APPENDIX 3

Brine Disposal System
Technical Memorandum #3

DRAFT

Brine Disposal System

Technical Memorandum No. 3

July 31, 2020

Prepared for

18500 Von Karman Avenue, Suite 1100
Irvine, CA 92612
T: 714.730.7600

Technical Memorandum

Prepared for: Inland Empire Utilities Agency

Project Title: Chino Basin Program PDR

Project No.: 153489.075

Technical Memorandum No. 3

Subject: Brine Disposal System

Date: July 31, 2020

To: Sylvie Lee, P.E., Manager of Planning & Environmental Resources
Liza Munoz, P.E., Project Manager

From: Andrew Lazenby, P.E., Director/Sr. Project Manager, Brown and Caldwell

Prepared by: ________________________________
Marcus Maltby, Civil Engineer, Brown and Caldwell
License No. C87226, Expiration 9/30/21

Windsor Lee, Brown and Caldwell

Reviewed by: ________________________________
Jennifer K. Thompson, P.E., Sr. Project Manager, Brown and Caldwell

Adam Zacheis, P.E., Director/Client Services, Brown and Caldwell

Table of Contents

List of Figures

List of Tables

List of Abbreviations

AC	asbestos cement
AF	acre-feet
AWPF	advanced water purification facility
CBP	Chino Basin Program
cfs	cubic feet per second
CU	capacity unit
EWL	Etiwanda Wastewater Line
EWLCU	Etiwanda Wastewater Line Capacity Unit
FOG	fats, oil, and grease
fps	feet per second
ft	feet
gpd	gallons per day
gpm	gallons per minute
HDPE	high-density polyethylene
IEBL	Inland Empire Brine Line
IEUA	Inland Empire Utilities Agency
in	inches
IX	ion exchange
JOS	Joint Outfall System
LACSD	Los Angeles County Sanitation District
mgd	million gallons per day
MVWD	Monte Vista Water District
NPDES	National Pollution Discharge Elimination System
NRWS	Non-Reclaimable Wastewater System
NRWSCU	Non-Reclaimable Wastewater System Capacity Unit
OCSD	Orange County Sanitation District
ppd	pounds per day
Program	Chino Basin Program
psi	pounds per square inch
‘RCP	reinforced concrete pipe
RO	reverse osmosis
RP-1	Regional Water Recycling Plant No. 1
RP-4	Regional Water Recycling Plant No. 4
SAWPA	Santa Ana Watershed Project Authority
Study	CBP Technical Feasibility Study
TAFY	thousand acre-feet per year
TM	technical memorandum
TM3	Technical Memorandum 3
TSS	total suspended solids
VCP	vitrified clay pipe
WDR	Waste Discharge Requirements

Section 1: Introduction

The Inland Empire Utilities Agency (IEUA) operates the Non-Reclaimable Wastewater System (NRWS), which is infrastructure for disposal of high-salinity wastewater (brine) and other non-reclaimable high-strength wastewater. The NRWS is comprised of three pipelines: the NRWS pipeline, the Etiwanda Wastewater Line (EWL), and the Inland Empire Brine Line (IEBL). The NRWS is split into two service areas within IEUA's jurisdiction. The North NRWS is comprised of the NRWS pipeline and EWL, while the South NRWS is comprised of the IEBL (and is referred to as IEBL in this technical memorandum [TM]). The NRWS pipeline and the EWL ultimately convey flow to the Los Angeles County Sanitation Districts (LACSD) through the Joint Outfall System (JOS). The IEBL directly conveys flow to the Orange County Sanitation District (OCSD) by gravity. The NRWS is shown graphically in Figures 1-1 and 1-2.

