North Hollywood West Wellhead Treatment Commissioning Summary Report

For the City of Los Angeles
System No. 19100067

Prepared for
California State Water Resources Control Board Division of Financial Assistance in Accordance with Grant Agreement No. D1712509 and Division of Drinking Water

Prepared by
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LOS ANGELES DEPARTMENT OF WATER AND POWER

North Hollywood West Wellhead Treatment Commissioning Summary Report

For the City of Los Angeles

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ACRONYMS AND ABBREVIATIONS

AOP	Advanced Oxidation Process
CERLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFS	Cubic Feet per Second
COPCs	Constituents of Potential Concern
DCE	Dichloroethene
DDW	State Water Resources Control Board - Division of Drinking Water
DRL	Detection Limit for Reporting
GAC	Granular Activated Carbon
gpm	US Gallons per Minute
H_2O_2	Hydrogen Peroxide
IRA	Interim Remedial Action
IRAD	Interim Remedial Action Decision
LADWP	Los Angeles of Water and Power
MDL	Method Detection Limit
NH	North Hollywood
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NHW	North Hollywood West
NHWWT	North Hollywood West Wellhead Treatment
OH	Hydroxyl Radical
PLC	Programmable Logic Controller
PCE	Tetrachloroethene
RIFS	Remediation Investigation / Feasibility Study
SP	Setpoint
TCE	Trichloroethene
µg/L	Microgram per Liter
UV	Ultraviolet
UV AOP	Ultraviolet Advanced Oxidation Process
UVT	Ultraviolet Transmittance

1 INTRODUCTION

This document presents the Los Angeles Department of Water and Power (LADWP) North Hollywood West Wellhead Treatment (NHWWT) Commissioning Summary Report. Additional details can be found in the LADWP NHWWT Commissioning Report (LADWP, July 2023) Commissioning is the final phase of start-up and performance testing for the NHWWT facility (Figure 1-1). The purpose of this report is to present a summary of the methodologies, activities, and results of NHWWT commissioning conducted from April 17 through May 05, 2023.

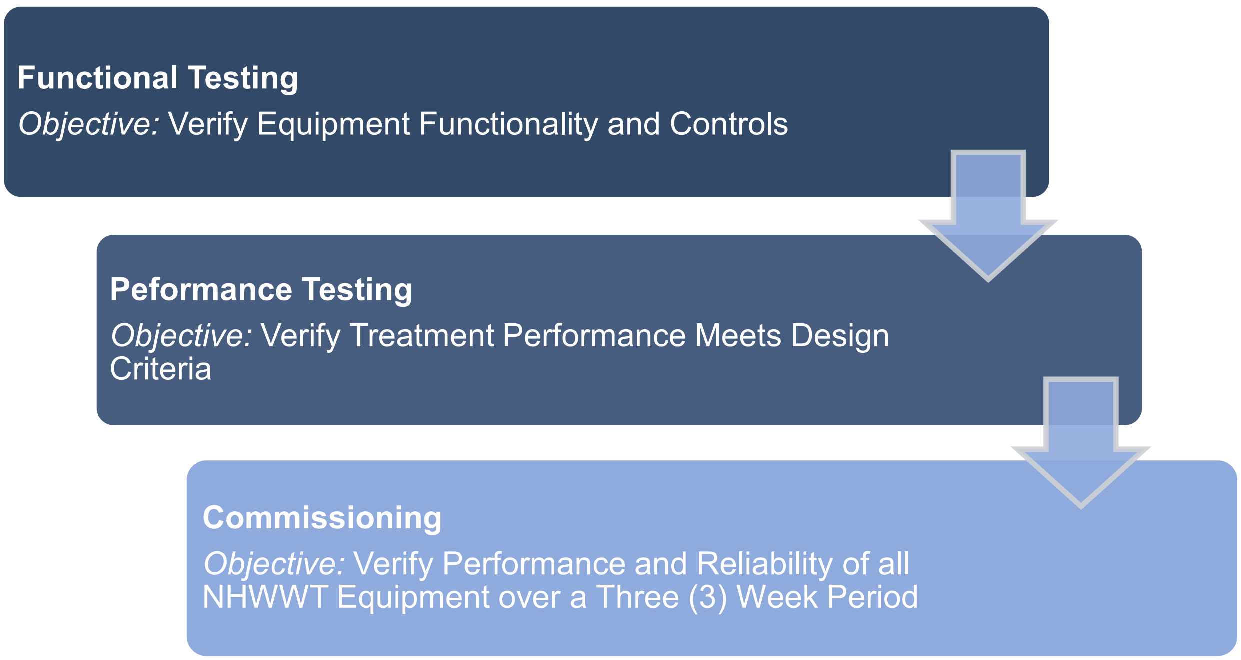


Figure 1-1. Overview of NHWWT Start-Up and Commissioning Phases

1.1 Objective

The objective of commissioning was to verify the performance and reliability of all NHWWT equipment at average well flow rates under normal operating conditions with the facility operating in automatic control. This included evaluating the accuracy of the UV AOP control equations for predicting 1,4-dioxane log reductions. Facility performance was evaluated under a range of flow and potential water quality variations between wells.

