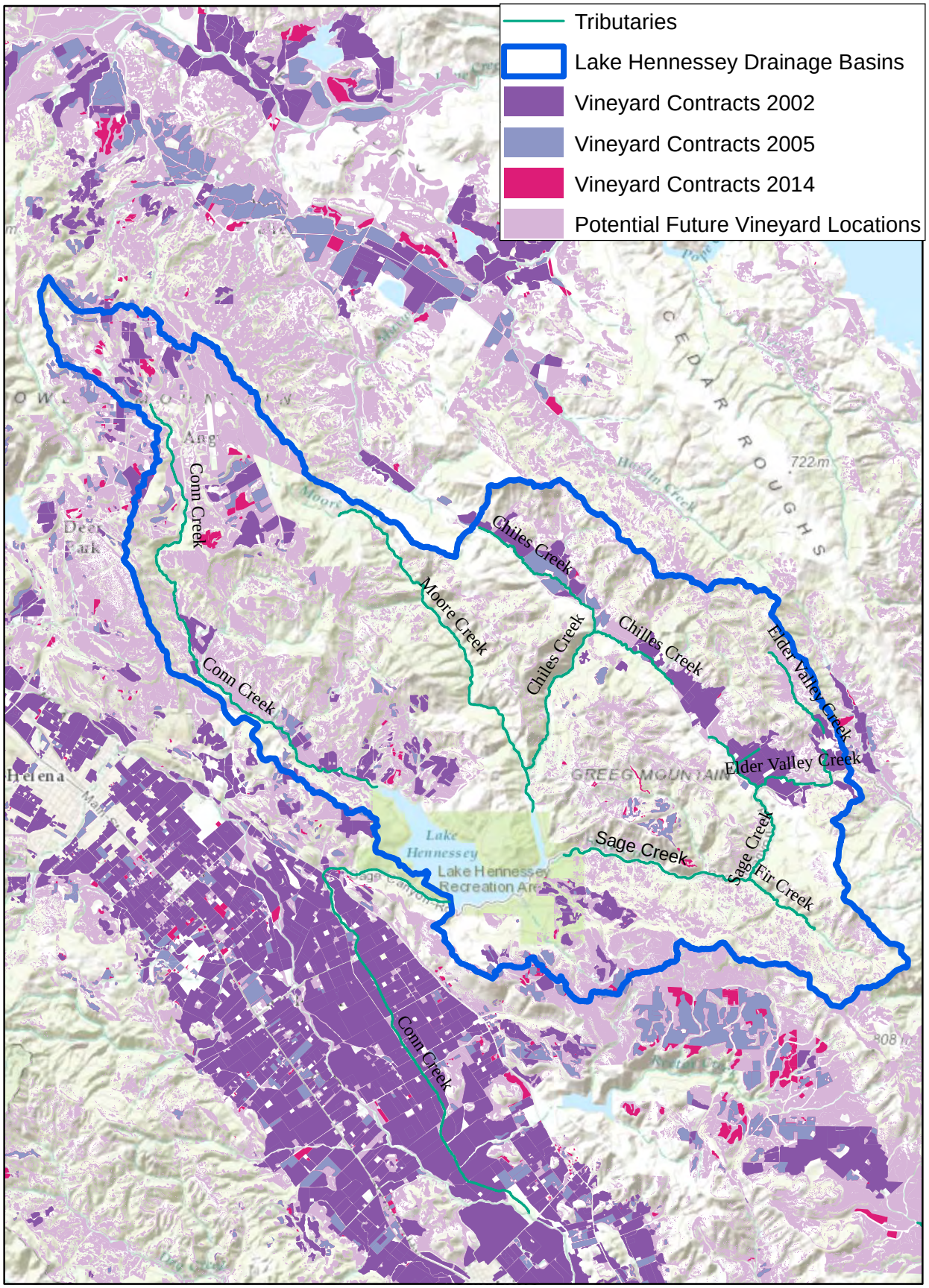
Napa County Drinking Water Supply Watersheds



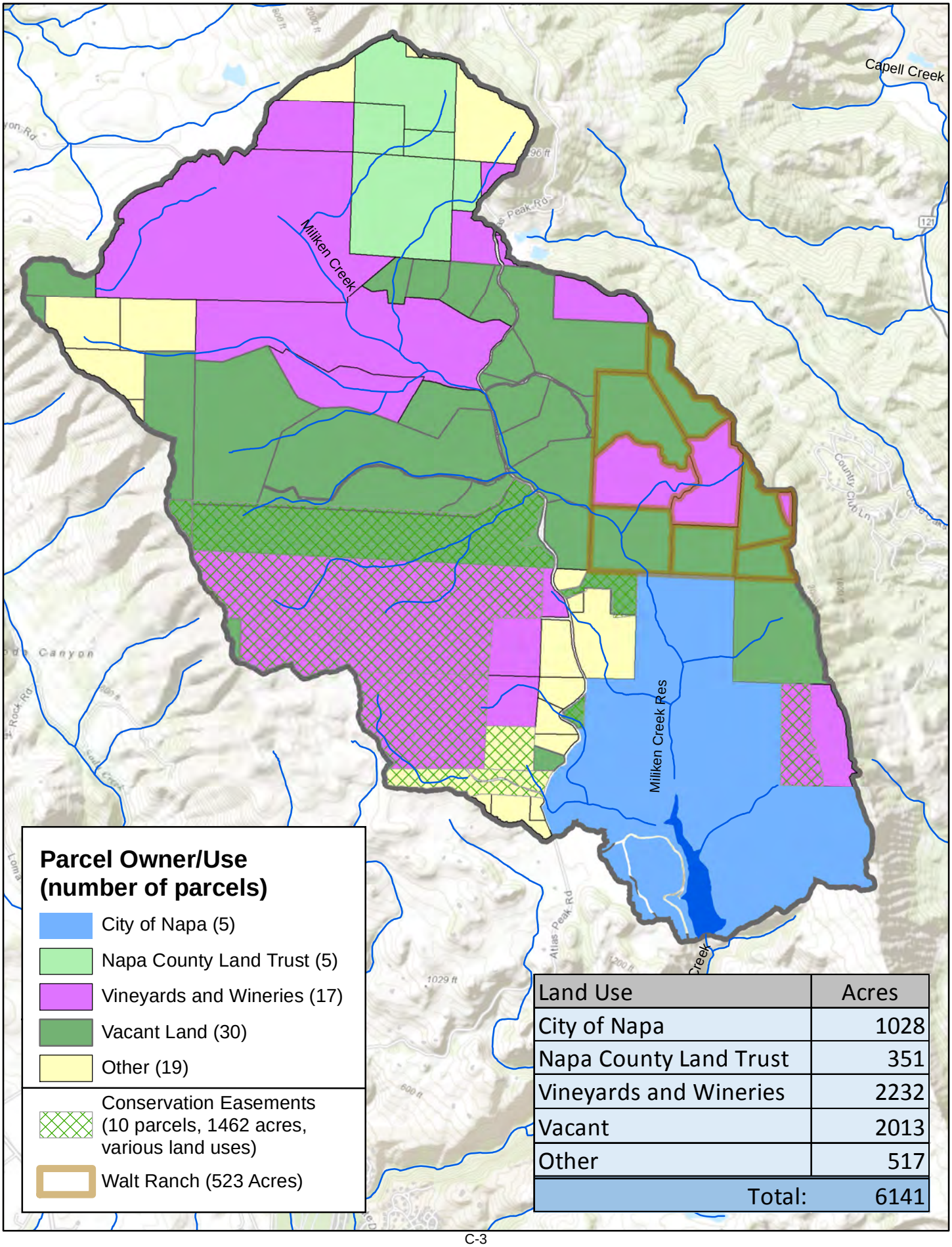
Napa County Watersheds	Acres (est.)	% of County (est.)
Hennessey	32,802	6
Milliken	6,141	1
Bell Canyon	3,457	1
Friesen Lakes	513	0.1
Kimball	2,159	0.4
Rector	6,972	1
Total	**52,046**	**10**
Napa County Total	**507,520**	**100**

Existing and Potential Vineyards

Lake Hennessey Drainage Basin



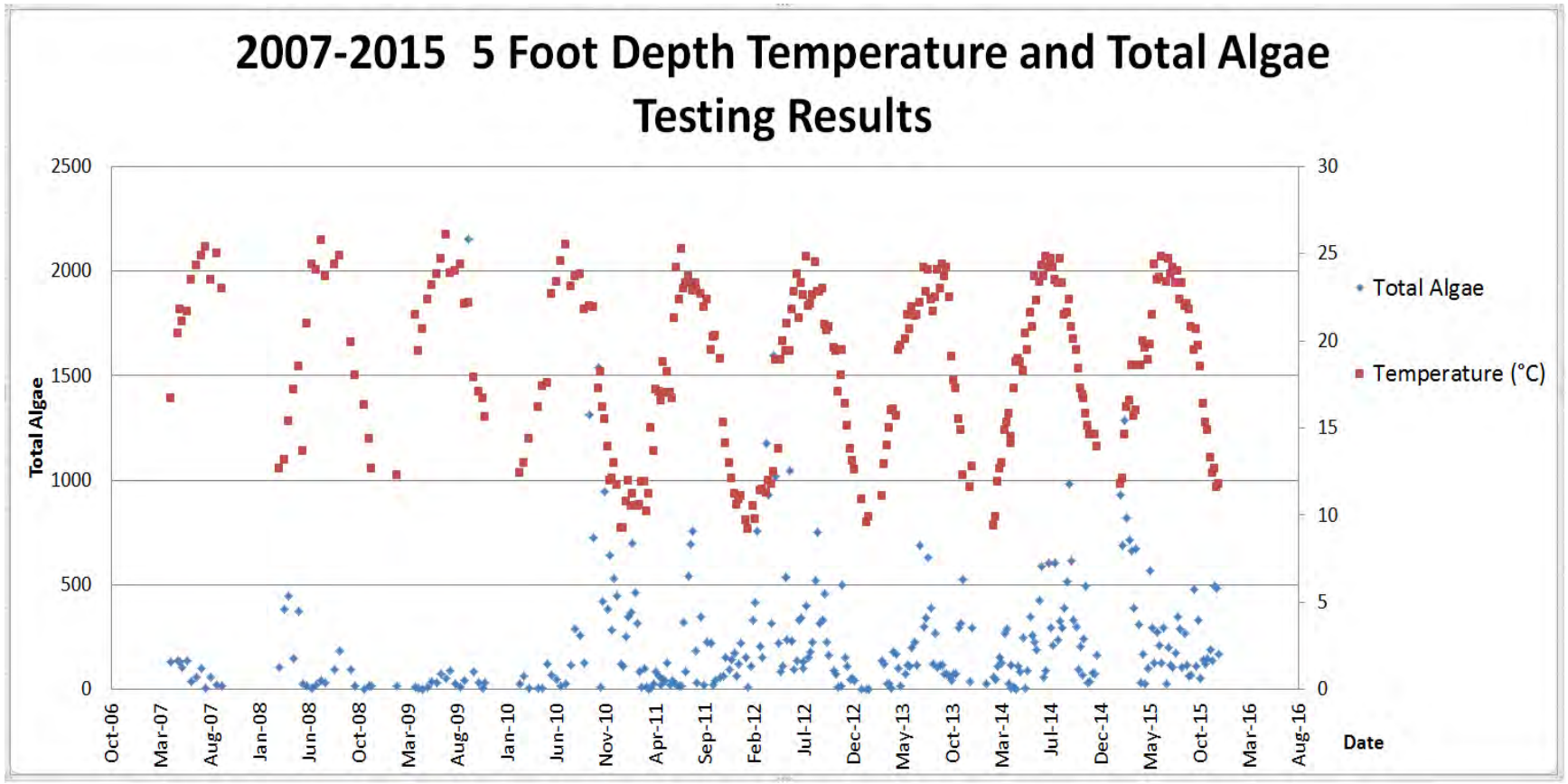
Lake Milliken Watershed Land Use



Land Use	Acres
City of Napa	1028
Napa County Land Trust	351
Vineyards and Wineries	2232
Vacant	2013
Other	517
Total:	6141

Exhibit D Graphs of Algae versus Temperature and Algae by Species

(Pages D1-D2)


2007-2015 5 Foot Depth Temperature and Total Algae Testing Results
Total Algae
2500
2000
1500
1000
500
0
30
25
20
15
10
5
0
Oct-06
Mar-07
Aug-07
Jan-08
Jun-08
Oct-08
Mar-09
Aug-09
Jan-10
Jun-10
Nov-10
Apr-11
Sep-11
Feb-12
Jul-12
Dec-12
May-13
Oct-13
Mar-14
Jul-14
Dec-14
May-15
Oct-15
Mar-16
Aug-16
Date
Total Algae
Temperature (°C)

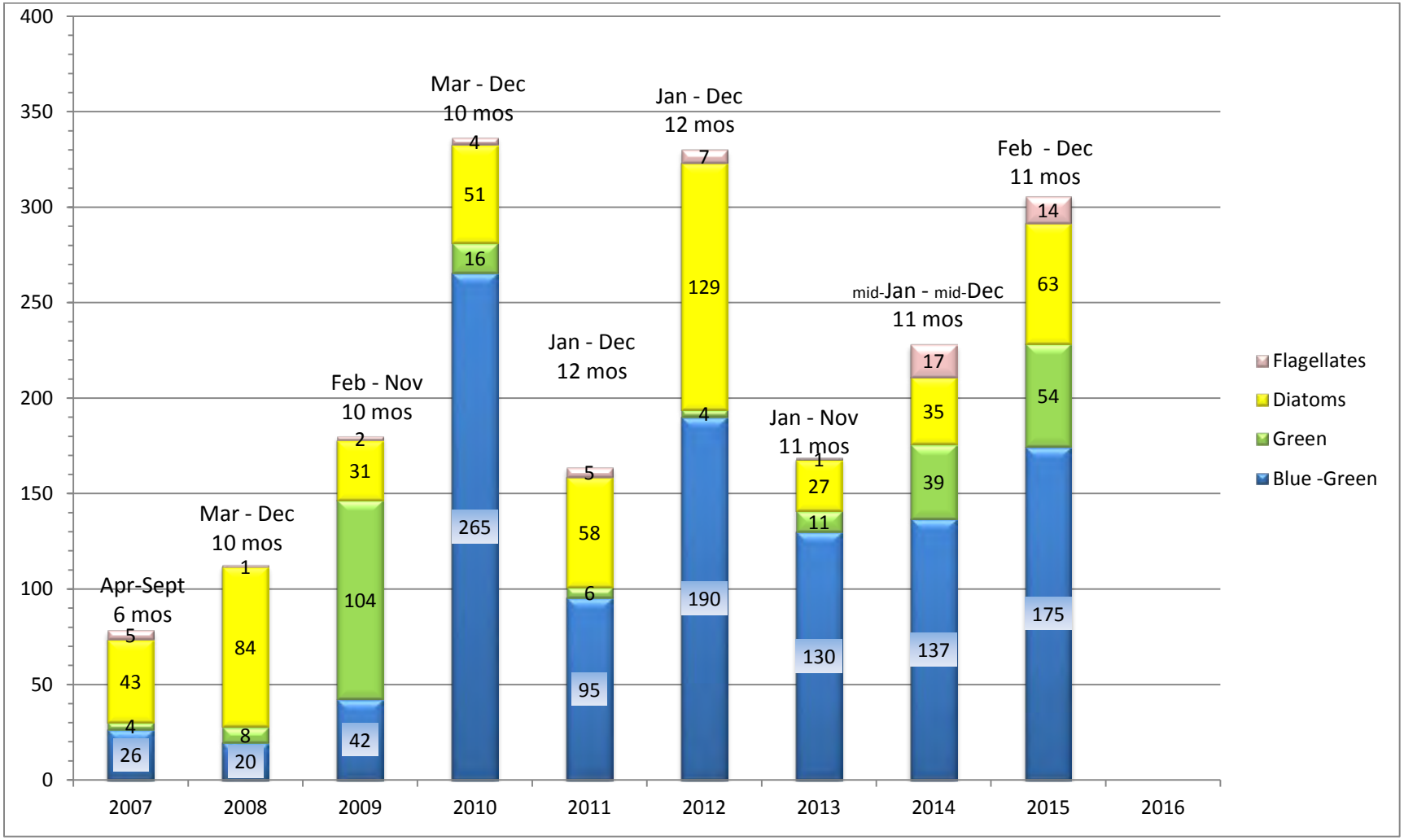

400
350
300
250
200
150
100
50
0
Apr-Sept
6 mos
5
43
4
26
Mar - Dec
10 mos
1
84
8
20
Feb - Nov
10 mos
2
31
104
42
Mar - Dec
10 mos
4
51
16
265
Jan - Dec
12 mos
5
58
6
95
Jan - Dec
12 mos
7
129
4
190
Jan - Nov
11 mos
1
27
11
130
mid-Jan - mid-Dec
11 mos
17
35
39
137
Feb - Dec
11 mos
14
63
54
175
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
Flagellates
Diatoms
Green
Blue -Green

Exhibit E Lake Hennessey Hypolimnetic Oxygenation Feasibility Study

(Pages E1-E36)

Final Technical Memorandum

DATE: September 29, 2011

TO: Erin Farnand, Project Manager
City of Napa Water Division

FROM: Tanya Yurovsky, P.E.
SRT Consultants

SUBJECT: Lake Hennessey Hypolimnetic Oxygenation Feasibility Study

Summary

The City of Napa Public Works Department, Water Division (City or Water Division), retained SRT Consultants (SRT) to evaluate the feasibility of utilizing Hypolimnetic Oxygenation at the Lake Hennessey Reservoir (Lake Hennessey or Reservoir) with the purpose of addressing the taste and odor (T&O) concerns and the Reservoir water quality. Lake Hennessey is the largest of the three major sources for the City of Napa. The T&O complaints have become an increasingly prevalent issue for the City, particularly in the warmer months of the year. T&O complaints of earthy, grassy, and fishy taste and odors reported by customers in the summer and fall months and the results of the data analyses indicate that the algal blooms and mass die-offs of algal species are the cause of T&O issues in water supplied by the Lake Hennessey Reservoir.

Water Division prefers preventative and comprehensive water quality management practices, including maintaining a healthy aquatic life environment coupled with the best source water quality in the Reservoir while delivering high quality drinking water to its customers' taps.

Based on the Water Division's goals and practices, the recommended project addressing the Lake Hennessey water quality and supporting aquatic life and recreation, while minimizing disinfection byproducts in the distribution system and consistently delivering high tap water quality, with combined benefit to the Tap and to the Lake, includes the following:

1. Near-Term Improvements:
    - Implement a Hypolimnetic Oxygenation System at Lake Hennessey utilizing a system of diffuser hoses installed near the Reservoir bottom. First, implement a pilot project, followed by a fine-tuned full-scale installation based on the pilot project results. The pilot project would involve leasing equipment for one to two years and conducting a monitoring program to verify its effectiveness. The pilot project approach would allow more a expedient implementation while permitting and environmental review is being completed. In addition, it would offer an immediate benefit to the Reservoir. Due to its temporary nature, this Pilot Project will most likely be exempt from review under the California Environmental Quality Act (CEQA). This project will most likely receive support from the State Department of Fish and Game.

The planning-level cost of the diffuser hose system with a liquid oxygen storage tank and vaporizer is estimated at $750,000 to purchase or $350,000 annually to lease.