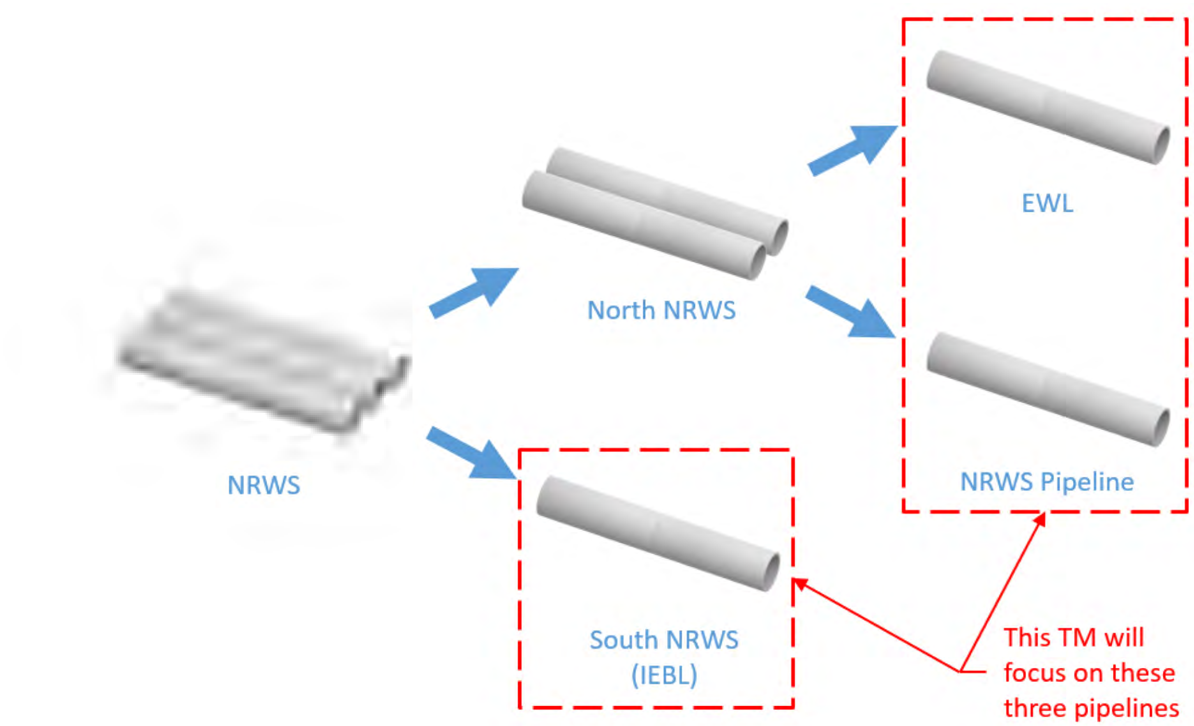

Figure 1-1. NRWS Nomenclature

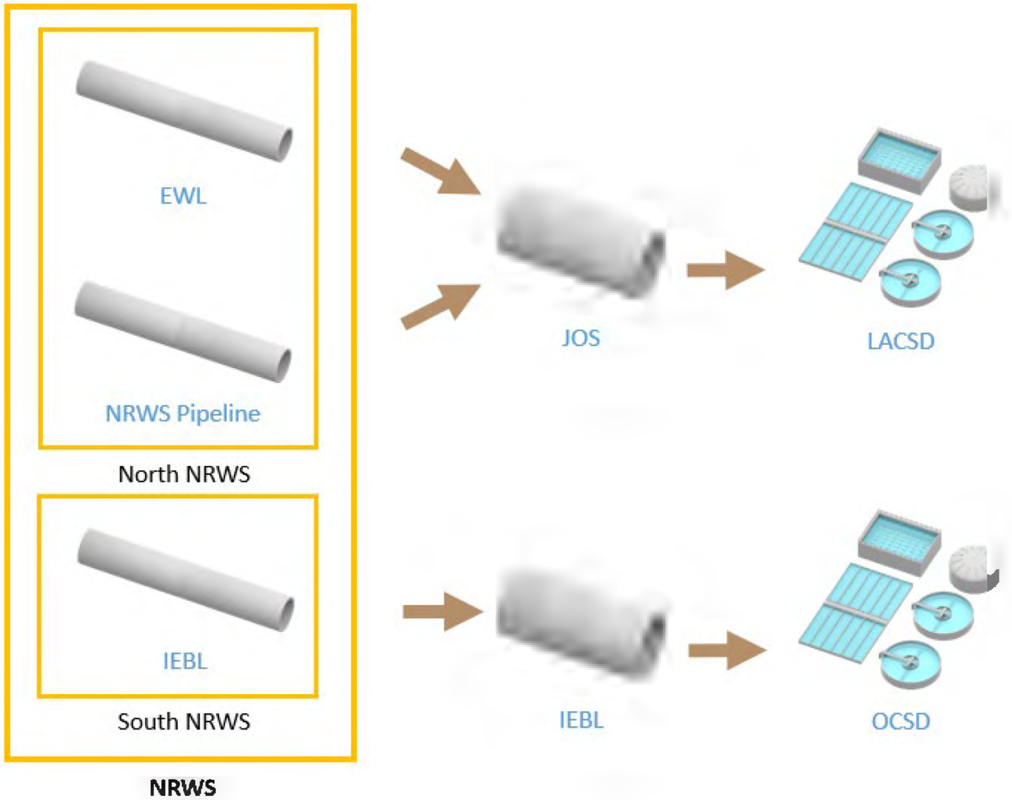

Figure 1-2. Overall System Schematic

The Chino Basin Program (CBP or Program) will purify recycled water for groundwater replenishment and treat extracted groundwater for potable water use. The proposed treatment processes will create brine streams that must be managed and disposed. Technical Memorandum 3 (TM3) presents a summary of NRWS infrastructure, available capacity in each system, requirements for new connections and tie-ins, a summary of system costs for connection capacity and operations, and future considerations for brine conveyance and scaling mitigation. New connections to the NRWS consider the existing hydraulics, requirements for physical connection, and operations and maintenance.