1.2 Background

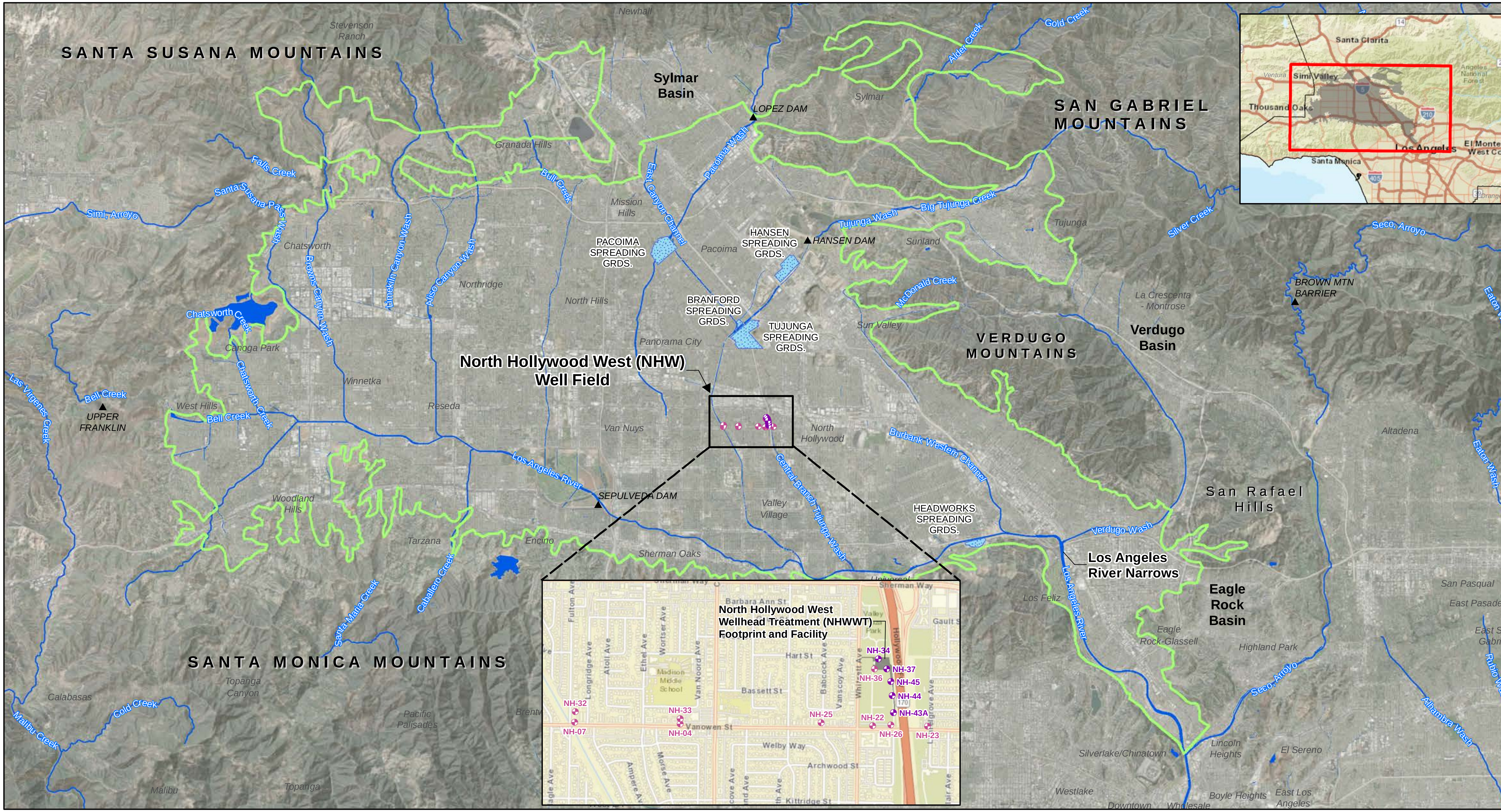
The North Hollywood West (NHW) Well Field is one of LADWP's production well fields within the San Fernando Basin and is located along Vanowen Street just west of State Route 170. The NHW Well Field includes 13[1] production wells. The well field setting and approximate NHW production well locations are shown in Figure 1-2.

LADWP, pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), selected the NHW Interim Remedial Action (IRA) to address dissolved 1,4-dioxane in groundwater entering the NHW Well Field under active pumping conditions. The NHW IRA involves extracting and treating impacted groundwater from three Remediation Wells (NH-34, NH-37, NH-45) with a design that allows expansion to enable treatment of five Remediation Wells [NH-34, NH-37, NH-45 plus NH-43A, NH-44]). The treated water will be used as a source of potable water supply. Details of the selected IRA for the NHW Well Field are documented in the Interim Remedial Action Decision (IRAD) document (Hazen and Sawyer [Hazen] 2017). The locations of the Remediation Wells and other NHW non-remedy production wells are shown in Figure 1-2.