- Implement GAC capped filters at the Hennessey Water Treatment Plant (HWTP).

  The cost of the GAC capped filters at HWTP will be comparable with the cost of the anthracite media replacement program already in place at the City. This work will be CEQA-exempt.

- Continue monitoring and data collection and, if needed, amend this Study.

2. Long-Term Improvements, in addition to the Near-Term Improvements:
   - Install Ozone Treatment at HWTP, and/or
   - Install permanent Hypolimnetic Oxygenation at Lake Hennessey.

     For planning purposes, the capital cost of implementing an ozonation system at HWTP is estimated at about $15 million. Based on the information available at the time of this Study, these improvements will most likely require a Mitigated Negative Declaration (MND) level of CEQA review.

This Technical Memorandum (TM) provides a summary of the work performed by SRT to evaluate historical water quality data, develop alternative solutions and conceptual engineering for the proposed preferred option, and outlines an Implementation Plan for the Water Division.

Scope of Work

The Water Division retained SRT to explore the feasibility of Hypolimnetic Oxygenation at Lake Hennessey and established the following scope of services for this Study:

- Evaluate historical water quality data collected and provided by the Water Division;
- Develop alternatives for addressing the T&O conditions at Reservoir;
- Evaluate the alternatives, and
- Develop conceptual engineering for the preferred alternative.

Background

The City currently receives water from three major sources: Lake Hennessey, Milliken Reservoir, and the State Water Project (SWP) through the North Bay Aqueduct (NBA). Water from these three sources is introduced into the City distribution system from three separate water treatment facilities. Based on the *City of Napa 2010 Urban Water Management Plan*, Lake Hennessey Reservoir is the largest of the three major sources, with a maximum yield of 31,000 acre-feet (ac-ft) and an average yield of 17,500 ac-ft. Milliken Reservoir has a

maximum and average yield of 700 ac-ft and the NBA provides 21,900 ac-ft.

Lake Hennessey

Lake Hennessey is a 36,000 ac-ft reservoir with a 790-acre surface area located approximately 13 miles to the northwest of Napa and 5.5 miles southwest of St. Helena. Figure 1 represents the location map. The Reservoir is fed primarily by Conn Creek, located to the northwest, and Sage and Chiles Creeks, located to the northeast. Lake Hennessey was constructed in 1946 with the completion of the Conn Creek Dam, located at the southwest end of the reservoir. The City of Napa withdraws water from the reservoir through an intake located near the Conn Creek Dam.

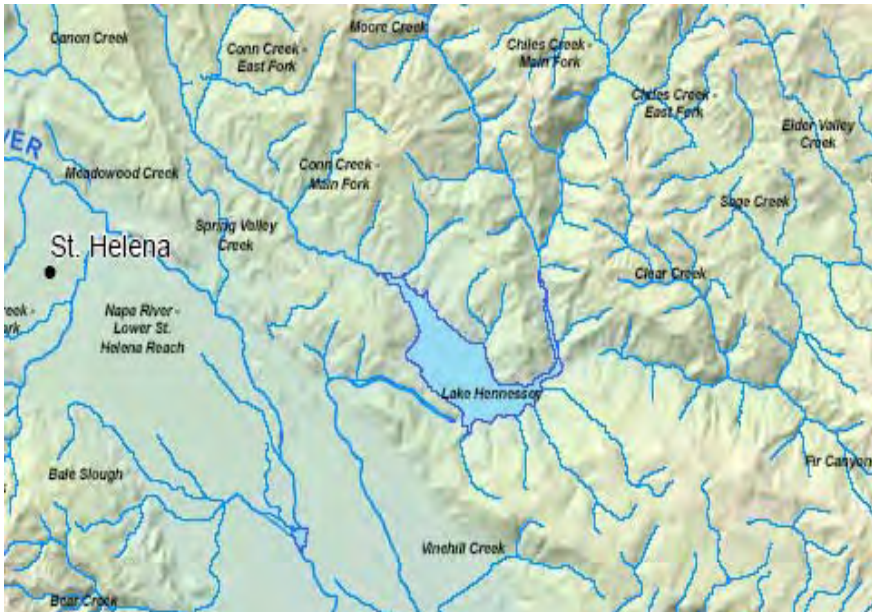


Figure 1 Map of Lake Hennessey and its Tributaries

Raw water from Lake Hennessey is pumped to the HWTP, which has a nominal treatment capacity of 20 million gallons per day (mgd). The HWTP includes the following treatment train: pre-oxidation with potassium permanganate, coagulation, flocculation, sedimentation, filtration, and disinfection. Treated water from the HWTP is delivered to the distribution system through the Conn Transmission Main, which is approximately 20 miles long and runs parallel to Conn Creek, Highway 128, and Highway 29.

A HWTP process flow chart is included as Figure 2.

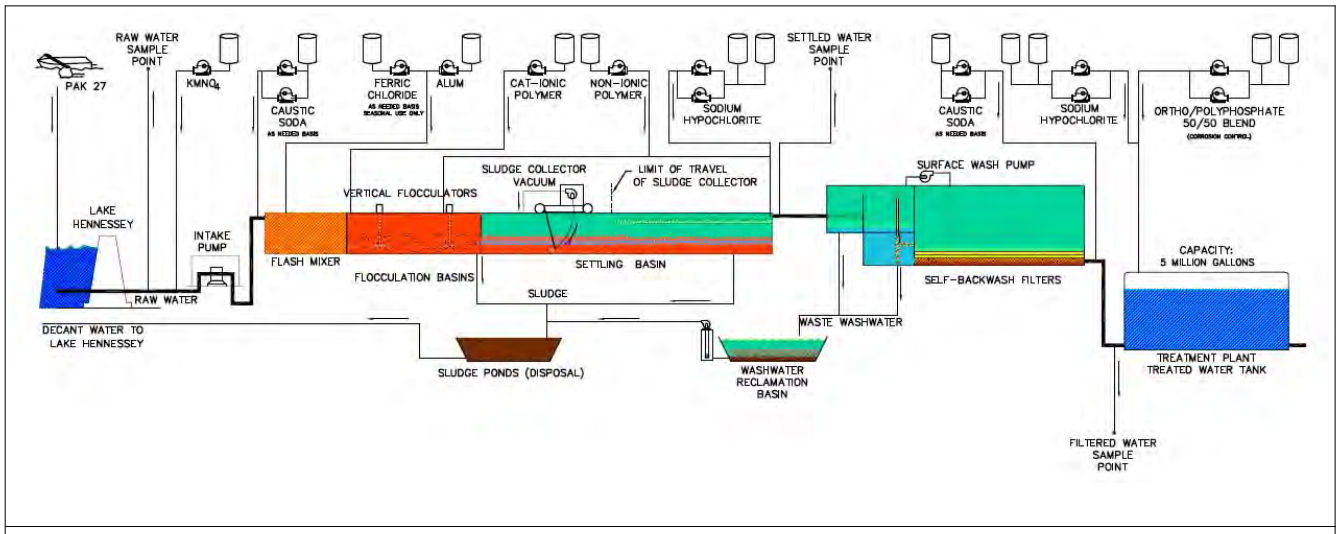


Figure 2 HWTP Process Diagram

Figure 3, on the following page, depicts the Lake Hennessey facilities and the transmission main.

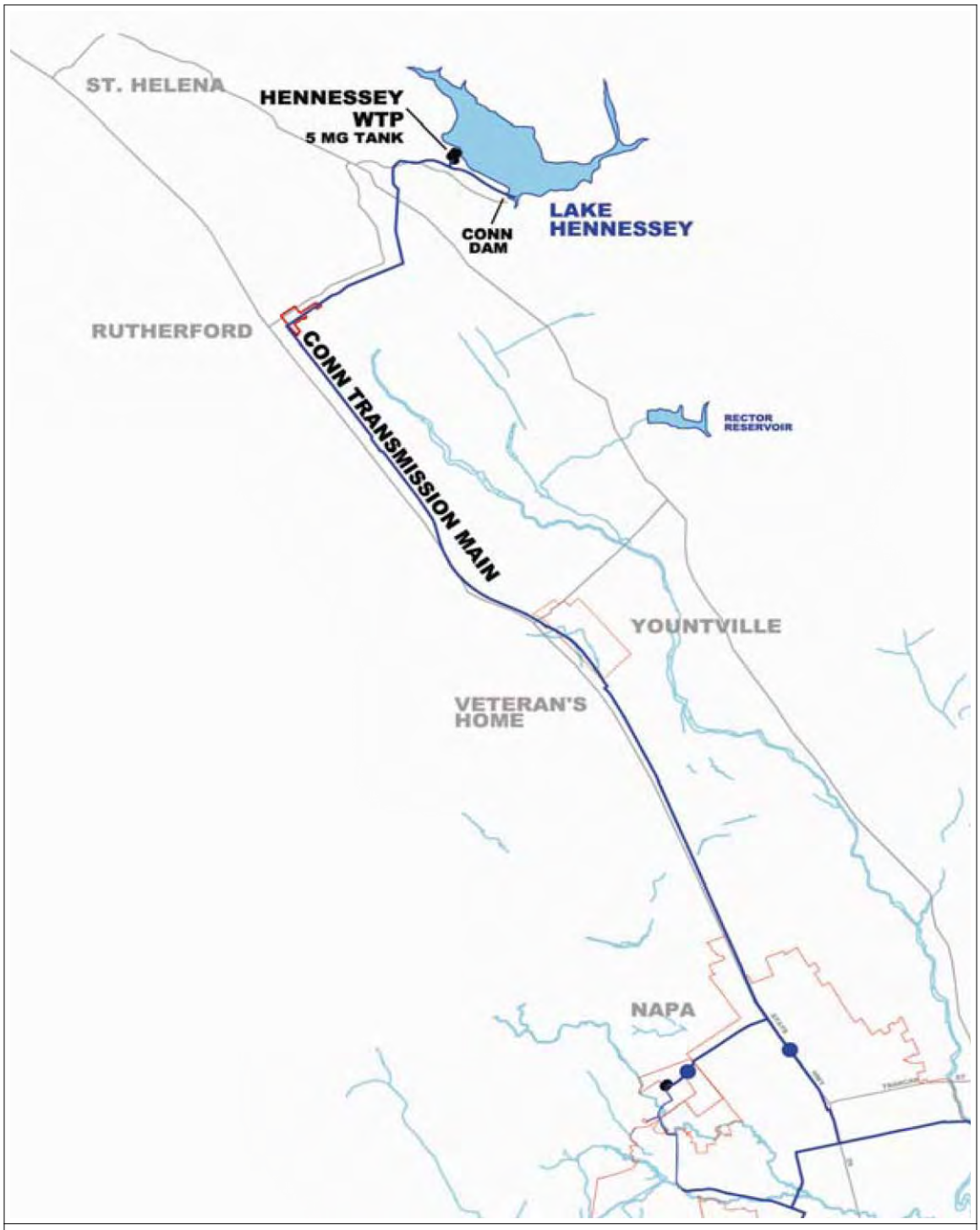


Figure 3 Lake Hennessey Facilities

Water Quality

The City of Napa consistently delivers to its customers water meeting all drinking water standards prescribed by the Federal and State of California regulations. High levels of turbidity are common during winter storms for the SWP source water, delivered through the NBA, and during the fall, winter, and spring at the Milliken Reservoir. The elevated turbidity levels present challenges to the water treatment facilities, however the facilities successfully treat the water to ensure that water quality being delivered to the customers meets all Federal and State standards. Lake Hennessey does not exhibit the turbidity challenges of the other two sources, however, it does experience seasonal taste and odor issues.

Taste and Odor Issues

Recently, T&O complaints have become an increasingly prevalent issue for the City of Napa system, particularly in the warmer months of the year. The pattern of these T&O events have been observed since 2006, when the Water Division received more T&O complaints from customers, particularly during the summer months. Table 1, below, presents a summary of monthly and annual T&O complaint counts.

Table 1 Recorded Taste and Odor Complaints

	Number of Reported Taste and Odor Events				
	2005	**2006**	**2007**	**2008**	**2009**
January	1	1	0	0	0
February	2	0	2	1	0
March	2	0	1	3	7
April	2	0	0	2	0
May	0	0	1	2	2
June	1	0	1	1	3
July	1	0	0	7	0
August	0	1	3	3	1
September	0	9	22	2	15
October	2	6	0	5	1
November	0	3	3	7	166
December	2	1	2	0	2
Total	***13***	***21***	***35***	***33***	***197***

In 2009, the number of T&O complaints reported rose significantly, nearly 15 times the previous years' numbers. The majority of the reported T&O issues occurred in February and November of 2009, with 287 and 166 reported customer complaints, respectively. The first spike in T&O complaints, during February, was attributed to the NBA water quality system

flush and was not related to the water quality in Lake Hennessey. This episode was excluded from Table 1. The second, November 2009, spike was attributed to Lake Hennessey Reservoir water quality.

The complaint count numbers do not necessarily represent a complete measurement of all the potential T&O episodes over the past five years, as the Water Division's strategy was to only serve water from the Reservoir during the times when it would likely not have T&O issues. The large spike in November 2009 was due to the Jamieson Canyon Water Treatment Plant (JCWTP) unable to meet the demand, resulting in water from Hennessey being served. The apparent absence of demonstrated spikes in the previous years does not necessarily mean there were no T&O problems, due to this selective serving program. The lack of data regarding Geosmin and 2-Methylisoborneol (MIB) levels coupled with the selective serving of Lake Hennessey water, allows only for a few conclusions drawn regarding the overall T&O issues at the reservoir.

The reported T&O complaints show a seasonal pattern, in which a rise in incidents happens during the reservoir turnover, notably July through November. Figure 4,on the following page, illustrates the trend of reported complaints over the past 5 years, excluding the spike caused by the NBA flushing event.

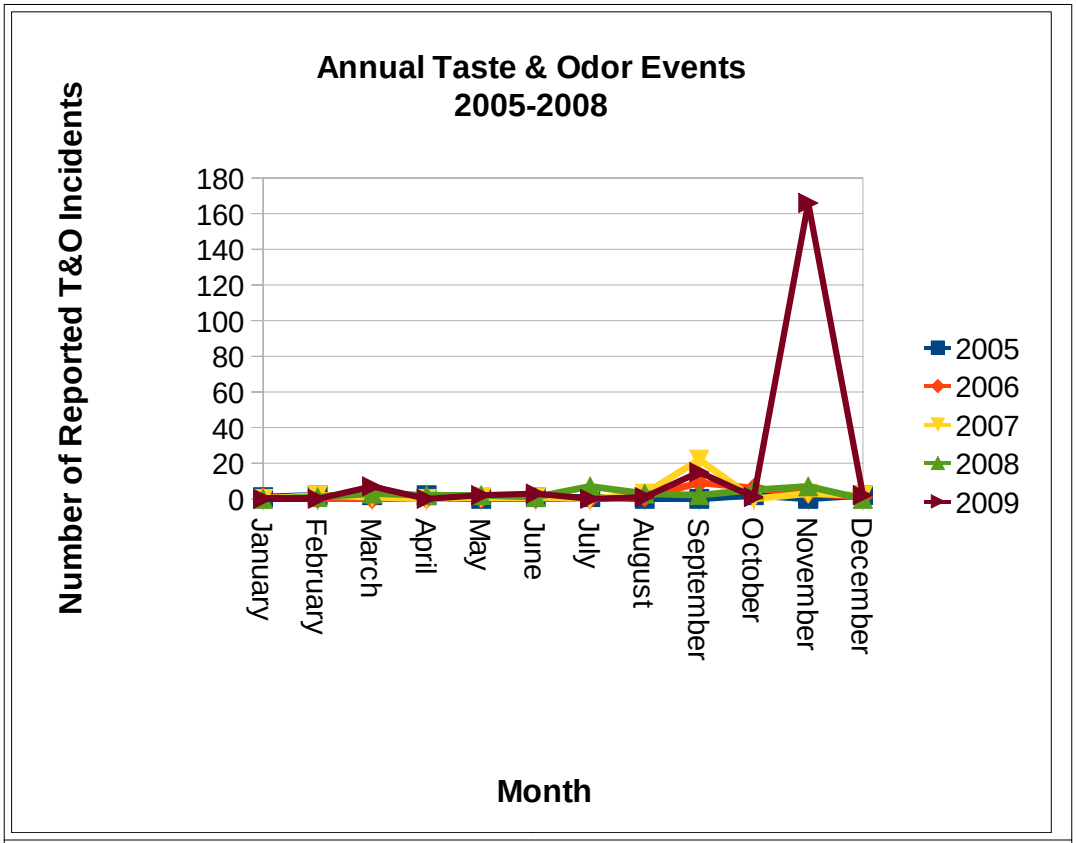


Figure 4 Seasonal Pattern of Taste and Odor Complaints

Reservoir Conditions

The seasonal trends of T&O events prompted the need for an evaluation of the conditions at the Reservoir to determine the cause. Source water quality monitoring records, depth profiles, available historical records of T&O events, and customer complaint logs were utilized to determine the water quality, operational, and temporal conditions that may have contributed to T&O episodes, and to provide the basis for important design parameters.

Thermal Stratification

Throughout the year, reservoirs and lakes often have periods of thermal stratification and periods of turnover, depending on seasonal conditions. When a reservoir turns over, it is completely mixed from the top to the bottom and achieves relatively uniform temperature across its depth. However, during the summer and winter months, reservoirs thermally stratify, due to weather conditions, into the following three layers: the epilimnion, metalimnion (or thermocline), and hypolimnion. Figures 5 and 6 below illustrate the seasonal stratification cycle and the three typical layers, respectively.

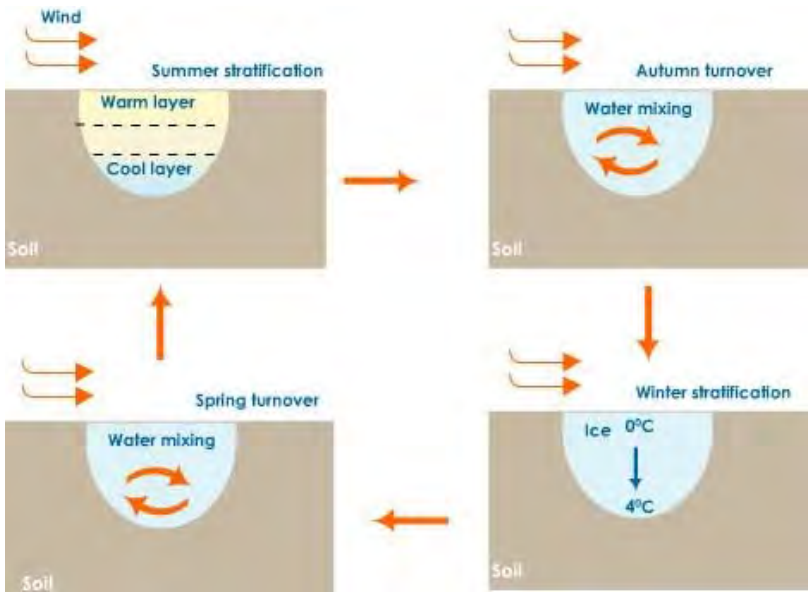


Figure 5 Thermal Stratification Cycle in a Reservoir

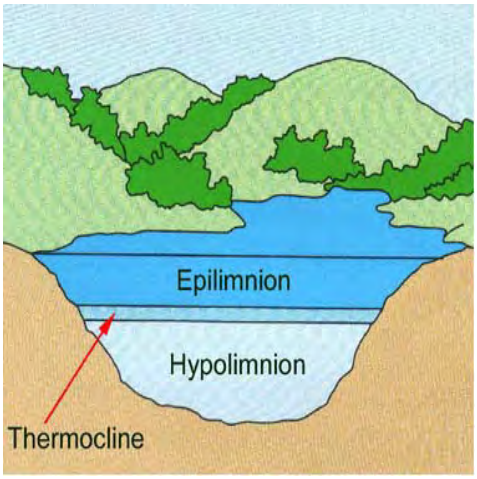


Figure 6 Thermal Stratification Layers in a Reservoir

The epilimnion is the surface layer characterized by less dense, warmer water that is well oxygenated and mixed due to turbulence generated by surface winds. Since this layer is closest to the surface, it receives the greatest amount of sunlight and contains more dissolved gases, allowing for photosynthesis to occur and large concentrations of algae to grow. This layer, however, often contains lower quality water since it is exposed to surface contaminants. The thermocline, which is formed during the seasonal weather cycle, is the transition barrier

zone between the epilimnion and the colder water of the hypolimnion. It is characterized by a drastic change in temperature per unit depth and serves as the water quality barrier between the typically cleaner hypolimnetic water and the more likely contaminated waters of the epilimnion. The hypolimnion is the deepest layer, characterized by more dense, colder water, typically containing lower levels of dissolved oxygen (DO). The hypolimnion serves as an important fish habitat during the summer months, by providing a refuge from the warmer surface waters. This layer usually contains higher quality water since it is protected from surface contaminants by the thermocline.