TM3 was developed as part of the CBP Technical Feasibility Study (Study), which is being completed to advance the projects that comprise the CBP. The CBP includes both PUT facilities, the components to recharge purified water to the Chino Basin, and TAKE facilities, the components to extract groundwater and convey potable water supply. The Study will be the primary deliverable for the overall project and will present the overall findings of the project, including the conceptual design for elements of the recommended program. Several background TMs document the assumptions, identification, and selection of the recommended CBP projects, which include:

- **TM1 – Chino Basin Program Assumptions:** Documents the assumptions used to develop the PUT and TAKE alternatives and presents the alternatives evaluation approach used to evaluate the PUT, TAKE, and program alternatives.
- **TM2 – Chino Basin Program – PUT, TAKE, and Program Alternatives Evaluation:** Presents the development and formation of the PUT and TAKE alternatives and evaluation, the development of the program alternatives (based on the results of the PUT and TAKE alternatives evaluation), and the selected program alternative for the overall CBP.

- **TM3 – Brine Disposal System (this TM):** Presents a summary of the brine disposal systems in IEUA's service area and how the CBP facilities would connect to the systems.

1.1 Program Objectives

The objective of the CBP is to produce 15.0 thousand acre-feet per year (TAFY) of purified water for groundwater recharge (PUT) and extract up to 50.0 TAFY of potable water to supplement the drinking water system during call years (TAKE). Refer to TMs 1 and 2 for more information about the CBP assumptions and alternatives.

To produce 15.0 TAFY, the CBP alternatives include potential advanced water purification facilities (AWPFs) at IEUA Regional Water Recycling Plant No. 1 (RP-1) or IEUA Regional Water Recycling Plant No. 4 (RP-4), with a potential smaller AWPF at the Monte Vista Water District (MVWD) Plant 28. The CBP may also include wellhead treatment facilities for In-Lieu Local projects. As described in TMs 1 and 2, example In-Lieu Local projects were included for the City of Chino and City of Chino Hills, which would contribute up to six TAFY, depending on the selected CBP alternative, to the groundwater extraction goals. The proposed AWPF(s) includes reverse osmosis (RO) and one of the example In-Lieu Local projects (the City of Chino Hills wellhead treatment facility) includes ion exchange (IX). Both of these processes generate brine that requires disposal in the NRWS. The potential AWPF locations are within the service area of the North NRWS and the example In-Lieu Local project for the City of Chino Hills is within the service area of the IEBL.

1.2 Background Information

An overall site map of the NRWS within the IEUA limits of jurisdiction is provided Figure 1-3.