Using State Water Resources Control Board - Division of Drinking Water's (DDW's) MCL-equivalent methodology[2] to assess the cumulative risk posed by multiple contaminants in treatment influent, the following treated water goals[3] were established for the NHHWT facility to ensure cumulative risk is addressed and provide extra caution in the protection of public health:

- 1,4-Dioxane (<1 micrograms per liter [μg/L]; DDW detection limit for reporting [DLR] = 1 μg/L).
- Trichloroethene (TCE) (<0.5 μg/L; DLR = 0.5 μg/L).
- Tetrachloroethene (PCE) (<0.5 μg/L; DLR = 0.5 μg/L).
- 1,1-Dichloroethene (1,1-DCE) (<0.5 μg/L; DLR = 0.5 μg/L).
- cis-1,2-Dichloroethene (cis-1,2-DCE) (<0.5 μg/L; DLR = 0.5 μg/L).

[1] A 14th production well, NH-23, is currently (June/July 2023) being decommissioned.
[2] Described in Section 4 of the DDW Process Memo 97-005-R2020 - Revised Guidance for Direct Domestic Use of Extremely Impaired Sources (DDW 2020).
[3] The treated water goals evaluation is documented in the *Effective Treatment and Monitoring for the North Hollywood West Well Field (Step 4 of 97-005 Evaluation) Report* (LADWP 2020b).



Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community. CA DWR - B118_BasinBoundaries_v4.1, LA County GIS, LADWP, NHD.

Note:
* - NH-23 is non-operational and will be destroyed in the future
Features shown on this figure are approximate and should be used for indicative purposes only.

Legend

- NHW REMEDIATION WELLS
- NHW PRODUCTION WELLS (NON-REMEDY)
- RIVERS/WASHES
- SPREADING GROUNDS
- SAN FERNANDO VALLEY GROUNDWATER BASIN

LA DWP Los Angeles Department of Water & Power

Hazen ARCADIS Advisian

NHW WELL FIELD SETTING, NHW REMEDIATION WELLS AND PRODUCTION WELL (NON-REMEDY WELL) LOCATIONS, AND APPROXIMATE LOCATION OF THE NHWWT FACILITY

SWL	SB	6/22/2023
308038-13235 DDW 97-005		1-2

FILE LOCATION: E:\GIS\Projects\308038-13235\mapdocuments\30216-22-2023\Fig 1-2 - NHW Well Field Setting B.mxd

USER NAME: Steven.Lindelof
ISSUING OFFICE: Orange County GIS
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1.3 North Hollywood West Wellhead Treatment Overview

Treatment includes ultraviolet advanced oxidation process (UV AOP) technology to remove 1,4-dioxane as well as TCE, PCE, 1,1-DCE and cis-1,2-DCE. Granular Activated Carbon (GAC) will quench any remaining hydrogen peroxide from water downstream of AOP and provide an additional volatile organic compound (VOC) treatment barrier in case of loss of treatment by AOP. Downstream of the facility, the treated water will be dosed with chlorine using the existing chemical dosing system at the North Hollywood West Chlorination Station using Onsite Sodium Hypochlorite Generation (OSHG). Water will then flow through the NHW Collector Line and on to the North Hollywood (NH) Sump and Forebay for ammonia dosing to form chloramines, chlorine trimming, and fluoride dosing. Flow from the NH Sump and Forebay is pumped through the existing NH Pump Station to the distribution system. The disinfection dosing system is not part of the NHWWT design and therefore is not described in this document. Figure 1-3 presents the NHWWT conceptual process flow diagram, and treatment capacities are presented in Table 1-1. Information pertaining to estimated NHWWT influent concentrations, design influent and treated water concentrations, and the log-reduction for the five constituents with treated water goals, i.e., 1,4-dioxane, TCE, PCE, 1,1-DCE and cis-1,2-DCE are provided in Table 1-2 (assuming *three* Remediation Wells pumping) and Table 1-3 (assuming *five* Remediation Wells pumping).

Table 1-1. Treatment Capacity

Remediation Wells	Design Flow (gpm)	Design Flow (cfs)
Three Remediation Wells: NH-34, NH-37, NH-45	9,750	21.7
Five Remediation Wells: NH-34, NH-37, NH-45, and NH-43A, NH-44	12,750	28.4

Notes*:* gpm = gallons per minute, cfs = cubic feet per second

Table 1-2. NHWWT Treatment Goals: Three Remediation Wells (NH-34, NH-37, NH-43A) Operating

COPC	Estimated UCL95 Conc.[1]	Estimated Max Influent Conc.[2]	Safety Factor	Design Influent Conc.[3]	Design Effluent Conc. & Treated Water Goal	Log Reduction
1,4-Dioxane	**3.6**	**8**	**2.5**	**20**	**<0.25**	**1.9-log reduction**
TCE	2.8	9.2	--	50	<0.5	2.0-log reduction
PCE	1.3	3.8	--	31.5	<0.5	1.8-log reduction
1,1-DCE	0.9	2.5	--	>500	<0.5	>3.0-log reduction
cis-1,2-DCE	0.5	0.7	--	>500	<0.5	>3.0-log reduction