Temperature data collected by the Water Division, from 2005 – 2010 for the Reservoir at several depths (Surface, 10 ft, 20 ft, 30 ft, 40 ft, 50 ft, 60 ft, 70 ft, and Reservoir Bottom) was plotted over time, as shown in Figure 7 on Page 11.

Based on the available data, Lake Hennessey Reservoir usually follows the typical pattern for shallow reservoirs and stratifies twice a year. The summer stratification occurs from April to November, with a difference in temperature from the surface layer to the bottom of the Reservoir of 13 degrees Celsius (ºC). The winter stratification occurs from December to March, with a temperature change of about 5ºC from the surface to the bottom layer.

In reviewing the temperature data during the period of summer stratification, the thermocline was established to occur just below 20 feet (ft), when the most dramatic change in temperature exists per unit depth. For the purpose of this analysis, the thermocline is defined to exist at a depth of 22 ft, which is average for lakes of this size. The average period of thermocline development in the Reservoir is 8 months; however there are important variations from year to year. For example, the recent T&O episode occurred during the longest period of thermocline development, which was 10 months. This longer period may have allowed for higher accumulations of nutrients in the hypolimnion, resulting in a more severe T&O episode.

Figure 7 on the following page illustrates the temperature trends in the Reservoir over the past five years.

Algal Cycle

Algae can be a very beneficial organism to reservoir ecology, however, invasive algae species such as blue-green or cyanobacteria produce T&O causing compounds, Geosmin and MIB in their cells that are released into the water once they die off. These compounds, once released into the water column, are very difficult to remove.

Algae typically starts growing in the surface layers of the reservoir where there is more sunlight and soluble nutrients in the spring and fall months when the reservoir is stratified. This initial algae growth can quickly grow to a large algal bloom covering a substantial surface area, blocking the lower levels of the reservoir from sunlight. Since the life cycle of algae species is short, the algal bloom is followed by a period of mass die-off, where the algae sinks into the hypolimnion and decomposes. This natural decomposition process requires oxygen to complete, increasing the biological oxygen demand (BOD) in the hypolimnetic waters. Once the BOD in the hypolimnion is great enough to deplete the DO levels down to anoxic

conditions (occur at DO levels of less than 2.5 mg/L), internal nutrients begin to release to the water column. This internal nutrient release accumulates in the hypolimnion until the next reservoir turnover event where they are mixed into the epilimnion feeding a larger algal bloom the next season.

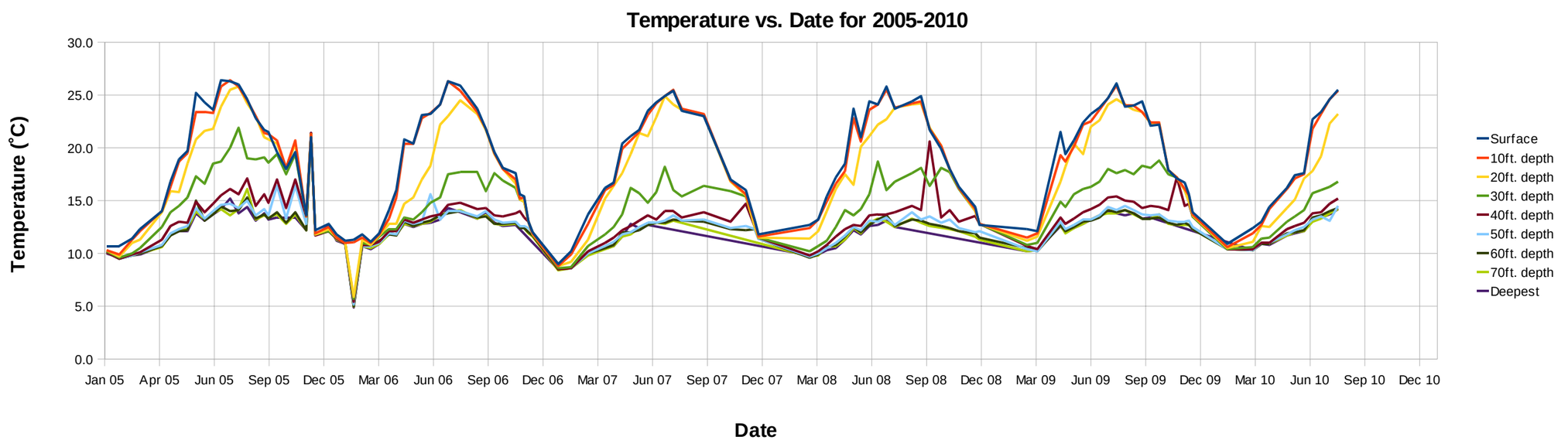


Figure 7 Lake Hennessey Reservoir Temperature Trends, 2005 – 2010

Algae has a naturally short life span and plays a vital role in the cycle illustrated in Figure 8 below.

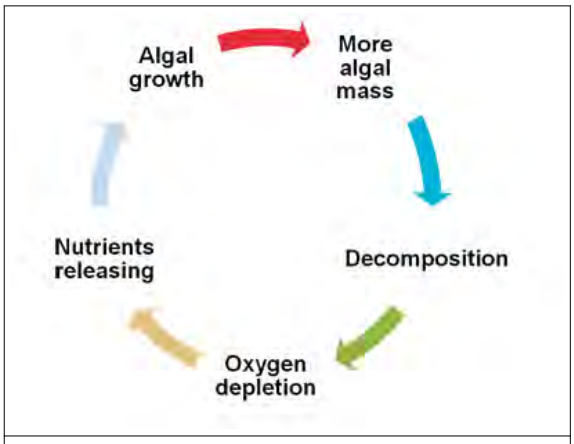


Figure 8 Algae Cycle

Large algal blooms have been observed in Lake Hennessey during the spring and fall stratification periods and algae surveys indicate the presence of blue-green and green algae species. When these algae species grow and die off, they release Geosmin and MIB into the surrounding reservoir waters. It is an established fact that the presence of Geosmin and MIB in water is associated with “earthy” and “musty” T&O issues. Human senses are very attuned to detecting these compounds and can detect Geosmin at levels as low as 6 micrograms per liter (µg/L). Similarly, the presence of green algae is associated with a “grassy” or “fishy” T&O issues.

T&O compound data was collected and indicated a spike in Geosmin levels at 13 µg/L in the reservoir in January 2010. This sample was taken about 2 months following the large T&O spike, which means the level in the Reservoir during November was likely much higher and on the decline by the time it was sampled. Geosmin is believed to be the primary T&O compound in the Reservoir, based on the information available.

Dissolved Oxygen

DO is a necessary component to a healthy reservoir ecosystem. DO levels greater than 9 miligrams per liter (mg/L) support large fish populations. Conversely, DO levels less than 2-3 mg/L will not support aquatic life. For the purpose of this TM, anoxic conditions are defined at a concentration of equal or less than 2.5mg/L. DO is transferred to the water column by surface mixing from wind, waves, and atmospheric oxygen and by photosynthesis of aquatic plants. DO is depleted from the water by respiration of aquatic animals and decay of organic matter at the bottom of the reservoir.

DO typically follows a similar pattern as the temperature data, with the concentrations

essentially leveling out at all depths during a turnover event and exhibiting a higher concentration in the epilimnion and a lower concentration in the hypolimnion during the periods of stratification.

DO concentrations at different depths in Lake Hennessey were measured from 2005 – 2010. The DO data are plotted on Figure 9, on Page 14. The anoxic condition boundary was also plotted as a dashed line at a constant value of 2.5 mg/L. Figure 9 shows that Lake Hennessey goes through three distinct periods throughout the year:

- a period of higher DO at all Reservoir depths,
- a period of greater difference between DO concentrations in the epilimnion and the hypolimnion, and, finally,
- a period of anoxia in the hypolimnion.

The DO concentrations pattern exhibiting by the Lake Hennessey waters, plays an important role in the algal cycle as well, with mass algae die-offs and decay resulting in anoxic conditions in the hypolimnion. Table 2 on the following page illustrates the cycle and the months that these three periods occur in Lake Hennessey Reservoir.

Table 2 DO Trends and Resulting Reservoir Conditions

Time Period	DO Trend	Reservoir Conditions
October/November- Feb/March	Higher DO at all depths	Nutrient rich waters, algal growth/blooms
Feb/March – May/June	Declining DO in hypolimnion, fluctuating DO at surface	Mass algae die-off, beginning of anoxic conditions
May/June - October/November	Anoxic conditions in hypolimnion	Nutrient transfer from sediment to water column, beginning of algal growth

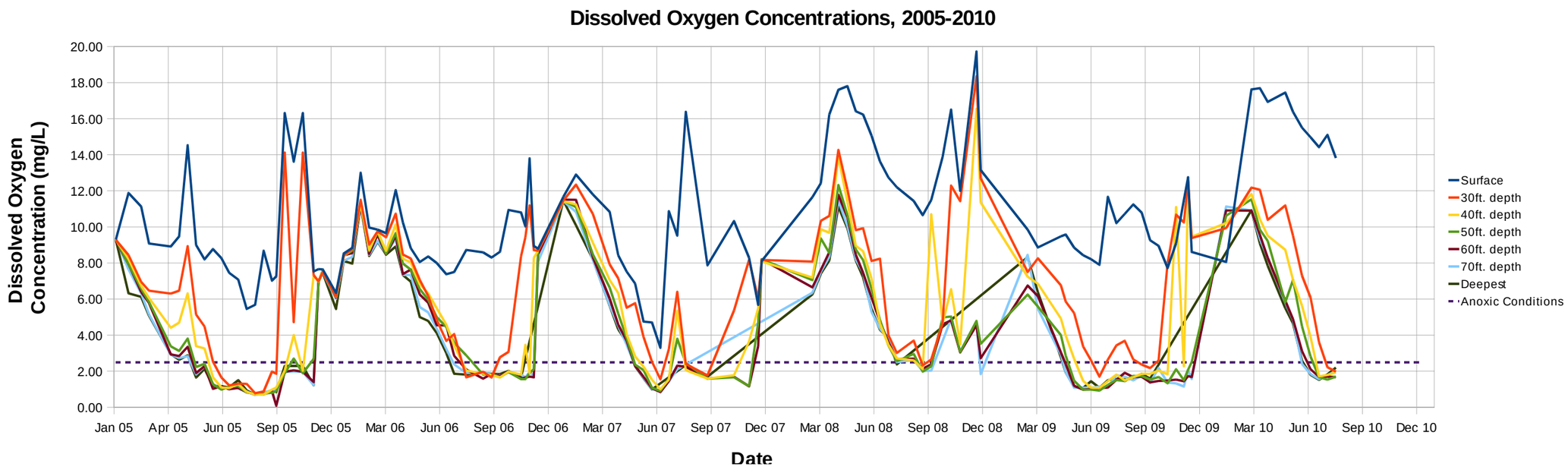


Figure 9 Dissolved Oxygen Concentrations, 2005 – 2010

Nutrient Loading

Algal blooms are dictated by nutrient availability in surface waters. Nutrient loading of surface water bodies can be both external and internal as illustrated in Figure10 below.

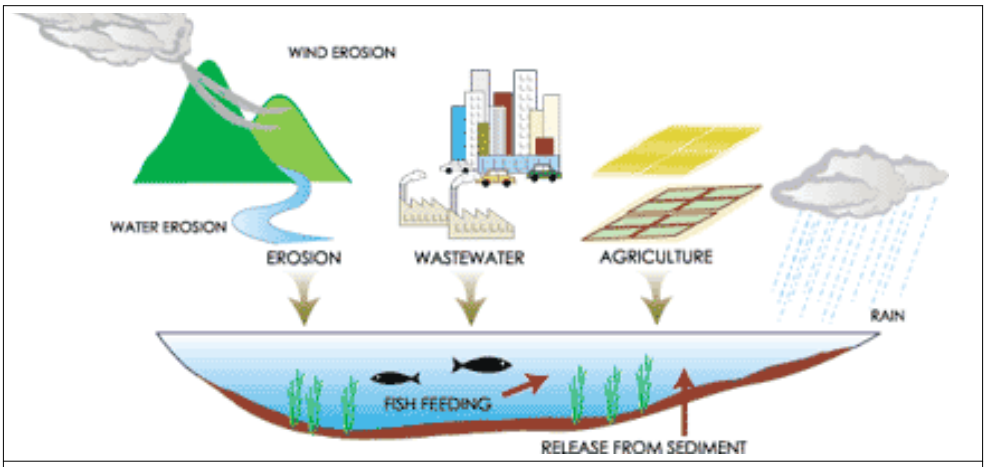


Figure 10 Nutrient Loading Sources

External nutrient loading occurs when nutrients, derived from land-based activities, are transported from the watershed area to the surface water body. Excess amounts of external nutrient loading settle into the reservoir depths and build up in the sediments. As illustrated in the Algae Cycle shown on Figure 8, when the hypolimnion reaches anoxic conditions, a chemical reaction occurs where compounds trapped in the sediments begin to dissolve into the surrounding water. This chemical reaction usually begins with Nitrate, then Maganese (Mn) and Iron (Fe) and ends with Phosphorus reductions from insoluble forms to soluble forms and then releasing into the surrounding waters. These excess nutrients remain in the hypolimnion until the next turnover event and then get mixed into the epilimnion waters feeding another larger algae bloom.

In Lake Hennessey Reservoir concentrations of indicator elements, Mn and Fe, were measured and compared with concentrations of DO in the hypolimnion. This comparison demonstrates whether or not Nitrates and Phosphates, nutrients, are being released into the hypolimnion. The comparison of Mn and DO, and Fe and DO, respectively, at the Reservoir bottom shown in Figures 11 and 12 on the following pages, demonstrates a much higher concentration of Fe and Mn during anoxic conditions. This confirms that during the anoxic conditions at Lake Hennessey nutrients are being released into the hypolimnion. The nutrients then get mixed into the epilimnion water during the next turn over event creating a larger algae bloom during the next season.