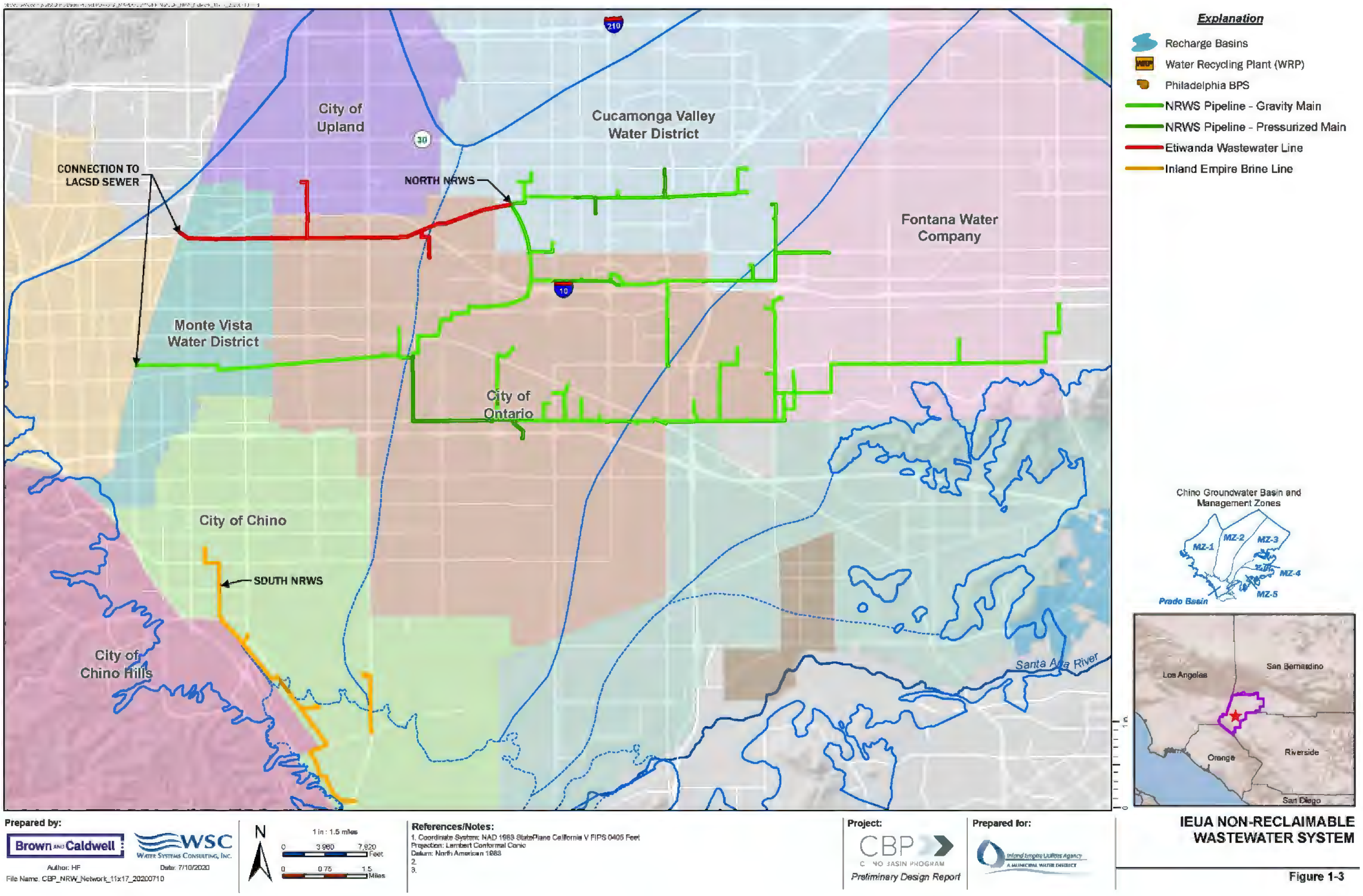

Figure 1-3. NRWS Overall Map

IEUA owns and maintains the North NRWS, which is within their jurisdiction. The North NRWS flows by gravity, except for approximately 2.5 miles of force main leaving the Philadelphia Pump Station. There is available capacity in the North NRWS. IEUA owns capacity units in the NRWS pipeline but does not currently own capacity units in the EWL.

The Santa Ana Watershed Project Authority (SAWPA) is a Joint Powers Authority that serves as an administrator for the Santa Ana River Watershed. SAWPA owns the IEBL and IEUA maintains the reach that is within their jurisdiction. IEUA owns and maintains the laterals connecting to the IEBL within their jurisdiction. There is available capacity in the portion of the IEBL within IEUA's jurisdiction and IEUA currently owns capacity units in the system.

Table 1-1 lists and summarizes the reference information utilized for the development of this TM.

Table 1-1. Reference Information

Source No.	Source Name	Description
1	NRWS Capacity Map	Excel file listing the pipeline capacity, purchased capacity, and actual flows for each pipe segment within the NRWS.
2	NRWS GIS File	GIS file mapping the NRWS. Information for each pipe segment is listed, including pipe diameter, slope, and material.
3	IEUA Resolution No. 2019-6-2	Resolution establishing the rate structure for brine disposal using the EWL, effective July 1, 2019.
4	IEUA Resolution No. 2019-6-3	Resolution establishing the rate structure for brine disposal using the NRWS pipeline, effective July 1, 2019.
5	IEUA Resolution No. 2019-6-4	Resolution establishing the rate structure for brine disposal using the IEBL, effective July 1, 2019.
6	IEUA Ordinance No. 99	Ordinance providing the terms for brine disposal using the NRWS pipeline and EWL, effective June 18, 2014.
7	IEUA Ordinance No. 106	Ordinance providing the terms for brine disposal using the IEBL, effective February 21, 2018.
8	LACSD Discharge Limits	Provides discharge limits for all wastewater within LACSD's service area. Available on LACSD's website.
9	Amended and Restated Wastewater Capacity Agreement	Provides the terms and discharge limits for brine disposal using the EWL, dated May 26, 2010 and effective May 23, 2012. The discharge limits listed in this document are additional to LACSD's discharge limits.
10	SAWPA Resolution No. 2017-11	Provides discharge limits for wastewater discharged to the IEBL, effective September 19, 2017.