Notes:
All concentrations expressed in ***micrograms per liter (µg/L)****; COPC = Constituent of Potential Concern; PCE = tetrachloroethene; TCE = trichloroethene; DCE = dichloroethene; Conc. = Concentration;*
(1) = Concentration based on the UCL95 (95% upper confidence limit of the population mean) calculated using production well data as presented in the NHW Well Field Raw Water Quality Characterization Report (Hazen 2020a).
(2) = For 1,4-dioxane, the maximum influent concentration was derived from forecast groundwater flow and fate and transport modeling. For TCE, PCE, 1,1-DCE and cis-1,2-DCE, maximum influent concentrations are estimated based on historical maximum values from production wells samples. For additional information refer to the NHW Well Field Raw Water Quality Characterization Report (Hazen 2020a) and NHW Well Field Interim Remedial Investigation / Feasibility Study (RI/FS) (Hazen 2016).
(3) = Design influent concentrations for TCE, PCE, 1,1-DCE, and cis-1,2-DCE based on treatment capacity when ***targeting 1,4-dioxane*** *at design influent concentrations of 20 µg/L (three remediation wells), and 10 µg/L (five remediation wells).*

Table 1-3. NHWWT Treatment Goals: Five Remediations Wells (NH-34, NH-37, NH-43A, NH-44, NH-45) Operating

COPC	Estimated UCL95 Conc.(1)	Estimated Max Influent Conc.(2)	Safety Factor	Design Influent Conc.(3)	Design Effluent Conc. & Treated Water Goal	Log Reduction
1,4-Dioxane	**5.6**	**4**	**2.5**	**10**	**<0.25**	**1.6-log reduction**
TCE	3.3	11.3	--	24	<0.5	1.68-log reduction
PCE	1.6	5.4	--	20	<0.5	1.6-log reduction
1,1-DCE	0.8	2.2	--	500	<0.5	>3.0-log reduction
cis-1,2-DCE	0.5	0.8	--	500	<0.5	>3.0-log reduction

Notes:
All concentrations expressed in ***micrograms per liter (µg/L)****; COPC = Constituent of Potential Concern; PCE = tetrachloroethene; TCE = trichloroethene; DCE = dichloroethene; Conc. = Concentration;*
(1) = Concentration based on the UCL95 (95% upper confidence limit of the population mean) calculated using production well data as presented in the NHW Well Field Raw Water Quality Characterization Report (Hazen 2020a).
(2) = For 1,4-dioxane, the maximum influent concentration was derived from forecast groundwater flow and fate and transport modeling. For TCE, PCE, 1,1-DCE and cis-1,2-DCE, maximum influent concentrations are estimated based on historical maximum values from production wells samples. For additional information refer to the NHW Well Field Raw Water Quality Characterization Report (Hazen 2020a) and NHW Well Field Interim Remedial Investigation / Feasibility Study (RI/FS) (Hazen 2016).
(3) = Design influent concentrations for TCE, PCE, 1,1-DCE, and cis-1,2-DCE based on treatment capacity when ***targeting 1,4-dioxane*** *at design influent concentrations of 20 µg/L (three remediation wells), and 10 µg/L (five remediation wells).*