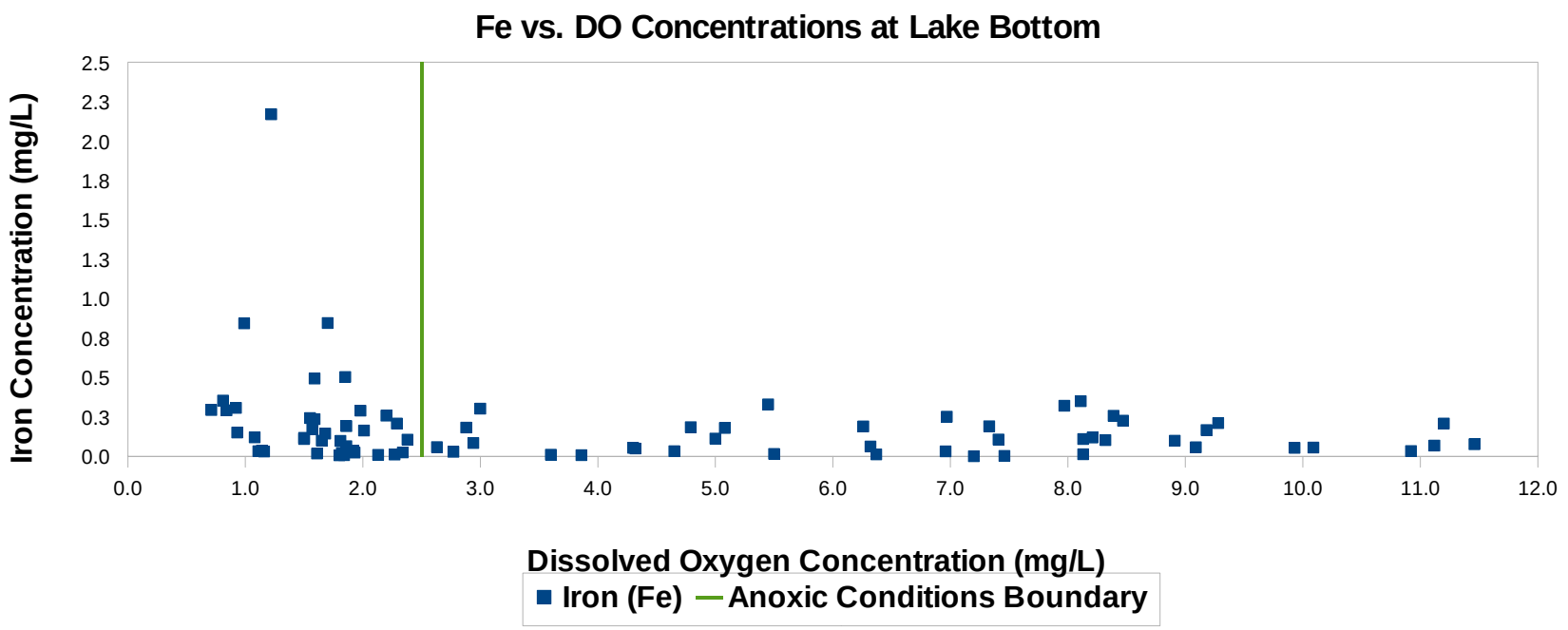


Figure 11 Fe Concentrations versus DO at Reservoir Bottom, 2005 – 2010

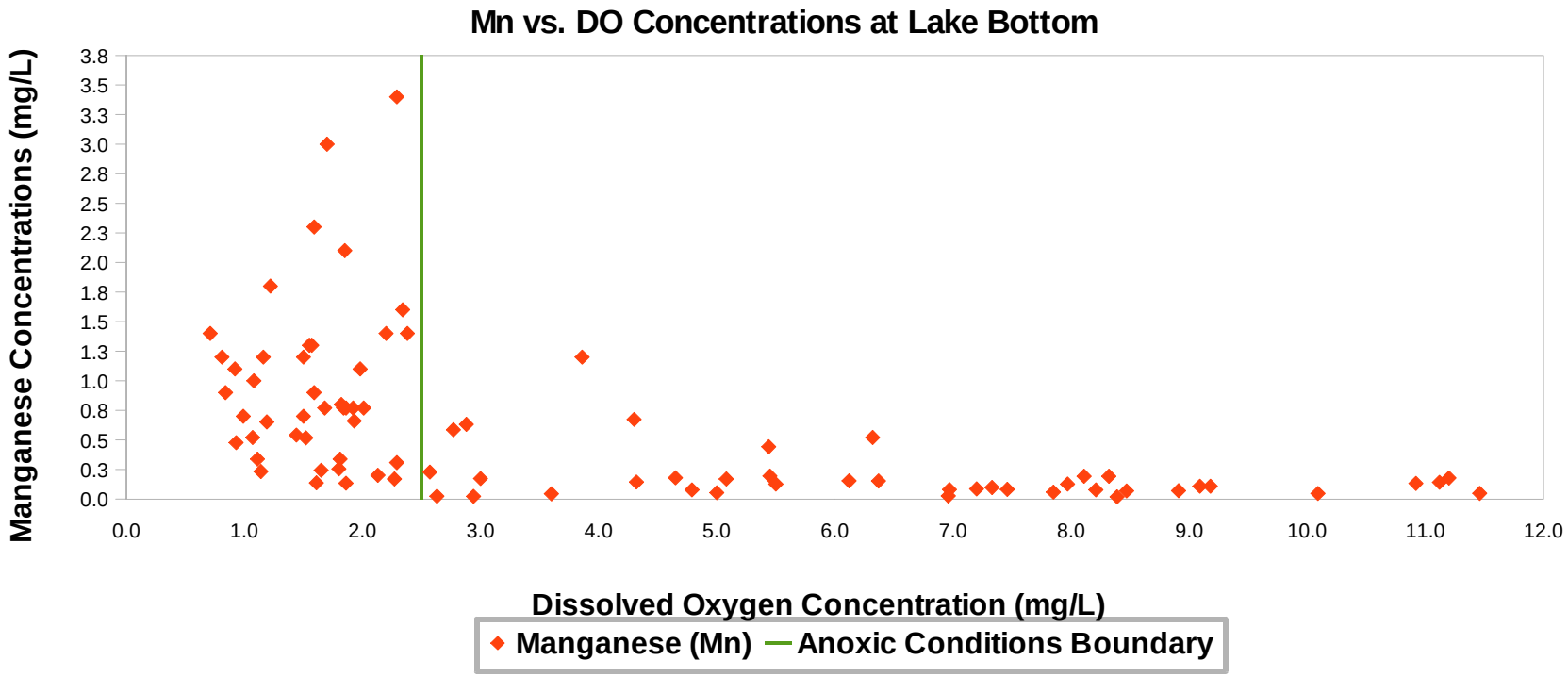


Figure 12 Mn Concentrations versus DO at Reservoir Bottom, 2005 – 2010

Findings

Lake Hennessey appears to follow the algal cycle discussed in the previous sections. The Reservoir experiences three distinct periods of time occur throughout the year characterized by DO concentration. These are detailed below in Table 3.

Table 3 Dissolved Oxygen and Associated Conditions at the Reservoir

Time Period	Dissolved Oxygen Trend	Associated Reservoir Conditions
October/November- Feb/March	Higher DO at all Reservoir depths	Nutrient rich waters, algal growth/blooms
Feb/March – May/June	Declining DO in hypolimnion, fluctuating DO at surface	Mass algae die-off, beginning of anoxic conditions in hypolimnion
May/June - October/November	Anoxic conditions in hypolimnion	Nutrient and T&O compound transfer from sediment to water column, beginning of algal growth

Figure 13, on the following page, is a graphical representation of these cycles isolating the DO data from 2008 – 2010.

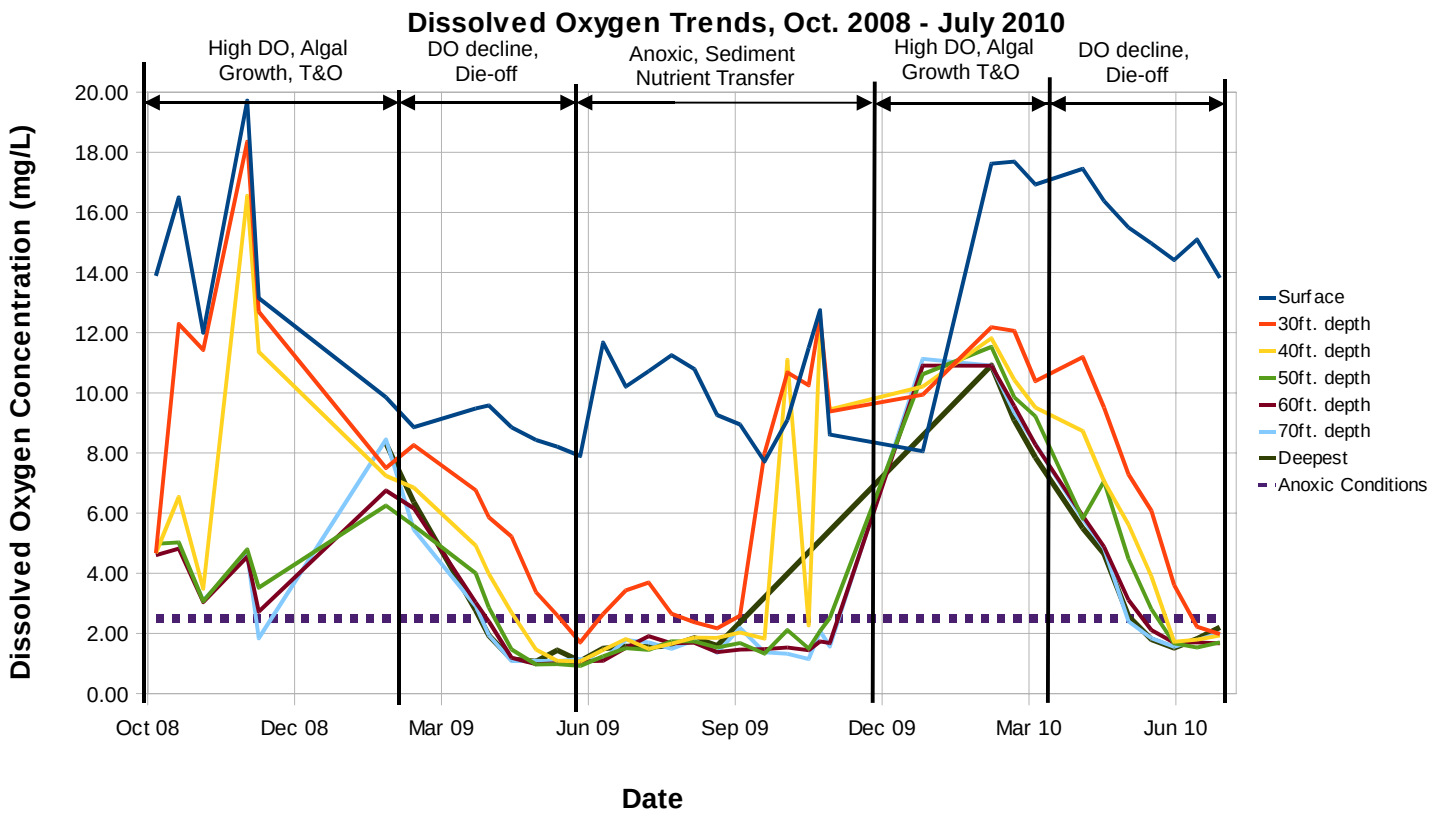


Figure 13 Dissolved Oxygen Trends and Associated Reservoir Conditions, 2008 – 2010

Development and Evaluation of Alternatives

Following the Lake Hennessey water quality data analysis, several potential methods for addressing the T&O issues were considered. Each method was evaluated based on its feasibility, and advantages and disadvantages. The methods considered included:

- Operational Adjustments
- Reservoir Mixing
- Chemical Addition at the Reservoir
- Treatment at the HWTP
- Hypolimnetic Oxygenation

Although Hypolimnetic Oxygenation was the planned focus of this Study, a comparison of this method with other T&O treatment alternatives was necessary to ensure that the Study explored the most feasible and effective solution. In addition, the scope was expanded, at the City's request, to include other treatment options to assist with future planning efforts.

Operational Adjustments

Operational Adjustments would permit avoiding T&O issues by not serving water from the Reservoir during the fall, once the Reservoir has turned over. The turnover is the time when Geosmin and MIB that have built up in the hypolimnion would be mixed throughout the Reservoir and the most likely time for complaints. HWTP will not be treating any water and the City would then be supplied solely from JCWTP.

This No-Project alternative has been practiced to some extent by the City in the past. The greatest difficulty with this alternative includes its severe limitations to the City's water supply. If the JCWTP could not meet the City's demands for some reason, water would have to be served from HWTP. JCWTP water supply can be limited for a variety of operational reasons, which makes this alternative not a reliable solution for the Water Division. In addition, this option provides no Reservoir water quality improvement, no active control of the T&O problems in the distribution system, and it limits the water system supply reliability.

Reservoir Mixing

Reservoir mixing is a preventative method for treating T&O issues at lakes by either preventing reservoir stratification or by catalyzing a turnover event. Catalyzing a turnover event allows oxygen from the epilimnion to circulate downward into the deeper hypolimnetic waters. There are two methods of mixing that were considered at the Reservoir: mechanical mixing and mixing with compressed air. Figures 14 and 15, below, show how mechanical mixers and compressed air mixing, respectively, operate.

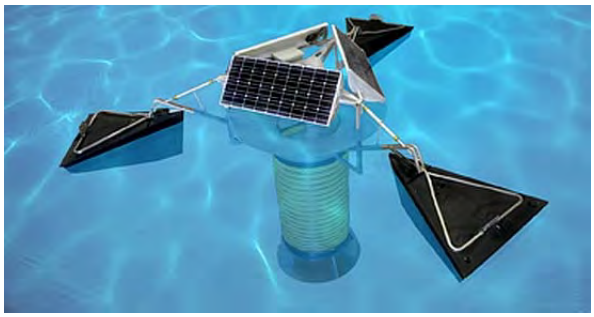
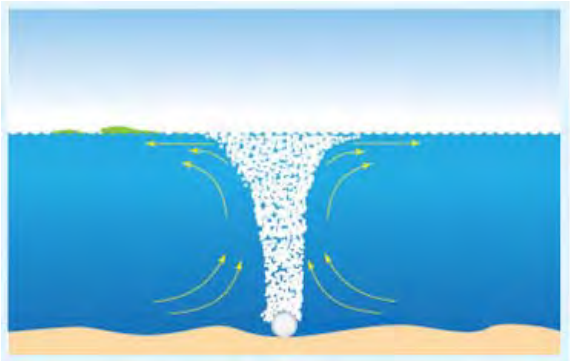
	

Figure 14 Mechanical Mixers (Solarbee®)	**Figure 15 Compressed Air Mixing**

These mixing options have been successful in reservoirs of similar size; however there are a number of significant concerns about them, including the following:

1. The overall water temperature will increase. This affects the fish habitat and stimulates Total Trihalomethane (TTHM) production in the distribution system.
2. Addition of compressed air leads to higher nitrogen levels in the reservoir, which can affect the fish habitat.
3. It is more difficult to control oxygen levels in the hypolimnion near the bottom sediments, leading to uncertainty in controlling nutrient release from the sediments. This situation can also trigger an algae bloom and subsequent T&O issues.
4. Mixing is more operationally complex and requires long lead times, careful planning, and considerable monitoring to avoid enhancing T&O problems.
5. Mechanical mixers would be visible in the Reservoir and require anchoring at various locations. The City explored this option once in the past, and as many as 4 mechanical mixers would be required throughout the Reservoir thus affecting the scenic beauty and boat recreation activities at the Reservoir.
6. Mixers are detrimental to fish life living in the cooler hypolimnetic waters during the warmer summer months.

The estimated installed cost of the mechanical mixer system is approximately $500,000 and the cost of the compressed air system is about $250,000.

Chemical Addition

Chemical treatment at the Reservoir would inject aluminum sulfate (alum) into the Reservoir to create a physical barrier against internal nutrient loading. Alum reacts with the lake water and forms a precipitate locking excess soluble phosphorus inside the molecule, called alum floc. This floc coats the Reservoir bottom and bars the release of internal nutrients from the sediment thus inhibiting the algal cycle from continuing. Figure 16, below, illustrates the alum

floc.

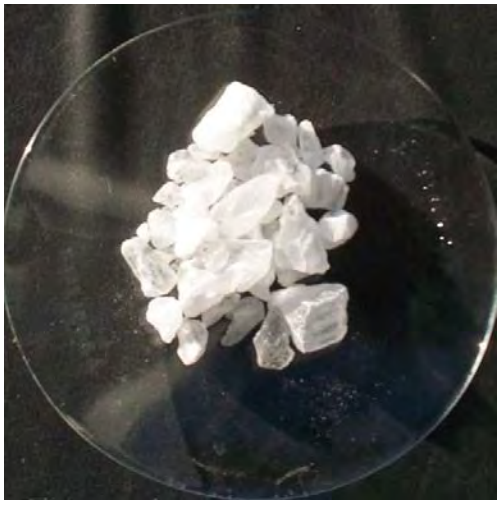


Figure 16 Alum Floc

Although alum treatment would address the excess nutrients in the Reservoir and prevent the algal cycle from continuing, it has many disadvantages. This treatment is not a permanent fix, and needs to be repeated every 5 years. Initially, following treatment, the DO concentrations in the hypolimnion will drop, which could lead to aluminum toxicity in the lake bottom sediments. The CEQA review for this alternative would be quite challenging as well.

The estimated cost of alum treatment is approximately $1.5 - $2 million per treatment, repeated every 5 years.

Treatment at the HWTP

Another method of treating T&O problems would be to treat the water at HWTP, after it is withdrawn from the Reservoir. There are three potential water treatment facility process modifications that can be implemented to limit the Reservoir T&O issues entering the distribution system. These potential modifications include:

- ozonation,
- peroxone addition, and
- granular activated carbon (GAC) capped filters.

These water treatment options are discussed below.

Ozonation. Ozonation is a treatment process where ozone gas is injected into the water through fine bubble diffusers thus oxidizing and neutralizing T&O causing compounds. Ozone is a powerful oxidant capable of removing about 80 percent of Geosmin and roughly 60

percent of MIB at normal ozone dosage rates. Ozone treatment is a widely used treatment option in the water industry today, including at the City's JCWTP.

Figure 17, below, depicts typical ozonation equipment.

Figure 17 Typical Ozonation Equipment

The main drawbacks of ozonation for T&O component control are the residual Geosmin and MIB remaining in the water. The remaining Geosmin and MIB not removed would still cause T&O complaints. For example, if the level of Geosmin is 100 nanogram per liter (ng/L) in the reservoir water, following treatment there would still be 20 ng/L remaining, which could still cause a major T&O episode.

The JCWTP recently completed an upgrade to include ozonation equipment at a significant capital expenditure. Ozonation is a very expensive alternative to control T&O alone; however, ozonation would be viable given the disinfection by-product issues and to control TTHMs. Ozonation can be installed in combination with either hydrogen peroxide treatment or GAC-capped filters at HWTP.

The estimated cost of ozonation at HWTP is approximately $15 million in capital costs and annual Operations and Maintenance (O&M) costs of approximately $0.08 per 1,000 gallons of water treated per year.

Peroxone. The use of hydrogen peroxide in addition to ozone is known as the peroxone process, which has shown improved removal of Geosmin and MIB at lower ozone dosages,

based on several pilot tests. However, other published pilot testing has produced conflicting results where there no significant difference between the use of ozone alone and ozone with peroxide was demonstrated. The overall removal of Geosmin and MIB using peroxone is expected to be around 90 percent.

While the addition of hydrogen peroxide may improve T&O compound removal, the operational aspects of adding hydrogen peroxide need to be considered along with the cost of implementation. Use of peroxone technology adds the following operational disadvantages:

1. Hydrogen peroxide storage is limited since the chemical degrades over time. Use of hydrogen peroxide would require careful planning around T&O events so that long storage times would not be imposed.
2. Hydrogen peroxide is a hazardous chemical and is known to create excessive heat in storage tanks at times.

The estimated installed cost of peroxone treatment will add about $5 million to the cost of ozonation. Use of peroxone treatment is not recommended for this site since it adds significant cost, operational concerns, questionable results for T&O removal.

GAC-Capped Filters. GAC is a form of carbon, usually derived from charcoal, that has been processed to make it highly porous. The processing allows the carbon to develop a large surface area and thus better adsorption rates.

Improved T&O control is possible by using GAC in place of anthracite in the existing dual media filters at the HWTP. GAC has been shown to remove as much as 50 percent of Geosmin and MIB in the source water after treatment. This technology is employed by many water agencies in the area and should be considered for HWTP. However, given the lower efficiency of T&O removal, it is important to consider this technology coupled with any in-reservoir T&O control methods.

The cost of GAC filters would be comparable to the cost of routine replacement of the anthracite filter media.

Hypolimnetic Oxygenation

Hypolimnetic Oxygenation is a preventative method of treating seasonal anoxic conditions that develop in a reservoir, by adding oxygen directly to the hypolimnion thus preventing the algal cycle from continuing. The most common practice of hypolimnetic oxygenation is to inject pure oxygen gas or compressed air directly into the hypolimnion, as close to the sediment-water interface as possible. As the gas bubbles rise toward the surface, oxygen dissolves into the surrounding water, oxygenating the hypolimnion and the sediment-water interface. The longer these bubbles rise through the hypolimnion, the more oxygen gets dissolved into the anoxic waters; thus, these systems are more efficient in deeper reservoirs.

Pure oxygen gas is the preferred method of oxygenation and the focus of this Study as it is the most efficient and most beneficial to aquatic life. Compressed air comes with many potential complications including: unwanted gases dissolving into surrounding waters (e.g.,

nitrogen), raised temperatures of injected gases, and low oxygen transfer efficiencies. Pure oxygen does not contain extra gases that can be transferred to the hypolimnion, is more efficient, and it is usually vaporized on-site so the temperature is controlled.

The three most common methods of hypolimnetic oxygenation include the Speece Cone, Diffuser Hose, and Diffuser Mat. The Speece Cone, shown in Figure 18, is a large cone-shaped piece of equipment installed on the Reservoir bottom.

Figure 18 Speece Cone

Water is pulled into the cone by a pump and mixed with pure oxygen piped from shore. This water supersaturated with oxygen is then released back into the reservoir. This method of oxygenation can be very effective, however, the cone required for Lake Hennessey Reservoir would be too large and would likely release water above the thermocline, causing a turnover event.

The Diffuser Hoses and Diffuser Mat, shown on Figures 19 and 20, respectively, include hoses attached to the Reservoir bottom. Pure oxygen is injected very close to the sediment-water interface, effectively stopping internal nutrient loading and oxygenating the hypolimnion. These two methods are the most viable options for preventing the T&O issues at Hennessey with efficiency rates as high as 90%.