1.3 Evaluation Assumptions

The following assumptions were made for the brine disposal system evaluation in TM3:

- The NRWS capacity, actual flow, and purchased capacity were provided by IEUA and verified with hydraulic calculations.
  - The capacity of the existing NRWS was calculated assuming full pipe flow, or a d/D of 1, and does not account for reduced open area due to scaling.
- The fees for CUs do not take into account any available purchased CUs that could be used. The CU fees are based on purchasing the entire volume of brine discharged. The brine disposal fees could be refined as the Study progresses to take into account IEUA's available purchased CUs.
- The brine system capacities evaluated in this TM are for the segments of the North NRWS and IEBL within IEUA's jurisdiction. The available capacity in the downstream segments of the NRWS North and IEBL needs to be confirmed.
- Determine if additional downstream treatment costs for discharge into the IEBL would be assessed. Per IEUA Ordinance No. 99, the NRWS North fees are assumed to be inclusive of LACSD treatment charges.

Section 2: New Connections to the NRWS

This section presents information about the potential new connections to the NWRS for CBP alternatives. The following information is presented in this section:

- Connection requirements for the NRWS.
- New North NRWS connections for the potential AWPF(s) at RP-1, RP-4, and MVWD Plant No. 28.
- New IEBL connection for the example In-Lieu Local project for the City of Chino Hills.
- Disposal fees and estimated annual disposal cost estimates.

2.1 Connection Requirements

To discharge to the NRWS, the user must obtain a Wastewater Discharge Permit and purchase capacity units (CU) for the respective pipeline. The typical terms for the permit are five years for the NRWS pipeline and EWL and two years for the IEBL. Permit application and renewal fees vary by industry and are listed in the Resolutions for each pipeline. Figure 2-1 summarizes the steps to obtain a permit.

Figure 2-1. Typical Process for Wastewater Discharge Permit

Plans detailing the facility layout, points of connection to the NRWS, and monitoring station must be submitted with the Wastewater Discharge Permit Application. As stated on IEUA's website, the following must be submitted with the Wastewater Discharge Permit Application:

- Six sets of plans, including:
  - Facility layouts and spill containment systems for storage tanks and containers.
  - Industrial and sanitary waste lines located within the facility and points of connections to the NRWS or domestic sewers.

- Schematic diagrams of wastewater treatment equipment and process, if any.
- Proposed plans for connection to the NRWS.
- Proposed monitoring station with flow meter (and data logger where applicable) for the discharge (upstream of connection to the NRWS).

- A schematic diagram for the water mass balance with average flow rates for water usage and discharge for the facility.
- Descriptions of manufacturing processes, wastewater generation processes, and wastewater treatment practices, if any.
- Lists of primary raw materials and end products.
- If possible, a wastewater characteristic report of wastewater from a similar facility that the user affiliates with.
- Other items that are required by the Agency's staff to properly determine industry's category and discharge limits.

The capacity units for the three pipelines are summarized in Table 2-1.

Table 2-1. Capacity Units Summary

Parameter	Description
Pipeline	NRWS Pipeline[1]
Capacity Units	Non-Reclaimable Wastewater System Capacity Unit (NRWSCU)
Capacity Unit Equivalent	$\left(0.6513 * \frac{Flow_{gpd}}{260}\right) + \left(0.1325 * \frac{COD_{ppd,dry}}{1.22}\right) + \left(0.2162 * \frac{TSS_{ppd,dry}}{0.59}\right)$
Minimum Capacity Units Acquisition[2]	25 NRWSCU
Pipeline	EWL[3]
Capacity Units	Etiwanda Wastewater Line Capacity Unit (EWLCU)
Capacity Unit Equivalent	15 gpm
Minimum Capacity Units Acquisition	No minimum
Pipeline	IEBL[4]
Capacity Units	Agency CU
Capacity Unit Equivalent	15 gpm
Minimum Capacity Units Acquisition	1 Agency CU

1. Per IEUA Resolution No. 2019-6-3 (see Source No. 4 in Table 1-1).

2. Optionally, NRWSCU can be leased on an annual basis for 5 percent of the purchase rate per year.

3. Per IEUA Resolution No. 2019-6-2 (see Source No. 3 in Table 1-1).

4. Per IEUA Resolution No. 2019-6-4 (see Source No. 5 in Table 1-1).

2.1.1 Water Quality Requirements

Non-reclaimable wastewater is conveyed through the NRWS to either LACSD or OCSD for eventual discharge to the Pacific Ocean. LACSD's ocean discharge is regulated under the existing National Pollution Discharge Elimination System (NPDES) Permit No. CA0053813 and Waste Discharge Requirements (WDR) Order No. R4-2017-0180. OCSD's ocean discharge is regulated under the existing NPDES Permit No. CA0110604 and WDR Order No. R8-2012-0035. Discharge limits are set for each pipeline in the NRWS to allow the wastewater treatment plants to generate a final effluent that meets their NPDES and WDR requirements. It is assumed that brine streams produced by the proposed AWPFs and wellhead treatment facility will not exceed the discharge limits.