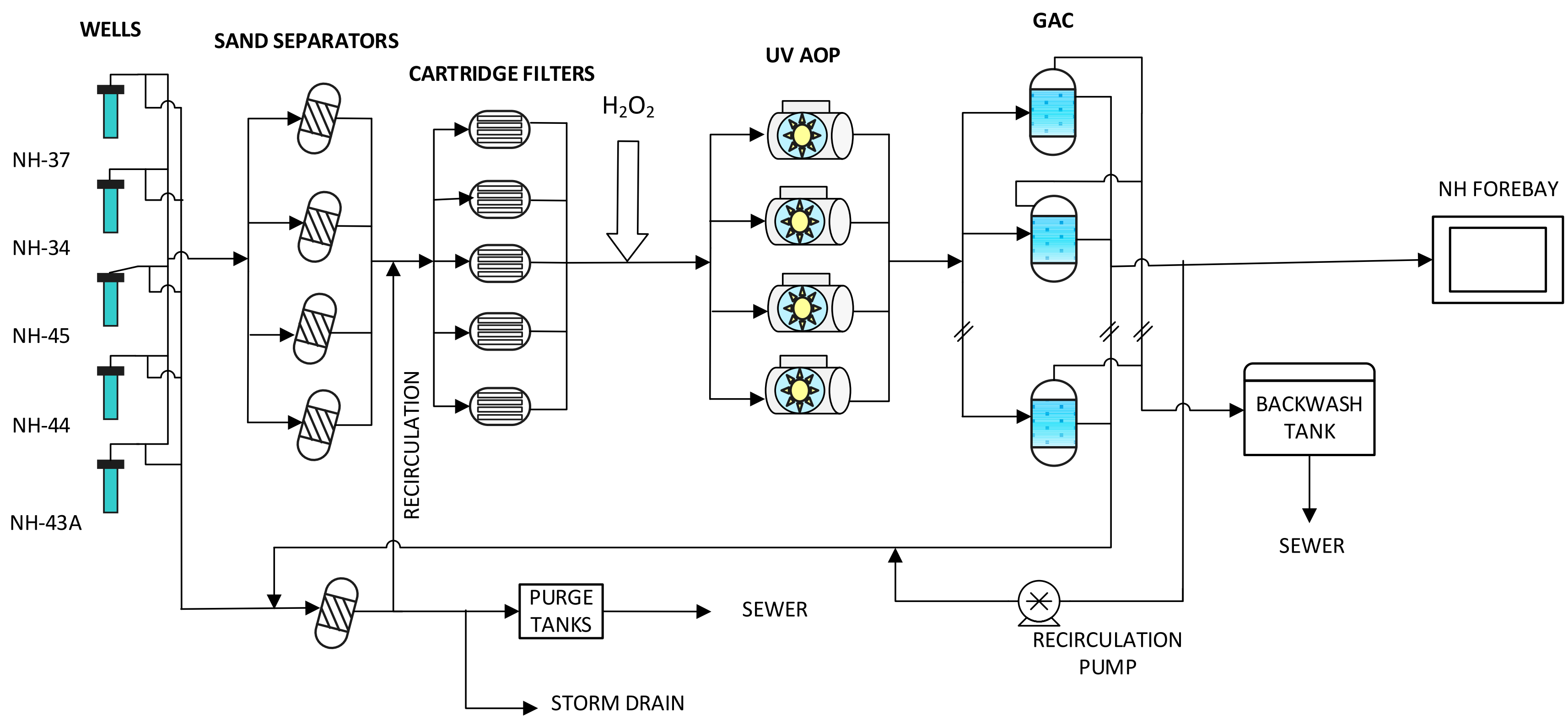

Figure 1-3. NHWWT Conceptual Process Flow Diagram

2 METHODOLOGY

This section presents the methodologies adopted for NHWWT commissioning, including roles and responsibilities, schedule of activities, and the following activities associated with commissioning:

- **Facility Operation:** The facility operated Monday through Friday and was shut down over the weekend. LADWP Treatment Operators monitored the equipment 24 hours a day during commissioning. Testing during the commissioning phase focused on critical alarms, contaminant log reductions, and monitoring of online analyzer calibration. Each reactor was cycled and sampled at least four times.
- **1,4-Dioxane Spiking:** Chemical (1,4-dioxane) spiking was conducted to establish sufficient concentrations in the influent to evaluate individual train performance. The intent of spiking was to achieve detectable concentrations in the UV AOP treated water to allow for accurate log reduction calculations. 1,4-Dioxane was injected upstream of the UV AOP reactors to allow for proper mixing.
- **Sampling and Analysis:** A comprehensive sampling plan was developed and implemented to demonstrate the performance of all NHWWT UV AOP reactors. Sampling was conducted on Tuesdays, Wednesdays, and Fridays for the duration of the commissioning phase. Laboratory and field sampling were performed to demonstrate the performance of the reactors.
- **Water Quality:** Testing was completed using four wells to evaluate treatment performance with potential water quality differences between wells. Testing was completed at background UV transmittance (UVT) values. Testing at lower UVTs was completed during performance testing to confirm treatment performance at and below the design UVT.

3 RESULTS

The following sections describe the findings of commissioning monitoring and sampling of the UV AOP and GAC process only. For more details regarding commissioning results, please see the NHWWT Commissioning Report (Hazen, 2023).

3.1 UV AOP

The main objective of commissioning was to gather more treatment data from the UV AOP system. Eighteen (18) tests were conducted across different log reduction targets with different wells and UV reactors in operation. All four UV reactors were tested in automatic mode with real-time adjustments for flow, ultraviolet transmittance (UVT), and hydrogen peroxide dose. The hydroxyl radical scavenging term used for commissioning was updated to the highest result (63,000 s^{-1}) observed during performance testing to achieve more accurate log reduction calculations. The hydroxyl radical scavenging demand is an adjustable setpoint entered in the vendor's proprietary algorithm used to calculate target contaminant log reductions. Table 3-1 lists the summary of hydroxyl radical scavenging demand values reported by the UV manufacturer during all phases of the project. The hydroxyl radical scavenging demand data demonstrates recent values have an average of 56,691 s^{-1}, which is lower than observed in the 2016 data (ranging from 58,300-90,500 s^{-1}). Lower hydroxyl radical scavenging demand results in more efficient treatment performance. However, the design hydroxyl radical scavenging demand of 90,500 s^{-1} will be the initial input during the beginning of plant operations for conservative log reduction calculations.