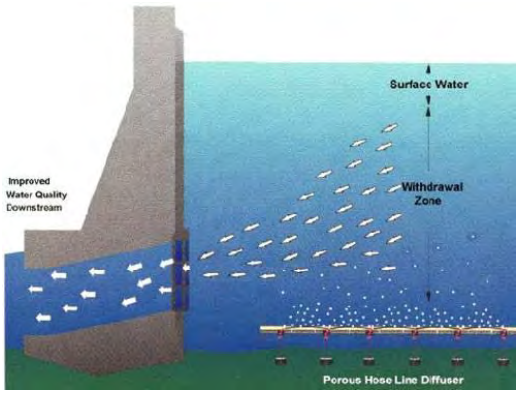


Figure 19 Diffuser Hose

Figure 20 Diffuser Mat

The estimated capital costs for the Speece Cone is about $2 million. The estimated capital costs to install the Diffuser Hoses is approximately $750,000. The capital costs for the Diffuser Mat system are about $850,000.

Since the Diffuser Hose and Mat are the two most viable prevention options at Lake Hennessey, annual lease options were explored for the purpose of pilot testing. The cost of renting the Diffuser Mat system is about $150,000 annually with additional O&M costs estimated at about $100,000 annually, including oxygen costs and system maintenance. The cost of the Diffuser Hose system annually to lease is about $350,000 per year including O&M costs.

Table 4, on the following page, provides a summary of the described alternatives, including their advantages and disadvantages.

Table 4 Summary of Alternatives

Alternatives	Description	Advantages	Disadvantages
Hypolimnetic Oxygenation *a. Speece Cone* *b. Diffuser Hoses* *c. Diffuser Mat* *Hypolimnetic Oxygenation allows for oxygenation of Lake Bottom without disrupting the thermocline and causing a turnover*	a. ***Hypolimnetic Oxygenation*** utilizing a ***Speece Cone*** is a method of adding pure oxygen to the hypolimnion by mounting a metallic cone and perforated pipe to the bottom of a water body. Water is pumped into the top of the cone by a submersible pump, mixed with pure oxygen pumped from an onshore facility, and released into the perforated pipe where it is discharged to the water body. Efficiencies for this method are reported to be as high as 80-90 percent.	• Preserves thermal stratification by reducing turbulence and preventing mixing of Lake layers • Allows for an oxygenated sediment-water interface and inhibits transfer of nutrients into water column • Higher efficiency when using liquid oxygen • Lower energy costs than mixing • On-shore capital improvements can be installed at existing facility near spillway • Most beneficial option to aquatic life	• Liquid Oxygen storage poses safety risks • Requires equipment to be installed in the Lake • The diffuser hose and mat efficiency is related to depth - works better in deeper reservoirs
	b, c. ***Hypolimnetic Oxygenation*** utilizing a ***Diffuser Hoses*** or a ***Diffuser Mat*** is a method of adding pure oxygen to the hypolimnion by pumping pure oxygen from an onshore holding tank into a water body through a perforated hose or mat mounted at a specific depth in the Lake. Oxygen is released along the length of the hoses, allowing for good horizontal spread of the oxygen. Efficiency of this method tends to be higher in deeper lakes.		
Water Treatment *a. Ozonation* *b. Peroxone* *c. GAC capped filters*	***Ozonation*** is a method of treating T&O issues by injecting ozone into the water thus oxidizing T&O-causing compounds. An ozonation system at the HWTP would require installation of four new components: ozone generation, feed gas preparation, contactors, and off-gas disposal units. Lake water would be pumped to the plant as usual within all the existing infrastructure, treated, and then distributed to customers. This requires no improvements to the Lake itself, however, includes substantial capital improvements at the HWTP.	• No capital improvements required at the reservoir • Can address other water quality issues such as TTHM, not just T&O issues • Requires low contact time • Peroxone may remove more Geosmin and MIB than Ozonation alone • GAC capped filters are used widely for treatment of nearby waters	• Ozone may not be effective enough in treating Geosmin (efficiencies as low as 65 percent); requires high dosage of ozone when treating MIB-caused T&O • Peroxone only 50% effective in Geosmin and MIB removal • Does not address low DO concentrations in hypolimnion and algae blooms • High energy demand from ozone generation and disinfection • Should be implemented in concert with ozone or some in reservoir control measure such as hypolimnetic oxygenation
	Peroxone is a method of treating T&O issues by injecting hydrogen peroxide in addition to ozone. Studies to date have varied results which show perhaps some minor improvement to T&O removal at lower ozone dosages. Use of hydrogen peroxide adds operational concerns related to storage of the chemical which in some cases cause excessive heating of the storage vessels when in contact with other impurities in the tank.		
	GAC-Capped Filters is a method of treating T&O issues by replacing the anthracite with GAC in the filters. This method does remove some T&O and is typically used in delta water treatment plants. This alternative should be highly considered in addition to one other T&O alternative to ensure an effective overall strategy for T&O control.		
Chemical Addition Alum Stabilization of Lake Bottom	***Alum Stabilization*** is a method of treating algal growth in water bodies by injecting aluminum sulfate (alum) into the water to form a physical barrier on the Lake bottom and prevent nutrient transfer.	• Mitigates the cause of the algal bloom problem - excess nutrients in the source water • Requires no installation at the Lake	• Not a permanent fix, needs to be recoated every 5 years • No immediate results, may drop DO concentration in hypolimnion initially • Does not fully address the source of excess nutrients • Can cause aluminum toxicity in the Lake sediments

Mixing *a. Mechanical* *b. Compressed Air* *Mixing promotes oxygen transfer by disrupting the thermocline and causing Lake destratification*	a. ***Mechanical Mixing*** utilizes solar-powered floating mixers that draw water from a selected depth and release it laterally to the epilimnion to mix a body of water and introduce oxygen. The flow pattern created by these mixers enables anoxic hypolimnion water to mix with the oxygenated epilimnion water. This system is designed to pull "good" bacteria and algae to the surface where it can grow and compete with the T&O-causing blue-green algae. In addition, constant mixing prevents the blue-green algae from forming clusters and blocking out the sun to deeper water plants. Solar-activated mixers are equipped with intake plates, propellers, and solar panels. The intake plate is adjustable based on the primary application; shallow for blue-green algae blooms and deep for hypolimnetic oxygenation. b. ***Compressed Air Mixing*** is a method of aeration where compressed air is released at the bottom of a water body to create enough turbulence to break the thermocline and allow for mixing and oxygen transfer. Compressed air is injected into the hypolimnion through perforated pipes mounted on the floor of the Lake, injecting warm, oxygenated water from the epilimnion to mix with the anoxic hypolimnion. This mixing method prevents blue-green algae from forming clusters and monopolizing the Lake.	• Increases DO in the hypolimnion • Prevents blue-green algal blooms ◦ Disrupts algae's ability to vertically position itself in the Lake ◦ Prevents algae from clustering and blocking sun transfer to deeper levels in the Lake ▪ Blue-green algae that do not cluster can be consumed more easily by zooplankton ▪ Sunlight transfer is beneficial to deep water aquatic plants • Promotes circulation; establishes beneficial algae dominance before the blue-green algae grow in early summer	• Causes artificial Lake destratification ◦ Mixing may cause additional water quality issues caused by an algae bloom once the Lake stabilizes ◦ Higher water temperatures at the Lake bottom during the summer may degrade fish habitat • The bottom of the water body, or lower hypolimnion, is not well aerated because mixing occurs at higher depths • Compressed air can lead to increased dissolved nitrogen in the Lake and lead to gas bubble disease in fish • Mechanical mixers are visible on water surface and may negatively affect the scenic vistas and could interfere with boat recreation at the Lake
NO Project - Operational Adjustments	***The No Project Alternative (Operational adjustments)*** for addressing the T&O issues at the HWTP entail ceasing HWTP operation during the reservoir turnover and algal bloom. Under this alternative, the City would supply water solely from the Milliken Reservoir and the North Bay Aqueduct (NBA). This alternative requires no capital improvements at the HWTP and/or at the Reservoir.	• Requires no capital improvements • Lowest capital investment of all options	• Significant loss of water supply reliability: ◦ Milliken Reservoir and NBA may not be able to meet the demands ◦ Supply shortage could cause Lake water to be served with the same T&O issues • Does not treat anoxic conditions in the hypolimnion ◦ Low ecosystem productivity, fish deaths, and continued high levels of organic matter in source water

Discussion

The various alternatives developed in the previous section for T&O control at Lake Hennessey have been evaluated based on the following criteria:

1. Reliability
2. Effectiveness in addressing the T&O issues
3. Overall benefit to the City of Napa water system

Table 5 presents the alternative analysis summary.

Table 5 Alternative Analysis Summary

Alternative	Reliability	Effectiveness	Overall Benefit
Operational Adjustments	Poor	Poor	Poor
Mechanical Mixing	Poor	Poor	Poor
Hypolimnetic Oxygenation	Excellent	Excellent	Moderate
Chemical Addition	Moderate	Moderate	Poor
Ozone	Moderate	Moderate	Moderate
Peroxone	Poor	Poor	Poor
GAC-Capped Filters	Moderate	Moderate	Moderate

The type of technology selected for T&O control is highly dependent on the overall goal of the City for water quality improvements. If the goal is to prevent T&O compounds from entering the water system at Lake Hennessey Reservoir, then hypolimnetic oxygenation is the preferred alternative. Of the hypolimnetic oxygenation alternatives previously discussed, the diffuser hose has broader history in the water industry and is the preferred alternative of the two under consideration.

However, since the goal is to control both TTHM's and T&O issues, then the preferred alternative is ozonation at the HWTP coupled with hypolimnetic oxygenation. A comprehensive approach would allow for the most efficient removal of Geosmin and MIB and would directly benefit the HWTP and the customers' tap. Peroxone is not currently recommended due to the water industry's inexperience with the process, the questionable improvement over ozonation for T&O control, operational concerns, and the increased risk in handling hydrogen peroxide. However, the analysis of this process may be revisited in about 2 to 3 years.

In both cases, GAC-capped filters at HWTP should be considered given the moderate cost, widespread use, and positive industry history on treating nearby waters. GAC-capped filters used in conjunction with ozonation systems have been shown to help remove additional T&O and AOC from entering the distribution system, which can lead to bacterial re-growth.

The City should continue to collect T&O data in order to determine the actual levels of Geosmin and MIB in Lake Hennessey near the surface and in the hypolimnion. The additional T&O data would enable the City to determine the potential effectiveness of either alternative throughout the year, and is particularly important when considering ozonation, since it removes only a portion of the T&O-causing compounds. The 65- to 80-percent removal may not be sufficient when Geosmin and MIB levels in the Reservoir are extremely high.

Recommended Alternative

The recommended method for treating the water at Lake Hennessey and improving the T&O issues for the City is hypolimnetic oxygenation using a diffuser hose coupled with GAC-capped filters at the HWTP. This section provides conceptual design for this alternative.

Hypolimnetic Oxygenation utilizing a Diffuser Hose is a method of adding pure oxygen to the hypolimnion by pumping pure oxygen from an onshore holding tank and releasing it to the Reservoir through a perforated hose mounted at the Reservoir bottom. This onshore facility would be constructed at the existing Conn Creek Dam Spillway Facility. This facility would receive truck shipments of liquid oxygen to vaporize on site. The oxygen created at the facility would be piped over the spillway and released to the hypolimnion through perforations in the diffuser hoses, which allows for good horizontal spread of the oxygen. Oxygen transfer takes place while the oxygen bubbles are in contact with water.

Oxygen Depletion

Oxygen depletion rates show how much DO is depleted over a specific period of time (in days) and how quickly the hypolimnion will turn anoxic. Statistical analysis of the oxygen depletion rates has been used to determine how much oxygen must be applied to the hypolimnion to restore the DO to prevent anoxic conditions and maintain an oxygen-containing environment in the Reservoir. The rates have been calculated by isolating the depletion periods, illustrated in Figure 9, and dividing the DO depletion by the time period of the isolation in days. When plotted, the depletion rate follows a roughly normal distribution with an average of 0.06 mg/L and a maximum of 0.2 mg/L. See Figure 21 on the following page.

Based on the analysis, hypolimnetic oxygenation should be designed, at a minimum, to deliver 0.06 mg/L/day of oxygen to maintain an oxygen-containing environment in the Lake Hennessey Reservoir.

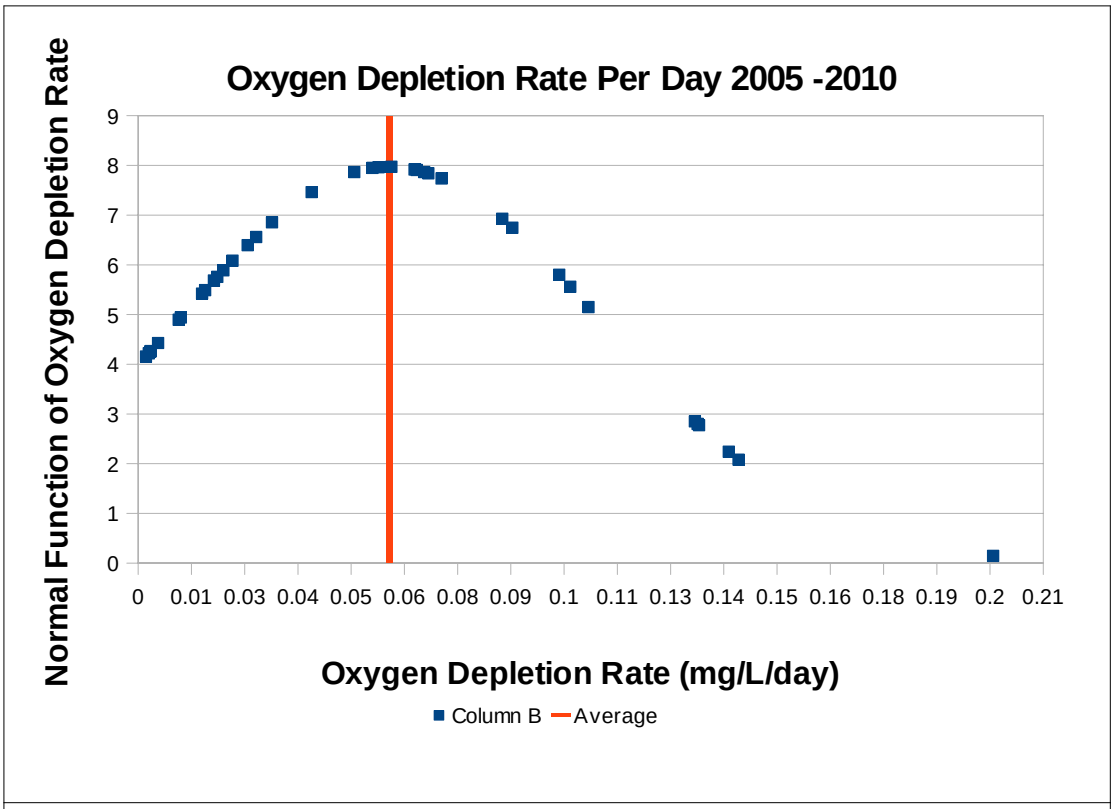


Figure 21 Statistical Analysis of Oxygen Depletion Rate

Design Criteria

The Hypolimnetic Oxygentation system design is based on the required oxygen delivery rates calculated based on the statistical analysis described above. The data analysis results, including the time period for thermocline formation, the anoxic condition boundary, the oxygen depletion rates, and the size of the hypolemnion, form the design criteria for the system. Table 6 below summarizes the design criteria for the hypolimnetic oxygenation system.

Table 6 Hypolimnetic Oxygenation Design Criteria

Parameter	Value
Maximum Oxygen Depletion Rate	0.20 mg/L/day
Average Oxygen Depletion Rate	0.06 mg/L/day
Anoxic Oxygen Level	2.5 mg/L
Minimum Period of Anoxic Oxygen Level	5 months
Maximum Period of Anoxic Oxygen Level	10 months

Average Period of Anoxic Oxygen Level	8 months
Volume of Reservoir	11,730 million gallons
Average Depth	39 feet
Hypolimnion Depth	22 feet
Percentage	29 percent
Volume of Hypolimnion	3,395 million gallons
Estimated Oxygen Transfer Efficiency	*75 percent*
Daily Average Oxygen Requirement	1.13 tons/day
Maximum System Capacity	3.78 tons/day
Minimum Seasonal Oxygen Use	170 tons
Maximum Seasonal Oxygen Use	340 tons

A conservatively low 75-percent oxygen transfer efficiency rate was used for the purpose of sizing the system. As noted previously, efficiency rates as high as 90 percent can be achieved, which would lead to a less expensive system and lower operational costs.

Equipment Sizing

The proposed hypolimnetic oxygenation system will include a 13,000-gallon liquid oxygen tank, vaporizer, associated piping, and an oxygen diffuser hose located at the bottom of the reservoir. The necessary equipment can either be purchased or leased from a vendor. Linde, Inc., of Sacramento, was contacted for the purpose of this Study and indicated they would lease the equipment and maintain it for the City at a cost of about $350,000 annually. If, however, the components were purchased, then the estimated cost of the system would be about $750,000.

The GAC-capped filters could be installed at the HWTP during a routine maintenance of the existing anthracite media filters.

Proposed Site Layout

The site was inspected during August 2010 to evaluate Reservoir features, determine potential sites for the treatment facility, and observe any environmental issues. The Reservoir is currently used for boating recreation including a boat launching facility, fishing, picnicking, and bird watching. The inlets into the Reservoir are very shallow and are subject to extensive algae growth.

Based on site investigation, the best location for the oxygen supply facility would be near the dam spillway, to the north of Conn Creek Dam, as shown below in Figure 22. The diffuser hoses would be submerged within one foot of the Reservoir bottom, covering an area of the

hypolimnion. The hoses would begin near the intake tower and then lead away from the tower to cover a wider area. Figure 22 shows the site layout for the conceptual design and labels key features. The existing HWTP access road, shown in the image below, could be utilized for liquid oxygen deliveries.

Figure 22 Hypolimnetic Oxygenation Layout

Potential Environmental Impacts

Based on the observations and the documents reviewed for the purpose of this Study, the anticipated level of review under CEQA for this project is an Initial Study/Mitigated Negative Declaration (IS/MND). Most anticipated impacts will be construction related, appear temporary, and could be mitigated. Increased truck deliveries providing liquid oxygen would be minimal since one truck load of oxygen per month would be the maximum impact, and truck deliveries of chemicals already occur along this route to HWTP. However, since no environmental studies were performed as part of this work, there is a possibility that an Environmental Impact Report (EIR) may be required, depending on the Initial Study (IS) findings.

Recommended Implementation Plan

The recommended option to treat the T&O problems at the Lake Hennessey is to use a system of diffuser hoses installed at the Reservoir bottom, approximately one foot from the sediment-water interface, coupled with GAC capped filters at the HWTP. The cost of the diffuser hose system is anticipated to be $350,000 per year, if leased, or $750,000 if purchased. The cost of the GAC capped filters is anticipated to be comparable with the cost of the anthracite media replacement program already in place at the HWTP.

The proposed implementation plan includes near-term and long-term activities. The near-term activities should take place in the next 2 to 3 years. The long-term activities are anticipated within the next 5 to 10 years.