As the control authority, LACSD establishes the discharge limits for the North NRWS. The North NRWS is subject to the same limits set for wastewater discharged within LACSD's service area, which are available on LACSD's website (see Source No. 8, Table 1-1) and summarized in Table 2-2.

Table 2-2. North NRWS Discharge Limits

Contaminant	Unit	Maximum Daily Limit
Cyanide (Total)	mg/L	10
Arsenic	mg/L	3
Cadmium	mg/L	15
Chromium	mg/L	10
Copper	mg/L	15
Lead	mg/L	40
Mercury	mg/L	2
Nickel	mg/L	12
Silver	mg/L	5
Zinc	mg/L	25
TICH	mg/L	Essentially none
pH	s.u.	Above 6
Dissolved Sulfide	mg/L	0.1
Temperature	°F	Below 140
Flash Point	°F	Above 140

LACSD set additional discharge limits for the EWL in the Amended and Restated Wastewater Capacity Agreement (see Source No. 9, Table 1-1), summarized in Table 2-3. The EWL is subject to the discharge limits listed in Tables 2-2 and 2-3.

Table 2-3. EWL Discharge Limits		
Contaminant	**Unit**	**Maximum Daily Limit**
Dissolved Sulfide	mg/L	0.1
Settleable Solids	mL/L	2
Fats, Oil and Grease (FOG)	mg/L	30
Carbonaceous Biological Oxygen Demand (CBOD)	mg/L	30

OCSD, as the control authority for the IEBL, establishes the discharge limits for the IEBL. SAWPA adopted these discharge limits under SAWPA Resolution No. 2017-11 (see Source No. 10, Table 1-1), summarized in Table 2-4.

Table 2-4. IEBL Discharge Limits		
Contaminant	**Unit**	**Maximum Daily Limit**
1,4-dioxane	mg/L	1.0
Arsenic	mg/L	2.0
Cadmium	mg/L	1.0
Chromium (Total)	mg/L	20.0
Copper	mg/L	3.0
Lead	mg/L	2.0
Mercury	mg/L	0.03
Nickel	mg/L	10.0
Selenium	mg/L	3.9
Silver	mg/L	15.0
Zinc	mg/L	10.0
Cyanide (Total)	mg/L	5.0
Molybdenum	mg/L	2.3
Polychlorinated biphenyls (PCB)	mg/L	0.01
Pesticides	mg/L	0.01
Sulfide (Total)	mg/L	5.0
Sulfide (Dissolved)	mg/L	0.5

Table 2-4. IEBL Discharge Limits		
Contaminant	**Unit**	**Maximum Daily Limit**
Oil and Grease (Mineral/Petroleum Oil Origin)	mg/L	100.0
Fats, Oil and Grease (FOG)	mg/L	500.0
Biochemical Oxygen Demand	mg/L	12,000
pH	s.u.	6.0 – 12

2.1.2 Connection Points

For this TM, it is assumed that new connections to the NRWS will utilize existing manholes. The user is required to provide and maintain monitoring stations upstream of the connections to the NRWS. At a minimum, the station must be equipped with a flow meter and, in some cases, equipment to measure pH or electrical conductivity. The station must be directly accessible to IEUA or SAWPA personnel for inspection at any given time. Isolation, metering, and sampling provisions will require coordination with IEUA or SAWPA.

2.1.3 Recommended Design Criteria

The following design criteria are recommended for the brine pipelines:

- Velocity: A maximum velocity of approximately 5 feet per second (fps) and a minimum velocity of approximately 2 fps to minimize scaling within the pipeline.
  - Note that IEUA requires a minimum diameter for new brine pipelines of 8 inches. If an 8-inch diameter pipeline exceeded the maximum recommended velocity or was less than the minimum recommended velocity, then an exception was proposed for IEUA's consideration to minimize scaling.
- Pipeline: High-density polyethylene (HDPE) pipe designed for full-pipe flow.

See Section 3 for additional discussion of scaling prevention and recommendations to minimize scaling. Refer to TM1 for additional brine pipeline design criteria and planning assumptions.

2.2 New North NRWS Connections

Each AWPF would require a new connection to the North NRWS. Table 2-5 provides a summary of the proposed AWPFs and the corresponding product water capacity for each PUT alternative, as described further in TM2.