Table 3-1. Hydroxyl Radical Scavenging Demand Summary

Well	Date	pH	Alkalinity (mg/L as $CaCO_3$)	UVT (%)	TOC (mg/L)	Total Iron (mg/L)	Nitrate (mg/L as NO3)	Nitrate (mg/L as N)	H_2O_2 at Sampling (mg/L)	Scavenging Term (s^{-1})
NH-34	10/26/2016	-	-	98.0	-	-	31.8	7.18	N/A	79,000
NH-37	**10/26/2016**			**98.0**			**30.6**	**6.91**	**N/A**	**90,500**
NH-45	11/18/2022	8.11	192	95.0	0.87	0.32	5.38	1.22	N/A	52,000
NH-37	11/21/2022	8.05	180	97.0	0.82	0.03	4.99	1.13	N/A	52,700
NH-34	11/23/2022	7.52	201	97.9	0.72	0.14	6.18	1.40	N/A	52,700
NH-34	11/30/2022	7.93	203	98.2	0.36	0.03	6.49	1.47	N/A	47,800
NH-37	12/6/2022	8.00	180	96.0	0.80	0.07	5.93	1.34	20.4	50,200
NH-37	12/7/2022	8.01	181	93.6	0.47	0.05	6.22	1.41	24.7	54,300
NH-37	12/8/2022	7.94	182	94.6	0.43	0.03	5.99	1.35	19.1	62,500
NH-37	**12/9/2022**	**7.87**	**182**	**98.3**	**0.33**	**0.04**	**5.17**	**1.17**	**0.15**	**63,000**
NH-45	4/19/2023	8.10	192	98.8	0.28	5.00	6.06	1.37	N/A	63,400
NH-43A	4/26/2023	7.92	188	98.6	0.67	ND	8.34	1.88	N/A	56,600
NH-34	5/8/2023	7.89	206	97.7	0.97	ND	6.50	1.47	N/A	68,400

Field measured samples for UVT and hydrogen peroxide were collected for each test condition. The UVT and hydrogen peroxide samples were compared against the Online UVT analyzer, and the required hydrogen peroxide dose calculated by the UV manufacturer algorithm. The online UVT readings and the benchtop unit showed an accurate correlation. Similarly, field measured and programmable logic controller (PLC) calculated hydrogen peroxide concentrations showed an accurate correlation.

10 of 18 tests achieved a treated water 1,4-dioxane concentration that provided an exact log reduction calculation. In cases of treated water concentrations below the method detection limit (MDL), the MDL of 0.028 µg/L was used as the UV treated water concentration to calculate log reductions. As presented in Figure 3-1, all tests resulted in the measured log reductions being higher than the values predicted by the UV AOP control algorithms. Higher measured log reductions show actual performance exceeded predicted removal. Tests that resulted in treated water concentration below the MDL are represented with an arrow on the bar graph to show higher treatment was achieved but could not be measured. All UV AOP treated 1,4-dioxane concentrations resulted in lower concentrations than the treatment goal of 0.25 µg/L.