Near-Term Activities

- ➔ Continue to collect additional T&O data. These data will help determine the actual levels of Geosmin and MIB in Lake Hennessey near the surface and in the hypolimnion. The additional T&O data would enable the City to determine the potential effectiveness of the reservoir management and/or treatment alternatives throughout the year, and is particularly important when considering ozonation, since it removes only a portion of the T&O-causing compounds.
- ➔ Install GAC caps for HWTP filters. GAC-capped filters have been shown to help address some T&O levels and AOC from entering the distribution system thus preventing bacterial re-growth.
- ➔ Amend this Study. Following a full year of MIB and Geosmin data collection, another data analysis should be conducted and the Study amended to include the data and revisit the conclusions.
- ➔ Implement a Pilot Test of Hypolimnetic Oxygenation System at Lake Hennessey utilizing a system of diffuser hoses installed near the Reservoir bottom. The pilot project would involve leasing equipment for one to two years and conducting a monitoring program to verify its effectiveness. The pilot project approach would allow more expedient implementation while permitting and environmental review is being completed. Due to its temporary nature, this Pilot Project will most likely be exempt from review under the California Environmental Quality Act (CEQA).

Long-Term Activities – Depending on the Amended Study and Pilot Testing

Water Division employs preventative and comprehensive water quality management practices, including maintaining a healthy aquatic life environment in the reservoir coupled with the best source water quality in the Reservoir while delivering high quality drinking water to its customers' taps.

Based on these practices, the recommended long-term project addressing the Lake Hennessey water quality and supporting aquatic life, while minimizing disinfection byproducts in the distribution system and consistently delivering high tap water quality, includes the

following:

- ➔ Implement a Hypolimnetic Oxygenation System at Lake Hennessey utilizing a system of diffuser hoses installed near the Reservoir bottom.

  The planning-level cost of the diffuser hose system with a liquid oxygen storage tank and vaporizer is estimated at $750,000 to purchase or $350,000 annually to lease; AND

- ➔ Install Ozone Treatment at HWTP.

  For planning purposes, the capital cost of implementing an ozonation system at HWTP is estimated at about $15 million.

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Exhibit F Description of Division of Boating and Waterways Grant for Invasive Species Vulnerability Assessment

(Pages F1-F13)

2016 – 2017 Lake Hennessey Invasive Species Protection Program

(Vulnerability Assessment/Planning Project)

Project Description

Section A. Reservoir, Project Area and Management of Activities

A-1. Reservoir and Project Area Description

Lake Hennessey is the main storage reservoir for the City of Napa's municipal water supply. Conn Dam was constructed in 1948. Lake Hennessey provides high quality water to approximately 85,000 residents in Cities of Napa, St Helena, Calistoga and American Canyon and unincorporated areas Napa County (see Figure 1). Recreation was not a purpose of the establishment of Lake Hennessey nonetheless public visitation has been permitted for fishing and boating so long as there is no bodily contact.

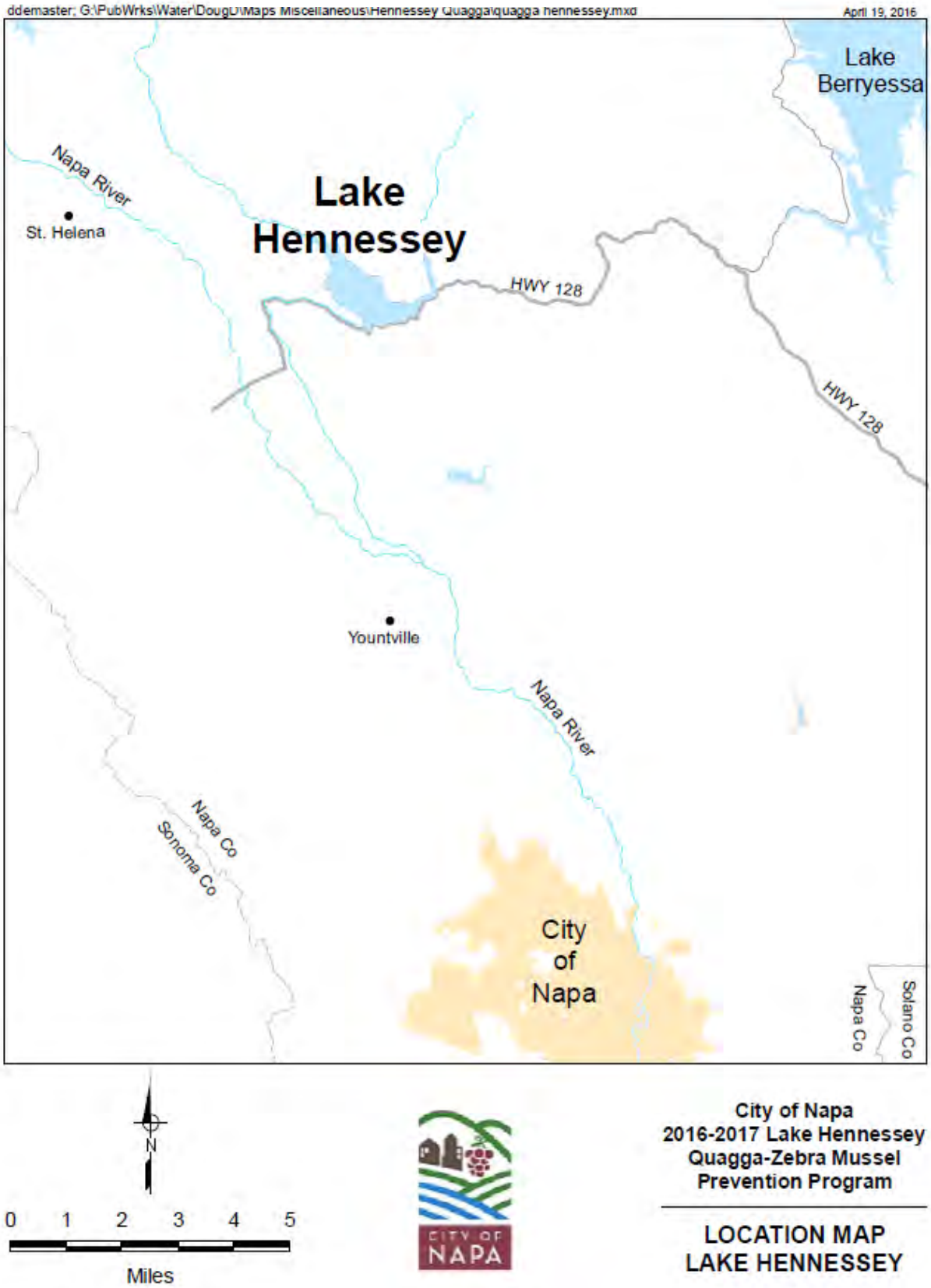
The City of Napa is responsible for operation and maintenance of the dam and reservoir including public access trails and a public boat launch facility. Lake Hennessey is fed by three main tributaries: Conn, Sage and Chiles Creeks. The maximum capacity of Lake Hennessey is 31,000 acre feet. The surface area is approximately 800 acres.

A-2. Description of the Recreational Activities

Recreational activities at Lake Hennessey include boating, fishing, picnicking, and hiking. Recreational boating at Lake Hennessey includes fishing and non-motorized boating including kayaking, and canoeing. There is one dedicated boat launch ramp at the lake. There are also three locations for picnicking / day-use, which are free to the public Figure 2 is a map and list of the boat launch which is the central location for boat launching facilities around Lake Hennessey.

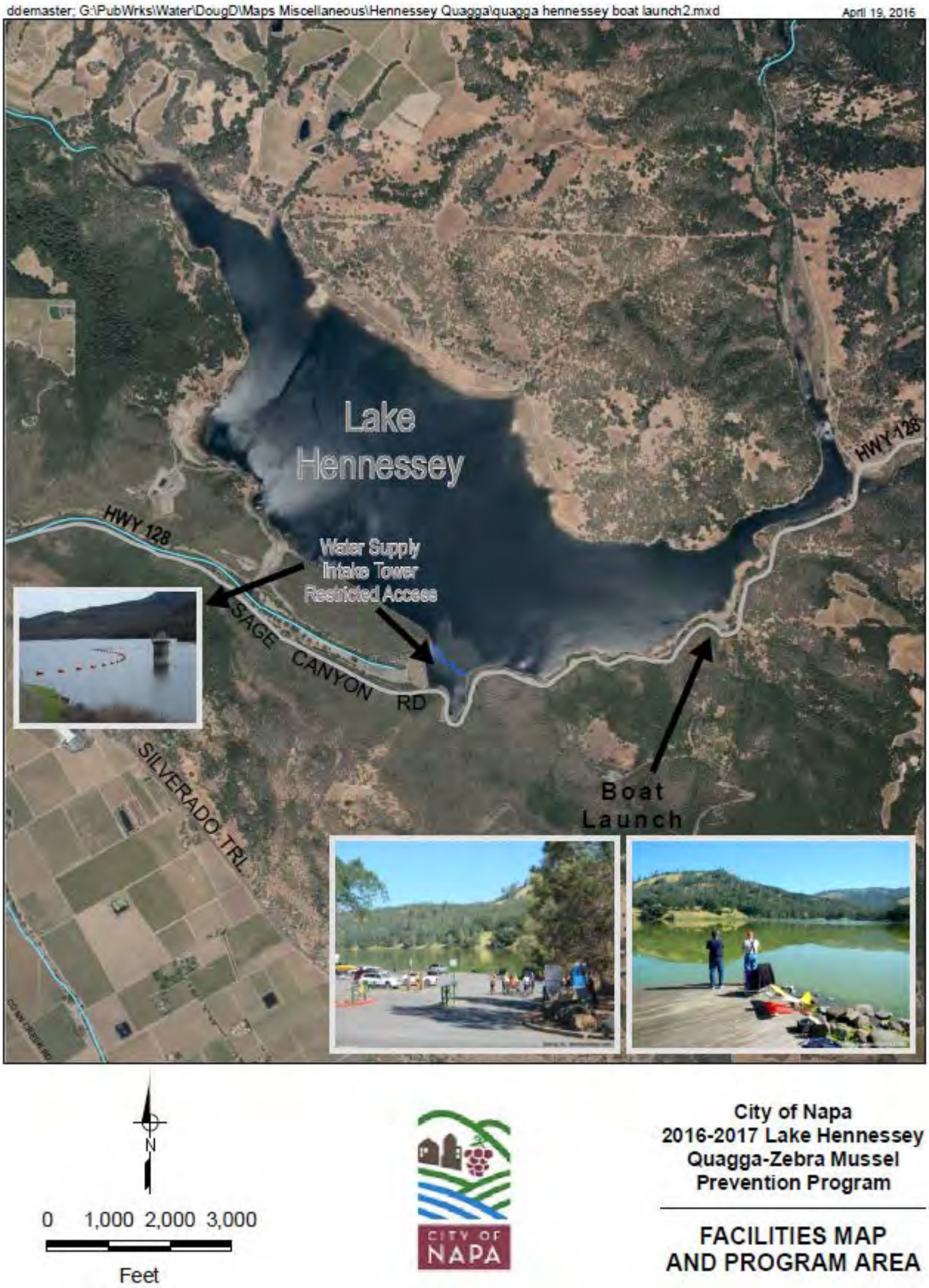
2016 – 2017 Lake Hennessey Invasive Species Protection Program

Figure 1.



2016 – 2017 Lake Hennessey Invasive Species

Figure 2.



The fishing and boating season at Lake Hennessey is typically all year long. The highest usage occurs from Memorial Day to Labor Day. Peak day-use is also from Memorial Day to Labor Day, with Saturday and Sunday being the busiest days of the week, with much reduced usage during the weekdays although fishermen are common in the evenings. The highest percentage of boaters to Lake Hennessey reside in Napa, Solano, and Contra Costa counties based on anecdotal conversations from watershed workers. Day-Users are primarily from Napa and Solano counties. Based on annual boating permits and day use fees the annual number of boat launchings is estimated at 2,740 and an estimated number of user days at 8,220.

Lake Hennessey contains a variety of both warm and cold water fish species including smallmouth bass, largemouth bass, blue gill, crappie, catfish, trout, and others. The fishing season is all year long. The California Department of Fish & Wildlife (DFW) stocks the lake periodically although the frequency has not been consistent over the last five years.

Lake Hennessey currently has restrictions to 10hP motor size, and vessels are allowed on the lake all year. There is an area on the lake that has boating restrictions, which restricts access around the water supply intake tower on the southwest shore extending beyond the shoreline of the earthen dam. There are no fishing restrictions regarding live bait. There is no bodily contact within the lake.

A-3. Description of Management of Recreational Activities

The City of Napa Water Division has two caretaker facilities near the dam that have been historically occupied by water division employees. Watershed facility workers have a presence throughout the watershed and periodically monitor the boat launch area, pick up fees, trash and close the parking lot gate. These individuals interact with boaters and educate them through conversation regarding preserving water quality, limiting bodily contact, and being aware of the potential spread of potential species but the outreach has historically not been performed with consistency on weekends, holidays and peak hours. They witness and address recreational boaters that launch their boats in unauthorized locations, over-fish the lake and generally violate acceptable recreational practices. For example during the summer 2015 a family and extended family was observed fishing from the shores and taking hundreds of crappie fish per day and the Department of Fish and Wildlife were notified and responded to the call to provide enforcement for this violation.

Section B. Project Description

The Lake Hennessey Vulnerability Assessment and Prevention Plan seeks to protect Lake Hennessey water quality, educate boaters and recreators on good boating and stewardship practices, and prevent the spread of invasive species specifically quagga/zebra mussels. The purpose of this grant application (i.e. Project) is to complete the Vulnerability Assessment and develop the Prevention Plan such that Lake Hennessey can improve its protection from the introduction of invasive species. The Project would identify known vulnerabilities of the facility

and develop a prevention plan for implementation to reduce the identified vulnerabilities. Each task is explained in more detail below.

The first task of the Project is to identify the avenues of high potential to introduce invasive Quagga and Zebra mussels. Lake Hennessey is in close proximity with major roads directly connecting it with Lake Berryessa and Clear Lake which both have prevention programs in place. Many boaters that visit Lake Hennessey also visit Lake Berryessa and Clear Lake. Unaware recreators pose the highest risk of inadvertent spread of invasive species. There is also risk of the spread of species through natural means such as being carried and deposited by bird or other predator, or migration during the rainy season, but this is significantly smaller than the risk of humans transporting an ill-wanted hitchhiker to the unaffected water body.

Upon completion of the Vulnerability Assessment the Prevention Plan will be developed. The Prevention plan will detail a multi-faceted approach to preventing the introduction of invasive species including: education and outreach through permanent and mobile signage, hiring and training of program interns to make personal contact with recreators and have consistent presence around the facility, planning for the establishment of a decontamination station.

Upon completion of the Prevention Plan, it is anticipated that in the future, Program interns will conduct invasive species screenings as well as boater and recreator outreach around Lake Hennessey during the high season from May until the last week of September. During the weekend and holiday periods, the Lake Hennessey boat ramp will be staffed by Program Interns with the primary focus on invasive species screening and secondary focus on boater and recreator outreach. From Memorial Day to Labor Day, Program Interns will conduct invasive species screening during the weekdays.

The future Program will also include random invasive species screenings for several fishing tournaments. The purpose of the random screenings during the off-season is to keep boaters and fishermen aware of the importance in preventing the spread of invasive species. The off-season screenings will also illustrate to boaters and fishermen just how serious the City of Napa Water Management considers the risk of invasive species (quagga/zebra mussels). As part of the Outreach Program, the Program Interns will be supported by temporary staff during the off-season, and Watershed staff as needed.

Section C. Regional Impact from Quagga and Zebra Mussel Infestation

Currently, there are no known infestations of quagga or zebra mussels within the region. The closest known infested water body is San Justo Reservoir in San Benito County, approximately 110 miles south of Lake Berryessa. However, if Lake Hennessey were to become infested, the ecological, recreational, and economic impacts would be devastating to the local communities and to the entire region as a whole. The impacts are discussed in more detail below.

C-1. Ecological Impacts

Lake Hennessey contains a variety of both warm and cold water fish species including smallmouth bass, largemouth bass, blue gill, crappie, catfish, trout, and others. Lake Hennessey also supports an abundant and diverse population of phytoplankton, which forms the basis of a healthy food chain, and in turn, healthy fish populations.

Eurasian mussels reduce the amount of nutrients, particulate matter, and phytoplankton in the water column by filtering large volumes of water. High densities of mussels can severely alter the ecosystem by decreasing the food sources necessary for native wildlife and increasing water clarity. The increased clarity allows for greater light penetration resulting in increased algal and aquatic macrophyte growth. While the mussels are not known to directly affect drinking water standards, they are known to affect water quality by contributing to and/or causing blue-green algal blooms (Britton 2010). If Eurasian mussels were to infest Lake Hennessey, the mussels would cause severe ecological impacts and decrease native wildlife food sources in Lake Hennessey, Napa River, San Pablo Bay which Napa River flows directly into. The degraded habitats would not only affect native fish species but also reduce sport-fishing and other recreational opportunities.

C-2. Recreational Impacts

Recreational activities at Lake Hennessey include boating, fishing, and picnicking. If Eurasian mussels were to infest Lake Hennessey and Napa River, there would be a significant loss to the sport-fishing industry, and potential wide scale impacts in San Pablo Bay and the Sacramento-San Joaquin Delta. Besides fishing, boating would likely be severely reduced at Lake Hennessey. Currently, almost 3,000 boat launches occur each year at Lake Hennessey. If the lake were to become infested, recreational boating would likely be stopped at Lake Hennessey which would have severe recreational impacts on the surrounding communities.

In summary, all recreational activities would likely be significantly and negatively impacted at Lake Hennessey, if a Eurasian mussel infestation were to occur.

C-3. Economic Impacts

The economic impact from ecological, recreational, and infrastructure impacts from a quagga or zebra mussel infestation would be significant to several local economies and to the region. A quagga or zebra mussel infestation in Lake Hennessey would significantly reduce recreation such as boating, fishing, and day-use in the lake and in Napa County.

Lastly, Lake Hennessey provides municipal and irrigation water to almost 85,000 residents and vineyards in Napa County. Local businesses rely on the affordable high quality water from Lake Hennessey. If an infestation of quagga or zebra mussels were to occur in Lake Hennessey, it would significantly impact the entire infrastructure as well as the Napa County economy. The Operation & Maintenance (O&M) cost of the drinking water supply would also significantly increase. For example, annual (or more frequent) dive team cleanings would be required to clean the Lake Hennessey intake tower, piping, and many other facilities associated with Conn Dam and the Lake Hennessey Treatment facilities. A chlorination or other chemical injection device would likely be installed near the intake tower to prevent the spread of mussels throughout the entire water system infrastructure. The chlorination device would require several million dollars of upfront capital
cost as well as reoccurring O&M costs. The Metropolitan Water District of Southern California spends approximately $10 million per year in managing quagga mussels. In comparison, the current annual O&M cost of the Lake Hennessey watershed is approximately $100,000 per year. A quagga or zebra mussel infestation in Lake Hennessey would have a significant financial impact on the water supply of City of Napa, surrounding cities and the unincorporated County area served by the City water system. In summary, a quagga or zebra mussel infestation would have a significant economic impact to the local regions throughout Napa Valley.

Section D. Technical and Feasibility Approach

Outreach and Education is considered the best strategy for preventing the introduction of invasive species. Understanding and intercepting vectors (pathways), educating the public using those pathways, and providing materials that communicate the magnitude and urgency of controlling invasive species is essential for success (USDA 2013). The U.S. Forest Service has expressed that *"The most effective strategy against invasive species is to prevent them from ever being introduced and established. Prevention includes education and outreach to raise the awareness of the invasive species problem and reduce the chance of unintentional introduction of invasive species."* (USFS 2012).