Table 2-5. CBP PUT Alternatives AWPF Capacities						
AWPF Location	**PUT-1**	**PUT-2**	**PUT-3**	**PUT-4**	**PUT-5**	**PUT-6**
RP-1	15 TAFY	15 TAFY	12 TAFY	-	-	-
RP-4	-	-	-	15 TAFY	15 TAFY	12 TAFY
MVWD Plant 28	-	-	3 TAFY	-	-	3 TAFY

The following sections provide additional detail for each new connection to the North NRWS.

2.2.1 AWPF at RP-1

PUT Alternatives 1, 2, and 3 assume that the AWPF is located at RP-1. For a product water capacity of 15 TAFY (PUT Alternatives 1 and 2), approximately 1.03 million gallons per day (mgd) of brine concentrate will require disposal; for a product water capacity of 12 TAFY (PUT Alternative 3), approximately 0.8 mgd of brine concentrate will require disposal. The size and alignment for the proposed brine line is the same for PUT Alternatives 1, 2, and 3. The elements of the proposed connection are as follows:

- Connection
  - Brine concentrate would be conveyed through a 3,900-foot 8-inch HDPE brine line using the residual pressure from the RO system. The residual pressure is projected to be a maximum of 80 pounds per square inch (psi) and would be reduced using a control valve. It is assumed that the brine concentrate would be discharged from an RO concentrate air gap.
  - The new brine line would exit the northeast corner of the AWPF, parallel to the new recycled water conveyance line, and connect to existing manhole NSST-149 on the NRWS pipeline. The connection point is located on Philadelphia Street between Proforma Avenue and Hellman Avenue.
  - To cross Highway 60, approximately 400 feet of the brine line would be installed using jack and bore.
- Capacity
  - At the proposed connection, the existing NRWS pipeline is a 27-inch asbestos-cement (AC) pipe with a capacity of 9.3 cubic feet per second (cfs) (6.0 mgd).
  - The current flow at this location is 2.3 mgd and the purchased capacity is 4.6 mgd.
  - The existing NRWS infrastructure is able to accommodate the additional brine stream at the point of connection and downstream.
  - 2,603 NRWSCUs (NRWSCUs) would need to be purchased for PUT Alternatives 1 and 2, and 2,088 NRWSCUs would need to be purchased for PUT Alternative 3.
- Hydraulics
  - At the proposed connection, flow would transition from pressurized to gravity.

The brine disposal for the AWPF at RP-1 is summarized in Table 2-6 and shown in Figure 2-2.

Table 2-6. RP-1 AWPF Brine Disposal

Parameter	Description
Brine Stream Characteristics	
Flow	1,027,300 gallons per day (gpd)
COD[1]	262 pounds per day (ppd), dry
TSS[1]	1 ppd, dry
Connection	
Disposal System	NRWS Pipeline
Pipeline	3,900 ft (8-inch)
No. of Crossings	1 (jack and bore 400 feet beneath 60 Highway)

Table 2-6. RP-1 AWPF Brine Disposal	
Parameter	**Description**
NRWSCUs Required	2,603 (PUT-1 and PUT-2) 2,088 (PUT-3)
Capacity	
NRWS Pipeline Capacity	6.0 mgd (27-inch)
Current Flow	2.3 mgd
Purchased Capacity	4.6 mgd
Hydraulics	
Design Velocity	5 fps

1. Values are estimated

Figure 2-2. RP-1 AWPF Brine Line

2.2.2 AWPF at RP-4

PUT Alternatives 4, 5, and 6 assume that the AWPF is located at RP-4. For a product water capacity of 15 TAFY, approximately 1.03 mgd of brine concentrate will require disposal; for a product water capacity of 12 TAFY, approximately 0.8 mgd of brine concentrate will require disposal. The size and alignment for the proposed brine line is the same for PUT Alternatives 4, 5, and 6. The elements of the proposed connection are as follows:

- Connection
  - Brine concentrate will be conveyed through a 1,400-foot 8-inch HDPE brine line using residual pressure from the RO system. The residual pressure is projected to be a maximum of 80 psi and would be reduced using a control valve. It is assumed that the brine concentrate would be discharged from an RO concentrate air gap.
  - The new brine line would exit the southeast side of the AWPF and connect to existing manhole EINL-008 on the NRWS pipeline, located on Etiwanda Avenue between Wells Street and 6th Street.
  - No trenchless crossings would be required for this brine line.
- Capacity
  - At the proposed connection, the existing NRWS pipeline is a 15-inch vitrified clay pipe (VCP) with a capacity of 7.1 cfs (4.6 mgd).
  - The current flow at this location is 20,000 gallons per day (gpd) and the purchased capacity is 21,600 gpd.
  - It has been verified that the existing NRWS infrastructure would be able to accommodate the brine stream at the point of connection and downstream.
  - 2,603 NRWSCUs would need to be purchased for PUT Alternatives 4 and 5, and 2,088 NRWSCUs would need to be purchased for PUT Alternative 6.
- Hydraulics
  - At the proposed connection, flow would transition from pressurized to gravity.