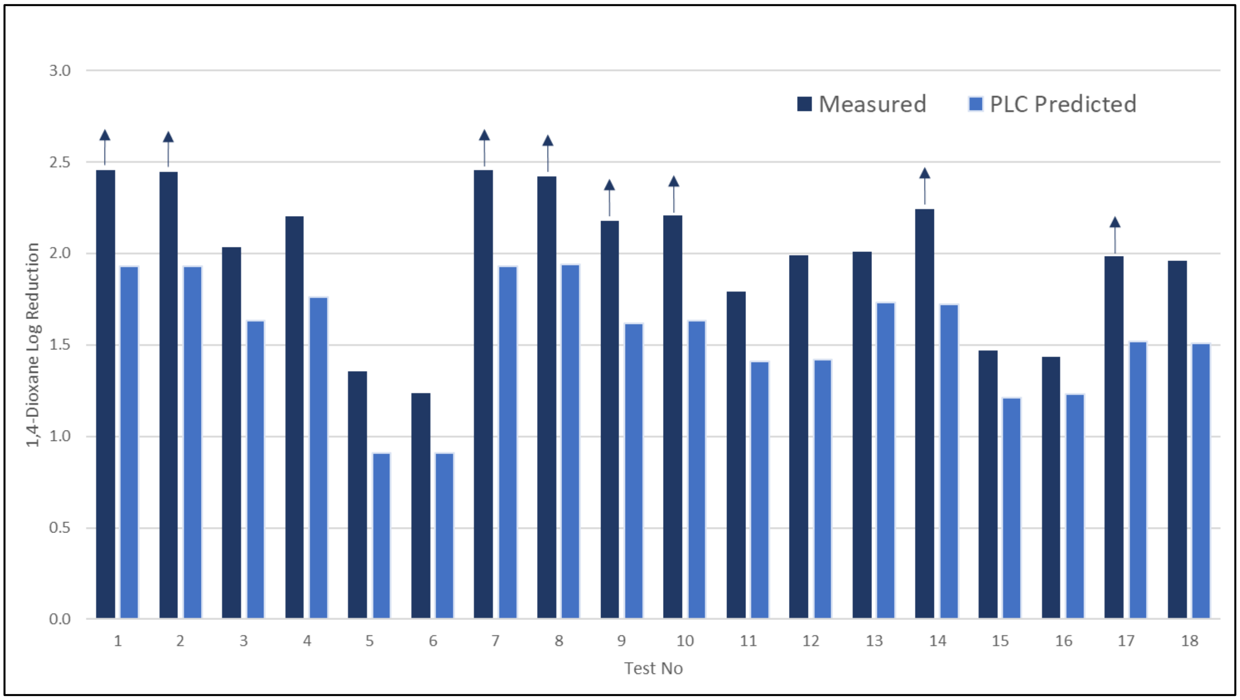

Figure 3-1. 1,4-Dioxane Log Reductions (Measured vs PLC Calculated)

Note: *An arrow on the bar graph to show higher treatment was achieved but could not be measured due to non-detect treated water concentrations.*

Although 1,4-dioxane was the only analyte spiked during commissioning, other VOCs were also monitored. Detectable concentrations of TCE of 0.2 and 0.3 µg/L were reported in two influent samples. The concentration of TCE in the treated water was non-detect (<0.18 µg/L), which is more favorable than the design treated concentration (<0.5 µg/L) for this constituent.

3.2 GAC

Eight GAC vessels were operational during commissioning to quench excess hydrogen peroxide from UV reactor effluent. GAC flow rates and differential pressures were monitored. Flow rates ranged between 348-358 gpm on average. The pressure differential across the header increased from 0.13 psi to 2 psi and stayed constant through Week 3.

In addition to flow and pressure monitoring, field sampling was conducted to evaluate hydrogen peroxide quenching by GAC. Only influent and treated water concentrations of the common header were tested; individual vessels were not tested. Influent concentrations averaged 6.63 mg/L and hydrogen peroxide was not detected in the treated water (Figure 3-2). Influent concentrations at the GAC were lower than the values used for GAC performance. The lower hydrogen peroxide values observed during commissioning are the residual hydrogen peroxide from the UV AOP treatment in automatic mode, whilst a concentration of 25 mg/L were used during performance to test design influent concentrations. The GAC media was successful at quenching excess hydrogen peroxide from the UV AOP system.

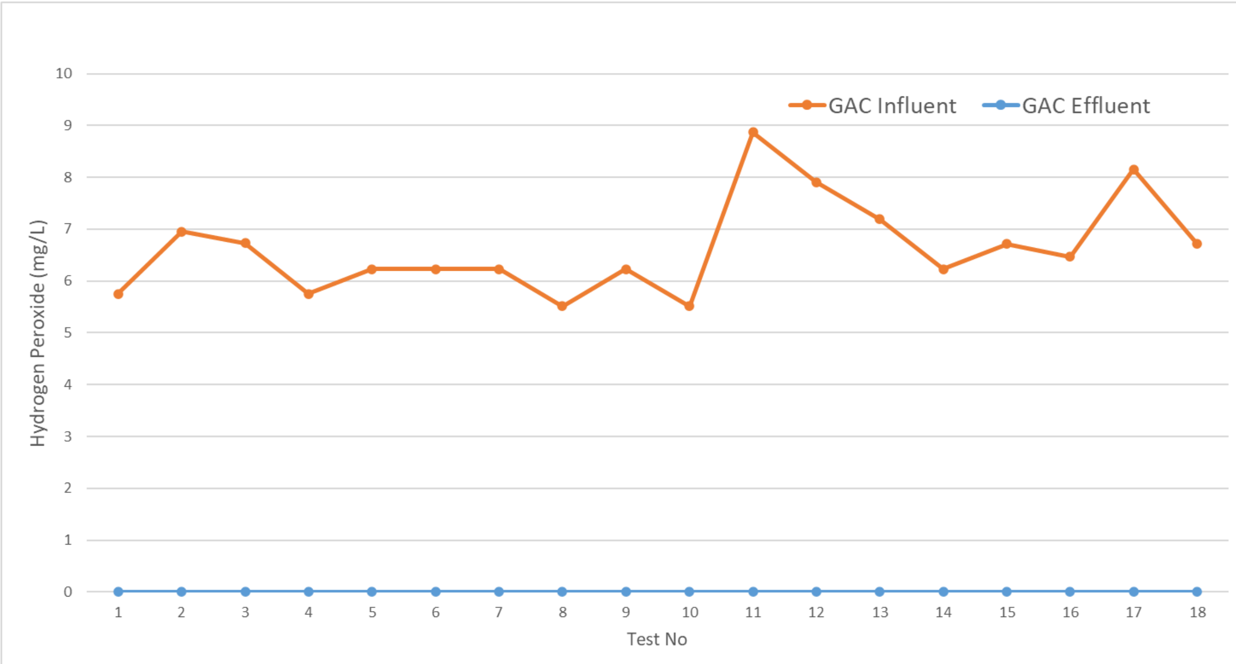

Figure 3-2. Hydrogen Peroxide Influent vs Treated

4 CONCLUSIONS

The objective of commissioning was to verify the performance and reliability of all NHWWT equipment at average well flow rates under normal operating conditions with the facility operating in automatic control.