Increasing the number of watercraft inspection interns at Lake Hennessey will dramatically increase the outreach to boaters that frequently want more information about protecting the vessels and the environment they use for recreation (Butler 2013). Interns inspect watercraft and provide information about mussels, preventing their introduction, their biology and known

infestations. That outreach concept falls within the USDA Framework for the Invasive Species Systems Approach (ISSA). Engaging the public to prevent the movement of invasive species will be a core concept of the proposed Lake Hennessey Mussel Plan.

The recreational boater represents the highest ranking vector for possible introduction of Eurasian Mussels into Lake Hennessey as concluded to be the highest ranking vector for the nearby Lake Berryessa (Davis 2014). Due to the close proximity, fishermen and boaters that visit Lake Berryessa often frequent Lake Hennessey as well as Clear Lake. As a result the potential threat of introduction of unwanted species within the two water bodies Lake Hennessy and Lake Berryessa are interrelated.

Previous information suggested that boaters engaged in Lollapalooza type events at Lake Havasu routinely move watercraft between Havasu City and Lake Berryessa. (Davis 2014). This represents a potential threat to Lake Hennessey due to the geographic proximity and traffic of visitors that frequent both facilities.

Section E. Monitoring/Tracking and Assessment of Project Outcomes

The Vulnerability Assessment and Prevention Plan will be a deliverable for the Project. Future phases of Project implementation will be tracked and assessed by specific deliverables for each task. Adaptive management will be used to maximize the Lake Hennessey Outreach efforts, such as optimizing staff time (Program Interns) based on boater and recreator trends. If there are any significant changes to the Project, the DBW grant manager will be notified and changes will be made upon approval from the DBW grant manager. The specific deliverables are discussed below, and are designed to establish and optimize the Lake Hennessey Outreach Program.

Scope of Work

1. Lake Hennessey Vulnerability Assessment The Vulnerability Assessment will include a review of water quality parameters and conditions in the existing Lake Hennessey Reservoir as well as an assessment of the recreators in the Lake, types of boats, and habits of visitors as well as information about what other recreational lakes and waterways the visitors frequent. This information will be synthesized into a report that identifies the level of risk of Zebra and Quagga Mussel invasive species infestation.

   Deliverables: *A report of the assessment summarizing the identified risks, potential pathways for introduction of invasive species to Lake Hennessey.*

2. Lake Hennessey Infestation Prevention Plan. The Lake Hennessey Zebra and Quagga Mussel Invasive Species Prevention Plan will detail an approach to implementing actions to educate visitors about identifying potential vectors preventing the spread of invasive species. The Plan is anticipated to include the approach to educating boaters and recreators at Lake Hennessey. Developing the Outreach Program and identifying the components (decontamination system, billboard, and training) to implement outreach.

   Deliverables: *A written Plan for the Outreach Program that includes the strategy and detailed list of action items and metrics to assess the effectiveness of the Program.*

Section E. Water Quality and Quagga/Zebra Mussel Monitoring

Water quality and quagga/zebra mussel monitoring is included in this Project proposal. The City of Napa considers this monitoring of the utmost importance, and is the lead agency on these efforts.

The quagga/zebra mussel monitoring program at Lake Hennessey is comprised of extensive Visual Surveys by City of Napa staff and Mussel Monitoring as performed by the Department of Fish and Wildlife. For the Visual Surveys, various shorelines, boat launch ramp and dock, and fishing sites are monitored on a monthly, bimonthly, or biannual basis. Adult colonization devices such as Secchi discs are monitored by the Department of Fish and Wildlife.

For water quality monitoring, the Water Division conducts in-situ monitoring in the major tributaries flowing into the Lake and near the intake tower that feeds the Lake Hennessey Water Treatment Plant. In-situ measurements include turbidity, pH, specific conductance, and water temperature. The Lake Hennessey Water Treatment Plant conducts water quality monitoring as part of the State Water Resources Control Board – Division of Drinking Water requirements.

Section G. Outreach and Education

The future phases of the Program is anticipated to include Lake Hennessey Outreach Program to provide guidance for early detection & education for Eurasian Mussels. The plan will identify best management practices, define issues, and communicate current understanding and research. Goals and outcomes of the education and outreach components of the Lake Hennessey Mussel Plan include: situational awareness, public education, boater/fishermen surveys, continued monitoring of facilities, and prevention of a mussel infestation at Lake Hennessey.

The development of an effective education program is key to preventing the introduction of quagga/zebra mussels into Lake Hennessey. The Hennessey Mussel Plan will implement a comprehensive education and outreach program beginning July 1, 2017 using the following:

- Training watercraft inspectors at Lake Hennessey
- On-site outreach to boaters
- On-site outreach to fishermen
- Development of educational flyers for local sporting goods stores that sell fishing licenses
- Development of educational flyers posted at the boat launch facility
- Newspaper articles

The education and outreach program was developed using standard practices implemented to prevent the introduction of aquatic nuisance species, which include:

- Identifying pathways
- Understanding life cycles
- Educating possible vectors (anglers/boaters)
- Changing behavior
- Rapid response plan

The education and outreach program will increase awareness through flyers on-site and at fishing licensing stores, newspaper articles, websites, signs and continued boater, fishermen and recreator contacts at Lake Hennessey.

Section H. Key Officers, Oversight Bodies, Consultants or Other Service Providers

Key Officers:

Joy Eldredge, Water General Manager
City of Napa Public Works Water Division
Responsibility: Ms. Eldredge oversees the Water Operation, provides guidance and vision, interacts with the City Council, and is responsible in implementing actions based upon the Council's direction.

Erin Kebbas, Water Quality Manager
City of Napa Public Works Water Division
Responsibility: Ms. Kebbas oversees all water quality and water treatment work as well as the Water Division's local water supply management operations. Ms. Kebbas also manages and oversees Sanitary Survey for water supply protections as well as staff and consultants in regards to all invasive species concerns, including the quagga/zebra mussel. Ms. Kebbas will be the main contact person for the DBW grant reporting and administration.

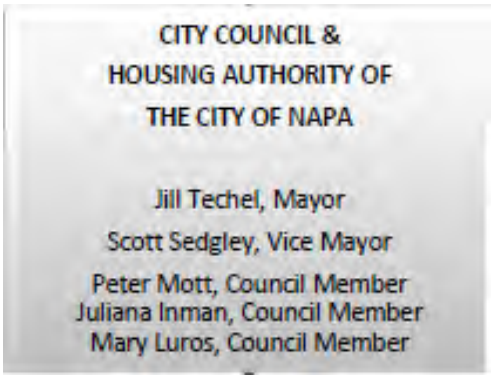
Ken Wright, Watershed Supervisor
City of Napa Public Works Water Division
Responsibility: Mr. Wright oversees various watershed maintenance and protection projects, O&M related issues, water quality monitoring, and has been involved with the Lake Hennessey Watershed on site operations. Mr. Wright will be the field contact person for the DBW grant implementation.

Oversite Body:

City Council
City of Napa
Responsibility: The Water Division is overseen by the City Council that is comprised of the Mayor of Napa and four elected City Council Members.

Figure 3 below shows the organizational chart of the City Council

Figure 3.



Consultants:

To be determined, Education Program Manager
Responsibility: This individual will be responsible for overseeing the education programs for the Lake Hennessey Outreach Program as well as the day-to-day oversite of the Program Interns, primarily during the peak season.

To be determined, Aquatic Biologist
Responsibility: This individual will conduct all of the quagga/zebra mussel monitoring for the Lake Hennessey. The individual shall be a certified mussel instructor by the DFW and will be responsible for writing and updating the City's Mussel Plan.

Section I. Readiness to Proceed

The proposed Project is ready to proceed. The Water Division will contract with an outside entity to write the Vulnerability Assessment and Prevention Plan. The City has determined that CEQA is not required, as the Project is to plan and establish a future program. The City has been successfully managing the Lake Hennessey Watershed and is now ready to document the Vulnerability Assessment and the Prevention Plan for the future Outreach Program to insure protection of Lake Hennessey from invasive species.

References

Britton, David. 2010. Quagga-Zebra mussel action plan for western U.S. waters. Submitted to Aquatic Nuisance Species Task Force. The Western Regional Panel on Aquatic Nuisance Species. 27 pages.

California Fish and Wildlife Service. 24 Sep 2014.
http://www.dfg.ca.gov/invasives/quaggamussel/incidentdescription.html

Davis, Ken W. 2014. Solano Project: Early Detection and Education Plan for Eurasian Mussels. Solano County Water Agency. 40 pages.

USDA. 2013. Forest Service National Strategic Framework for Invasive Species Management. FS-1017. 35 pg.

USFS. Invasive Species Program. Prevention. 1 Feb 2012.
http://www.fs.fed.us/invasivespecies/prevention/index.shtml

Exhibit G References

(Page G1)

REFERENCES

Please provide three (3) Customer References from recent projects, within last ten (10) years. Local and similar size contract references are preferred.

REFERENCE #1	
NAME OF FIRM	
ADDRESS	
CITY, STATE, ZIP CODE	
TELEPHONE #	( )
CONTACT	
PROJECT NAME/COMPLETION DATE	
APPROX. COST	

REFERENCE #2	
NAME OF FIRM	
ADDRESS	
CITY, STATE, ZIP CODE	
TELEPHONE #	( )
CONTACT	
PROJECT NAME/COMPLETION DATE	
APPROX. COST	

REFERENCE #3	
NAME OF FIRM	
ADDRESS	
CITY, STATE, ZIP CODE	
TELEPHONE #	( )
CONTACT	
PROJECT NAME/COMPLETION DATE	
APPROX. COST	

Exhibit H Cost Proposal

(Pages H1-H2)

The undersigned, as proposer, certifies that this submittal is made without collusion with any other person, firm, or corporation; and in submitting a response to this request; has examined instructions, specifications, and all terms and conditions of the solicitation. Proposer proposes and agrees to execute and fully perform in accordance with the instructions, specifications, terms and conditions of this request and any resulting agreement.

Not to Exceed Price for the Scope of Work contained herein (fixed price including all reimbursable):

$_____

Not to Exceed Price (in Words): _____

Name of Firm_____ **Date**_____

Authorized

Signature_____ **Name**_____

Mailing

City_____

Address_____ **State, Zip**_____

Phone_____ **Fax**_____

Email Address _____

Attach an itemization of costs that follows the format listed on the following pages. If necessary, recreate the table to add subcomponents or additional line items to further clarify costs for the City. If a specific item(s) does not apply, then state not applicable with clarifying rationale

Exhibit H shall be submitted in a separate sealed envelope labeled, "RFP FOR MASTER PLAN FOR RESERVOIR AND WATERSHED OPERATIONS – DO NOT OPEN UNTIL EVALUATIONS ARE COMPLETE", the contents of which shall include the following:

1. Total cost by task (see table below)
2. A separate spreadsheet outlining a detailed breakdown of estimated labor hours, proposed rate and method of payment for all services, hourly rates, description of any reimbursable charges, equipment or instrument rentals or purchases, et al.
3. Not-to-exceed price for all work included herein.

TASK NO.	ITEM	COST
1	TM1	
2	TM2	
3	TM3	
4	TM4	
5	TM5	
6	Model of Watershed Runoff Quantity and Quantity	
	Mark-up on direct costs	
	Overhead rate as a percentage of direct labor (_____%)	
	Total:	

Exhibit I Business Information - Primary and Subconsultant

(Pages I1-I2)

Complete one form for the primary firm included in the proposal.

1. Length of time your firm has been in business:_____
2. Length of time at current location:_____
3. List types and business license number(s):

   _____

   _____

4. Names and titles of all officers of the firm:_____

   _____

   _____

   _____

   _____

5. Is your firm a sole proprietorship doing business under a different name? ☐ YES ☐ NO
6. If yes, please indicate sole proprietorship name and the name you are doing business under:

   _____

7. Please indicate your Federal Tax ID Number : _____
8. Is your firm incorporated? ☐ YES ☐ NO
9. Primary Business Address:

   _____

   _____

Complete one form for each sub-consultant included in the proposal.

1. Length of time your firm has been in business:_____
2. Length of time at current location:_____
3. Total.number of employees:_____ _____
4. List types and business license number(s):

   _____

   _____

5. Names and titles of all officers of the firm:

   _____

   _____

6. List the names of similar projects you have worked on within the last ten years.

   _____

   _____

   _____

7. List the number of past projects partnering with Primary Consultant.

   _____

Exhibit J Additions, Deletions and/or Exceptions to Scope of Work

(Page J1)

Please state any and all Additions, Deletions and Exceptions that you are taking to any portion of this solicitation. If not addressed below, then City of Napa assumes that the Proposer will adhere to all terms and conditions listed.

Exhibit K City Standard Agreement for Professional Services

(Pages K1-K11)

AGREEMENT FOR SERVICES

_____

[Note: Describe services, e.g., Auditing Services for Finance Dept, Etc..

This Agreement is dated this ____ day of _____, _____, by and between the City of Napa, a municipal corporation (hereinafter referred to as the "City"), and _____, a _____ *[fill in type of organization]* (hereinafter referred to as "Consultant").

RECITALS

A. The City requires _____ _____.

B. The Consultant is qualified and experienced to provide such services.

NOW, THEREFORE, said City and said Consultant for the considerations hereinafter set forth, mutually agree as follows:

1. SCOPE OF WORK. Consultant shall perform those services described as Tasks in the Scope of Work and Schedule of Performance attached hereto as Exhibit "A" and incorporated herein by reference within the time frames stated therein.

2. COORDINATION. Consultant shall assign _____, to personally participate in said project and to coordinate the activities of the Consultant.

3. COMPENSATION.

[choose one of the following:]

A. City shall pay Consultant as compensation in full for such services and expenses at the rates set forth in the Standard Hourly Rates and Charges attached hereto as Exhibit "B" and incorporated herein by reference. Notwithstanding the above, it is agreed that Consultant shall complete all the services set forth in Exhibit "A" for a total sum not to exceed $_____. Progress payments will be tied to completion of tasks so all payments are proportional to the work completed.

OR

A. City shall pay Consultant as compensation in full for such services the lump sum of $_____ upon completion (and acceptance) of the work. Additional compensation terms, if any, are set forth in the attached Exhibit "B."

B. Consultant shall submit itemized monthly statements for work performed. City shall make any payment due within thirty (30) days after approval of the invoice by City. [OPTIONAL: Payment will be made for the approved amount of the invoice minus ten (10) percent. The ten (10) percent retained by City will be held until 30 days after final completion and acceptance of the contract work.]

C. Payments due and payable to Consultant for current services are within the current budget and within an available, unexhausted and unencumbered appropriation of the City. In the event the City has not appropriated sufficient funds for payment of Consultant services beyond the current fiscal year, this Agreement shall cover only those costs incurred up to the conclusion of the current fiscal year; payment for additional work is conditional upon future City appropriation.

[choose one of the following:]

4. TERM. The term of this Agreement shall be from the date of its execution until the completion of the work contemplated by this Agreement and its final acceptance by City unless terminated earlier as provided herein; except that the obligations of the parties under Paragraph 12 (Indemnification) and Paragraph 13 (Insurance) shall continue in full force and effect after said expiration date or early termination in relation to acts or omissions occurring prior to such dates during the term of this Agreement, and the obligations of Consultant to City shall also continue after said expiration date or early termination in relation to the obligation prescribed by Paragraph 10 (Records of Performance), Paragraph 21 (Taxes), and Paragraph 26 (Confidentiality).

OR

4. TERM. The term of this Agreement shall be from ____ to _____, unless terminated earlier as provided herein; except that the obligations of the parties under Paragraph 12 (Indemnification) and Paragraph 13 (Insurance) shall continue in full force and effect after said expiration date or early termination in relation to acts or omissions occurring prior to such dates during the term of this Agreement, and the obligations of Consultant to City shall also continue after said expiration date or early termination in relation to the obligation prescribed by Paragraph 10 (Records of Performance), Paragraph 21 (Taxes), and Paragraph 26 (Confidentiality).

5. NOTICES. All notices, bills, and payments shall be made in writing and may be given by personal delivery or by mail. Notices, bills and payments sent by mail should be addressed as follows:

TO CITY:
Public Works Department
Attn: Joy Eldredge, Water General Manager
CITY OF NAPA
P.O. Box 660
NAPA, CA 94559-0660

TO CONSULTANT:
_____
_____
_____
_____

and when so addressed, shall be deemed given upon deposit in the United States mail, postage prepaid. In all other instances, notices, bills and payments shall be deemed given at the time of actual delivery. Changes may be made in the names and addresses of the person to whom notices, bills and payments are to be given by giving notice pursuant to this Paragraph.

6. AMENDMENT OF SCOPE OF WORK. City shall have the right to amend the Scope of Work within the Agreement by written notification to the Consultant. In such event, the compensation and time of performance shall be subject to renegotiation upon written demand of either party to the Agreement. Failure of the Consultant to secure City's written authorization for extra or changed work shall constitute a waiver of any and all right to adjustment in the contract price or time due, whether by way of compensation, restitution, quantum merit, etc. for work done without the appropriate City authorization.

7. CITY'S RIGHT TO TERMINATE/SUSPEND CONTRACT. At any time and for any or no reason, City shall have the right to terminate this Agreement, take possession of the Consultant's work, e.g., studies, preliminary drawings, computations, specifications, etc., insofar as they are complete and acceptable to the City and use the same, and pay the Consultant such equitable proportion of the total remuneration as the work satisfactorily done by the Consultant at the time of such discontinuance bears to the whole of the work required to be done by the Consultant under the terms of this Agreement. Notwithstanding the above, Consultant shall not be relieved from liability to City for damages sustained by virtue of any breach of this Agreement by Consultant, whether or not the Agreement was terminated for convenience or cause, and City may withhold payments not yet made to Consultant for the purpose of setoff until such time as the exact

amount of damages due City from Consultant is determined.

8. CORRECTION OF WORK. The performance of services or acceptance of information furnished by Consultant shall not relieve the Consultant from obligation to correct any defective, inaccurate or incomplete work subsequently discovered and all such work shall be remedied by the Consultant on demand without cost to the City.

9. DELAYS AND EXTENSIONS. Time is of the essence concerning performance of this Agreement; however, the Consultant will be granted time extensions for delays beyond the Consultant's control. Time extensions will be equal to the length of the delay or as otherwise agreed upon between the Consultant and the City.

10. RECORDS OF PERFORMANCE. Consultant shall maintain adequate records of contract performance costs, expenses, etc., and make these records available for inspection, audit, and copying by the City during the agreement period and for a period of three (3) years from the date of final payment. Such time for retention shall be extended if grant funds are used to fund this project require the same.

11. SUBCONTRACTING. The City shall be an intended beneficiary of any work performed by a subconsultant for purposes of establishing a duty of care between subconsultant and City. In accordance with Government Code Section 7550, Consultant agrees to state in a separate section of any filed report the numbers and dollars amounts of all contracts and subcontracts relating to preparation of the report.