As presented in Table 4-1, data generated during commissioning (presented in this report) and performance testing demonstrates that the NHWWT UV AOP system was able to meet the 1,4-dioxane treatment goal. Based on the 26 tests, the system treatment performance exceeds the design and target log reductions, and the calculated log reduction algorithm was shown to be conservative when operated in automatic mode. A range of log reductions of 0.9 to 1.9 were tested to cover the expected operating range. Additionally, the commissioning results demonstrate that the UV AOP equipment operates above the required level of treatment. All four UV AOP reactors were shown to have consistent treatment performance while treating water from four different wells.

During testing, water quality from the wells were also evaluated. Critical water quality parameters for UV AOP operation include the hydroxyl radical scavenging demand, nitrate, and UVT. Recent hydroxyl radical scavenging demand values average approximately 57,000 s^{-1} and have been generally consistent and less than the design value of 90,500 s^{-1}. Although recent data is lower than the design value, it is recommended to initially operate the facility at the design hydroxyl radical scavenging demand of 90,500 s^{-1}. Monthly hydroxyl radical scavenging demand samples will be collected to continue to evaluate changes during ongoing facility operation. Hydroxyl radical scavenging demand input will be reevaluated after a year of operation.

Nitrate concentrations were found to be low, averaging 1.4 mg/L as N. It is important to monitor nitrate in the Remediation Wells as nitrate photolyzes to nitrite, which acts as a hydroxyl radical scavenger. Periodic sampling and monitoring are planned during normal operations. The data will be used to monitor levels and adjust the algorithm input after a year of operation.

The design UVT for the UV AOP system was 97%. However, the data collected during performance testing and commissioning demonstrate treatment over a range (88 to 99.5%) of UVTs, confirming the UV AOP system is capable of treating a range of UVTs.

Performance testing and commissioning were also able to confirm operation and controls of the other treatment processes and equipment:

- Online UVT analyzer provided accurate readings compared to grab samples.
- Hydrogen peroxide concentrations at the UV influent and UV effluent were consistent with the UV AOP required influent hydrogen peroxide dose and the calculated residual concentrations. These sample values were closely correlated to the PLC calculated values.
- GAC provided complete quenching of the hydrogen peroxide residual.

Table 4-1. Combined 1,4-Dioxane Summary Results (Performance and Commissioning)

Test Number	Train Flow Rate (GPM)	Reactor	Power (%)	No. of Sections	UVT (%)	Hydrogen Peroxide (mg/L)	Target 1,4-Dioxane Log Reduction	Measured 1,4-Dioxane Log Reduction
Performance								
Control	1538	R2	100	0	98.1	0.2	0.0	0.07
1	1528	R2	100	4	97.3	15.9	>1.9	>2.54
2	1566	R2	95	4	97.1	12.0	>1.6	>2.25
3	1429	R2	100	3	99.2	10.5	>1.4	>2.29
4	1533	R2	100	2	99.5	10.0	>0.9	1.98
5	1479	R2	100	4	94.5	17.8	>1.4	>1.73
6	1464	R2	100	4	88.0	19.8	>1.0	>1.27
7	1524	R2	100	4	98.8	10.8	>1.9	>2.64
8	1521	R2	100	3	99.2	16.8	>1.7	>2.39
Commissioning								
1	3252	R1	87.5	6	98.8	10.1	1.9	>2.5
2	3235	R2	94.5	5	98.8	11.3	1.9	>2.4
3	3233	R1	77.0	5	99.4	9.1	1.6	2.0
4	3222	R2	77.5	5	99.3	9.1	1.6	2.2
5	3213	R1	75.0	3	98.9	8.2	0.9	1.4
6	3176	R2	78.5	3	98.5	8.9	0.9	1.2
7	2646	R3	91.5	5	98.4	11.0	1.9	>2.5
8	2610	R4	89.5	5	98.7	10.1	1.9	>2.4
9	2620	R3	85.5	4	99.0	9.8	1.6	>2.2
10	2590	R4	79.0	4	99.4	8.9	1.6	>2.2
11	2587	R3	93.5	3	99.0	11.8	1.4	1.8
12	2560	R4	91.5	3	99.0	11.0	1.4	2.0
13	2568	R1	85.5	4	99.0	10.8	1.7	2.0
14	2566	R3	80.0	4	99.4	9.8	1.7	>2.2
15	2494	R2	75.5	3	99.1	9.4	1.2	1.5
16	2522	R4	73.0	3	99.3	9.1	1.2	1.4
17	2571	R3	91.5	4	98.0	11.8	1.5	>2.0
18	2537	R4	85.5	4	98.4	10.6	1.5	2.0

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