12. INDEMNIFICATION. To the full extent permitted by law, Consultant shall indemnify, hold harmless, release and defend City, its officers, employees and agents from and against any and all actions, claims, demands, damages, disability, losses, expenses including attorney's fees and other defense costs and liabilities of any nature that may be asserted by any person or entity including Consultant, in whole or in part, arising out of Consultant’s activities hereunder, including the activities of other persons employed or utilized by Consultant in the performance of this Agreement (including design defects and regardless of City's approval, use or acceptance of the work or work product hereunder) excepting liabilities due to the admitted or adjudicated sole negligence or willful misconduct of City. If the adjudicated or admitted sole negligence or willful misconduct of City has contributed to a loss, Consultant shall not be obligated to indemnify City for the proportionate share of such loss caused by such sole negligence or willful misconduct. This indemnification obligation is not limited in any way by any limitation on the amount or type of damages or compensation payable by or for Consultant under Worker's Compensation, disability or other employee benefit acts or the terms, applicability or limitations of any insurance held or provided by Consultant.

13. INSURANCE. Without limiting Consultant's indemnification provided herein, Consultant shall take out and maintain, throughout the period of this Agreement, the following policies of insurance placed with insurers (if other than the State Compensation Fund) with a current A.M. Bests rating of no less than A:VII or its equivalent against injury/death to persons or damage to property which may arise from or in connection with the activities hereunder of Consultant, its agents, employees or subcontractors:

A. Comprehensive or Commercial General Liability Insurance at least as broad as Insurance Services Office Commercial General Liability coverage (occurrence form CG 0001), in an amount of $1,000,000.00 per occurrence. If work involves explosive, underground or collapse risks, XCU must be included. If a general aggregate limit is used, either the general aggregate limit shall apply separately to this project or the general aggregate shall be twice the required occurrence limit. Said policy shall contain, or be endorsed with, the following provisions:

(1) The City, its officers, employees and agents, are covered as insureds for liability arising out of the operations performed by or on behalf of Consultant. The coverage shall contain no special limitations on the scope of protection afforded to the City, its officers, agents and employees.

(2) The policy shall not be canceled or materially reduced in coverage without thirty (30) days prior written notice ten (10) days for non-payment of premium to City by certified mail.

B. Automobile liability insurance with coverage at least as broad as ISO Form numbers

CA 0001 06 92, Code 1 (any auto), for vehicles used in the performance of this Agreement with minimum coverage of not less than $1,000,000 per accident combined single limit (CSL). Such policy shall contain or be endorsed with the provision that coverage shall not be canceled or materially reduced in coverage without thirty (30) days prior written notice ten (10) days for non-payment of premium to City by certified mail.

C. Worker's Compensation insurance meeting statutory limits of Labor Code which policy shall [contain or be endorsed to contain a waiver of subrogation against City, its officers, agents, and employees and] provide for thirty (30) days prior written notice to City in the event of cancellation. If Consultant has no employees, Consultant may sign and file the following certification in lieu of insurance:

> *"I am aware of the provisions of California Labor Code Section 3700 which requires every employer to be insured against liability for workers' compensation or to undertake self-insurance in accordance with the provisions of that code, and I will comply with the provisions of that code before commencing with and during the performance of the work of this contract."*

D. Professional liability insurance/errors and omission coverage in an amount no less than $1,000,000.00 combined single limit (CSL). If insurance is written on a claim-made basis, Consultant agrees to maintain such insurance in effect for at least three (3) years following completion of performance under this Agreement.

E. Consultant shall furnish City with certificates and original endorsements effecting the required coverage prior to execution of this Agreement by City. The endorsements shall be on forms provided by City or as approved by City Attorney. Any deductible or self-insured retention over $100,000.00 shall be disclosed to and approved by City. If Consultant does not keep all required insurance policies in full force and effect, City may, in addition to other remedies under this Agreement, terminate or suspend this Agreement.

14. STANDARD OF CARE. City relies upon the professional ability of Consultant and representations regarding the type of work to be performed as a material inducement to entering into this Agreement. Consultant agrees to use reasonable care and diligence in rendering services under this Agreement. Consultant is responsible for the work of all employees, subconsultants, and agents, and the negligence of one of them, if not adequately remedied by Consultant, shall be conclusively deemed to be the negligence of Consultant. Consultant agrees that the acceptance of his work by City shall not operate as a waiver or release of said obligation of Consultant. The absence, omission, or failure to include in this Agreement, items which are normally considered to be a part of generally accepted professional procedure or which involve specialized professional judgment appropriate to the type of work to be performed under this Agreement shall not be used as a basis for submission of inadequate work or incomplete performance.

15. COVENANT AGAINST CONTINGENT FEES. The Consultant warrants that he has not employed or retained any company or person, other than a bona fide employee working for the Consultant, to solicit or secure this Agreement, and that he has not paid or agreed to pay any company or person, other than a bona fide employee, any fee, commission, percentage, brokerage fee, gift, or any other consideration, contingent upon or resulting from the award or making this Agreement. For breach or violation of this warranty, the City shall have the right to annul this Agreement without liability, or, in its discretion to deduct from the Agreement price or consideration, or otherwise recover, the full amount of such fee, commission, percentage, brokerage fee, gift, or contingent fee.

16. CONFLICT OF INTEREST. Consultant covenants that it presently has no interest and shall not acquire any interest, direct or indirect, which would conflict in any manner or degree with the performance of its services hereunder. Consultant further covenants that in the performance of this Agreement, no person having any such interest shall be employed.

17. STATEMENT OF ECONOMIC INTEREST. If City determines Consultant comes within the definition of Consultant under the Political Reform Act (Government Code §87100), Consultant shall

complete and file and shall require any other person doing work under this Agreement to complete and file a "Statement of Economic Interest" with the Clerk of the City of Napa disclosing Consultant and/or such other person's financial interests. In such case, Consultant shall not make or participate in making or in any way attempt to use Consultant's position to influence a governmental decision in which Consultant knows, or has reason to know, Consultant has a financial interest other than the compensation promised by this Agreement. Consultant represents that Consultant has diligently conducted a search and inventory of Consultant's economic interests, as defined in the regulations promulgated by the Fair Political Practices Commission, and has determined that Consultant does not, to the best of Consultant's knowledge, have an economic interest that would conflict with Consultant's duties under this Agreement. Consultant will immediately advise the General Counsel of Authority if Consultant learns of an economic interest of Consultant's during the term of this Agreement.

18. DEFAULT. If Consultant should fail to perform any of his obligations hereunder, within the time and in the manner herein provided or otherwise violate any of the terms of this Agreement, City may terminate this Agreement by giving Consultant written notice of such termination, stating the reason for such termination. In such event, Consultant shall be entitled to receive as full payment for all services satisfactorily rendered and expenses incurred hereunder, an amount which bears the same ratio to the total fees specified in the agreement as the services satisfactorily rendered hereunder by Consultant bear to the total services otherwise required to be performed for such total fee; provided, however, that the City may withhold payments not yet made to Consultant for the purpose of setoff until such time as the exact amount of damages due City from Consultant is determined.

19. THIRD PARTY BENEFICIARIES. Nothing contained in this Agreement shall be construed to create and the parties do not intend to create any rights in third parties.

20. INDEPENDENT CONTRACTOR. The parties intend that Consultant, in performing the services specified herein, shall act as an independent contractor and shall have control of the work and the manner in which it is performed. Consultant is not to be considered an agent or employee of the City and is not entitled to participate in any pension plan, insurance, bonus or similar benefits City provides its employees. In the event City exercises its right to terminate this Agreement, Consultant expressly agrees that he/she shall have no recourse nor right of appeal under rules, regulations, ordinances or laws applicable to employees.

21. TAXES. Consultant agrees to file tax returns and pay all applicable taxes on amounts paid pursuant to this Agreement and shall be solely liable and responsible to pay such taxes and other obligations, including, but not limited to, state and federal income and FICA taxes. Consultant agrees to indemnify and hold the City harmless from any liability which it may incur to the United States or to the State of California as a consequence of Consultant's failure to pay, when due, all such taxes and obligations.

22. EMPLOYMENT PRACTICES. Consultant shall not discriminate in its performance under the Agreement either directly or indirectly on the grounds of race, color, religion, sex, age, national origin, or other prohibited grounds in its employment practices, and shall take affirmative steps to ensure that applicants are employed and employees are treated during employment without regard to race, color, religion, sex, age, national origin, or other prohibited grounds.

23. COMPLIANCE WITH LAW.

A. Consultant shall study and comply with all applicable federal, state and local laws, rules and regulations affecting the Consultant and his/her work hereunder and shall ensure that all subcontractors do the same. *[if surveyors will be used for field survey work, add: including, without limitation, compliance with the prevailing wage requirements of Labor Code Sections 1720 and 1770]*. Consultant represents and warrants to City that Consultant has and will keep in effect during the term of this Agreement all licenses (including but not limited to the City of Napa business license), permits, qualifications and approvals of whatsoever nature which are legally required for Consultant to practice Consultant's profession and to do the work hereunder.

B. Consultant agrees to abide by the requirements of the Immigration and Control Reform Act pertaining to assuring that all newly-hired employees of Consultant performing any services under this Agreement have a legal right to work in the United States of America, that all required documentation of such right to work is inspected, and that INS Form 1-9 (as it may be amended from time to time) is completed and on file for each employee. Consultant shall make the required documentation available upon request to City for inspection.

24. TITLE TO DOCUMENTS. Title to all plans, specifications, maps, estimates, reports, manuscripts, drawings, descriptions and other final work products compiled by the Consultant under the Agreement, including the unlimited license to use the same for completion and maintenance of the project described in this Agreement, shall be vested in the City, none of which shall be used in any manner whatsoever, by any person, firm, corporation, or agency without the expressed written consent of the City. Basic survey notes and sketches, charts, computations, and other data prepared or obtained under the Agreement shall be made available, upon request, to the City without restriction or limitations on their use. Consultant may retain copies of the above-described information but agrees not to disclose or discuss any information gathered, discussed or generated in any way through this Agreement without the written permission of City during the term of this Agreement or until ninety (90) days after receipt of final payment from City.

25. RIGHT TO ADEQUATE ASSURANCE OF PERFORMANCE. Each party to this Agreement undertakes the obligation that the other's expectation of receiving due performance will not be impaired. When reasonable grounds for insecurity arises with respect to the performance of either party, the other may in writing demand adequate assurance of due performance, and until it receives such assurance, may, if reasonable, suspend any performance for which the agreed return has not been received. "Reasonable" includes not only the conduct of a party with respect to other agreements with parties to this Agreement or others. After receipt of a justified demand, failure to provide within a reasonable time, but not exceed fifteen (15) days, such assurance of due performance as is adequate under the circumstances of the particular case is a repudiation of this Agreement. Acceptance of any improper delivery, service or payment does not prejudice the aggrieved party's right to demand adequate assurance of future performance.

26. CONFIDENTIALITY. Consultant shall treat all information obtained from City in the performance of this Agreement as confidential and proprietary to City. Consultant shall treat all records and work product prepared or maintained by Consultant in the performance of this Agreement as confidential. Consultant agrees that it will not use any information obtained as a consequence of the performance of work for any purpose other than fulfillment of Consultant's scope of work. Consultant will not disclose any information prepared for City, or obtained from City or obtained as a consequence of the performance of work, to any person other than City, or its own employees, agents or subcontractors, who have a need for the information for the performance of work under this Agreement unless such disclosure is specifically authorized in writing by the City. Consultant shall advise City of any request for disclosure of information or of any actual or potential disclosure of information. Consultant's obligations under this paragraph shall survive the termination of this Agreement.

27. ACCIDENT REPORT. If any damage (including death, personal injury, or property damage) occurs in connection with the performance of this Agreement, Consultant shall promptly submit to the City Clerk's Office a written notice of such accident with the following information:

A. Name and address of the injured or deceased person(s);
B. Name and address of any witness;
C. Name and address of Consultant's insurance company; and
D. A detailed description of the damage and whether any City property was involved.

28. ELECTRONIC COMMUNICATIONS. During the course of this Agreement, communications may occur through sending, receiving or exchanging electronic versions of documents and e-mails using commercially available computer software and Internet access. Consultant and the City acknowledge that the Internet is occasionally victimized by the creation and dissemination of so-called viruses or similar

destructive electronic programs. Consultant and the City view the issues raised by these viruses seriously and have invested in document and e-mail scanning software that identify and reject files containing known viruses. Consultant agrees to update its system with the software vendor's most current releases at regular intervals. Because of the virus scanning software, the respective computer systems of the parties may occasionally reject a communication. The parties acknowledge that this occurrence is to be expected as part of the ordinary course of business. Because the virus protection industry is generally one or two steps behind new viruses, neither party can guarantee that its respective communications and documents will be virus free. Occasionally, a virus will escape and go undetected as it is passed from system to system. Although each party will use all reasonable efforts to assure that its communications are virus free, neither party warrants that its documents will be virus free. Each party agrees to advise the other if it discovers a virus in its respective system that may have been communicated to the other party.

29. ELECTRONIC OR MAGNETIC DATA. If the Scope of Work requires that Consultant provide documents in electronic or magnetic formats, they shall be provided in a manipulative form. City recognizes that electronic or magnetic data and its transmission may be damaged, may develop inaccuracies during use, and may contain viruses or other destructive programs, and that software and hardware operating systems may become obsolete. Consultant shall not be liable for any loss of use, profit, or any other damages arising from City's reuse, misuse, modification, or misinterpretation of the data submitted in electronic or magnetic form. Nothing contained in this paragraph shall affect the indemnification or standard of care required hereunder for Consultant with respect to Consultant's work and work products delivered in hard copy.

30. GENERAL PROVISIONS.

A. Headings. The heading titles for each paragraph of this Agreement are included only as a guide to the contents and are not to be considered as controlling, enlarging, or restricting the interpretation of the Agreement.

B. Severability. If any term of this Agreement (including any phrase, provision, covenant, or condition) is held by a court of competent jurisdiction to be invalid or unenforceable, the Agreement shall be construed as not containing that term, and the remainder of this Agreement shall remain in full force and effect; provided, however, this paragraph shall not be applied to the extent that it would result in a frustration of the parties' intent under this Agreement.

C. Governing Law, Jurisdiction, and Venue. The interpretation, validity, and enforcement of this Agreement shall be governed and interpreted in accordance with the laws of the State of California. Any suit, claim, or legal proceeding of any kind related to this Agreement shall be filed and heard in a court of competent jurisdiction in the County of Napa.

D. Attorney's Fees. In the event any legal action is commenced to enforce or interpret this Agreement, the prevailing party is entitled to reasonable attorney's fees, costs, and expenses incurred, whether or not such action proceeds to judgment.

E. Assignment and Delegation. This Agreement, and any portion thereof, shall not be assigned or transferred, nor shall any of the Consultant's duties be delegated without the written consent of City. Any attempt to assign or delegate this Agreement without the written consent of the City shall be void and of no force or effect. A consent by the City to one assignment shall not be deemed to be a consent to any subsequent assignment.

F. Modifications. This Agreement may not be modified orally or in any manner other than by an agreement in writing signed by both parties.

G. Waivers. Waiver of a breach or default under this Agreement shall not constitute a continuing waiver or a waiver of a subsequent breach of the same or any other provision of this Agreement.

H. Time. Time is of the essence in carrying out the duties hereunder.

I. Entire Agreement. This Agreement, including all documents incorporated herein by reference, comprises the entire integrated understanding between the parties concerning the services described herein. This Agreement supersedes all prior negotiations, agreements, and understandings regarding this matter, whether written or oral. The documents incorporated by reference into this Agreement are complementary; what is called for in one is binding as if called for in all.

J. Each Parties' Role in Drafting the Agreement. Each party to this Agreement has had an opportunity to review the Agreement, confer with legal counsel regarding the meaning of the Agreement, and negotiate revisions to the Agreement. Accordingly, neither party shall rely upon Civil Code Section 1654 in order to interpret any uncertainty in the meaning of the Agreement.

K. Signatures. The individuals executing this Agreement represent and warrant that they have the right, power, legal capacity, and authority to enter into and to execute this Agreement on behalf of the respective legal entities of the Consultant and the City.

IN WITNESS WHEREOF, the parties hereto have caused this Agreement to be executed the day and year first above written.

CITY OF NAPA:

_____
(Signature)

_____
(Type name and title)

ATTEST:

_____
(Signature)

Dorothy Roberts, City Clerk
(Type name and title)

COUNTERSIGNED:

_____
(Signature)

Desiree Brun, City Auditor
(Type name and title)

APPROVED AS TO FORM:

_____
(Signature)

Michael W. Barrett, City Attorney
(Type name and title)

Budget Code:_____

CONSULTANT:

_____
*(Type name of Consultant/form of organization)**

By: _____
(Signature)

_____
(Type name and title)

By: _____
(Signature)

_____
(Type name and title)

Address: _____
_____

Telephone: _____

*Corporation, partnership, limited liability corporation, sole proprietorship, etc.
Unless corporate resolution delegates an individual to sign contracts, an agreement with a corporation shall be signed by the President or Vice President **and** the Secretary or Treasurer of the corporation. A general partner shall sign on behalf of a general partnership. The managing member, if authorized, may sign on behalf of a limited liability corporation.

EXHIBIT "A"

SCOPE OF WORK

AND

SCHEDULE OF PERFORMANCE

EXHIBIT "B"

COMPENSATION RATES AND CHARGES

CERTIFICATE OF CONSULTANT

I HEREBY CERTIFY that I am the _____, and a duly authorized representative of the firm of _____, whose address is _____, and that neither I nor the above firm I here represent has:

a) Employed or retained for a commission, percentage, brokerage, contingent fee, or other consideration, any firm or person (other than a bona fide employee working solely for me or the above consultant) to solicit to secure this Agreement.

b) Agreed, as an express or implied condition for obtaining this contract, to employ or retain the services of any firm or person in connection with carrying out the Agreement; or

c) Paid, or agreed to pay, to any firm, organization or person (other than a bona fide employee working solely for me or the above consultant) any fee, contribution, donation, or consideration of any kind for, or in connection with, procuring or carrying out the Agreement;

Except as here expressly stated (if any);

I acknowledge that this certificate is subject to applicable State and Federal laws, both criminal and civil.

_____ _____

Date Signature

Exhibit L Consultant Evaluation Form

(Page L1)

TECHNICAL CONSULTANT EVALUATION FORM				
	Criteria	**Maximum Score**	**Score**	**Comments**
1	**Statement of qualifications and experience:** summary of the proposer's qualifications and recent experience in providing services related to the topics requested in this proposal (including a list of subconsultants and their qualifications and experience).	30		
2	**Approach and methodology:** summary of proposer's approach and team organization which shall include a summary of the firm's understanding of issues, approach to gathering information, potential challenges and proposed solutions, etc. as outlined in Section III.	20		
3	**References and completeness:** summary of references as provided in Exhibit G and overall quality/completeness of proposal package.	20		
4	**Cost:** price to include all labor, equipment, etc. for consultant services as outlined in Section III and shall be delivered in a separate sealed envelope.	20		
5	**Work schedule and timeline:** summary of assigned timelines to each task and/or subtask outlined in Section III.	10		
		TOTAL SCORE =_____(MAXIMUM SCORE = 100)		

The City is interested in maximizing the value of outsourcing consultant services. Prospective Firms should propose the most cost effective methodology and technology to meet the requirements of this RFP.

Completed copies of evaluation forms will not be made available to proposers. However, upon completion of the evaluation and selection process, proposers will be advised of the top-ranked design firms. The selected Firm will be invited to negotiate the terms of an agreement for design services with the City. If an agreement is not reached within a reasonable period, negotiations will be opened with the next ranked choice of the selection committee.