The brine disposal for the AWPF at RP-4 is summarized in Table 2-7 and shown in Figure 2-3.

Table 2-7. RP-4 AWPF Brine Disposal

Parameter	Description
Brine Stream Characteristics	
Flow	1,027,300 gpd
COD[1]	262 ppd, dry
TSS[1]	1 ppd, dry
Connection	
Disposal System	NRWS Pipeline
Pipeline	1,400 ft (8-inch)
No. of Crossings	None
NRWSCUs Required	2,603 (PUT Alt 4, 5)

Table 2-7. RP-4 AWPF Brine Disposal	
Parameter	**Description**
	2,088 (PUT Alt 6)
Capacity	
NRWS Pipeline Capacity	4.6 mgd (15-inch)
Current Flow	20,000 gpd
Purchased Capacity	21,600 gpd
Hydraulics	
Design Velocity	5 fps

1. Values are estimated

Figure 2-3. RP-4 AWPF Brine Line

2.2.3 MVWD Plant 28

PUT Alternatives 3 and 6 assume that a smaller 3-TAFY AWPF would be located at MVWD Plant 28 in addition to a larger AWPF at either RP-1 or RP-4, respectively. For a product water capacity of 3 TAFY, approximately 0.2 mgd of brine concentrate will require disposal. The size and alignment for the proposed brine line is the same for PUT Alternatives 3 and 6. The elements of the proposed connection are as follows:

- Connection
  - Brine concentrate will be conveyed through a 900-foot 4-inch HDPE brine line using residual pressure from the RO system. The residual pressure is projected to be a maximum of 80 psi and would be reduced using a control valve. It is assumed that the brine concentrate would be discharged from an RO concentrate air gap.
  - The new brine line would exit the north side of the AWPF, parallel to the new recycled water conveyance line, and connect to existing manhole EWL-036 on the EWL, located on Palo Verde Street near Ramona Avenue.
  - No trenchless crossings would be required for this brine line.
- Capacity
  - At the proposed connection, the existing EWL pipeline is a 21-inch reinforced concrete pipe (RCP) with a capacity of 5.0 cfs (3.2 mgd).
  - The current flow at this location is unknown and the purchased capacity is 26,000 gpd.
  - It has been verified that the existing EWL infrastructure would be able to accommodate the brine stream at the point of connection and downstream.
  - 10 EWLCUs would need to be purchased for PUT Alternatives 3 and 6.
- Hydraulics
  - Although IEUA has stated that the minimum diameter for brine lines is 8-inches, it is recommended that a 4-inch diameter brine line is installed to prevent scaling due to low velocity in an 8-inch pipeline.
  - At the proposed connection, flow would transition from pressurized to gravity.

The brine disposal for the AWPF at MVWD Plant 28 is summarized in Table 2-8 and shown in Figure 2-4.

Table 2-8. MVWD Plant 28 AWPF Brine Disposal	
Parameter	**Description**
Brine Stream Characteristics	
Flow	205,460 gpd
COD[1]	53 ppd, dry
TSS[1]	0.2 ppd, dry
Connection	
Disposal System	EWL
Pipeline	900 ft (4-inch)
No. of Crossings	None
EWLCUs Required	10 (PUT Alt 3, 6)
Capacity	
EWL Capacity	3.2 mgd (21-inch)
Current Flow	Unknown
Purchased Capacity	26,000 gpd
Hydraulics	
Design Velocity	5 fps

1. Values are estimated

Figure 2-4. MVWD Plant 28 AWPF Brine Line

2.3 New IEBL Connection

The CBP may include groundwater wellhead treatment facilities that could generate brine. Two example In-Lieu Local projects were included in the TAKE alternatives for the City of Chino Hills and the City of Chino. The City of Chino Hills wellhead treatment facility would require a new connection to the IEBL. Table 2-9 provides a summary of the proposed example In-Lieu Local project for the City of Chino Hills and the corresponding product water capacity for each TAKE alternative (see TM2 for more information).

Table 2-9. CBP TAKE Alternative Wellhead Treatment Facility Capacity

Wellhead Treatment Facility Location	TAKE-1	TAKE-2	TAKE-3	TAKE-4a	TAKE-4b	TAKE-4c	TAKE-6a	TAKE-6b
City of Chino Hills	-	-	3 TAFY	2.95 TAFY	1.95 TAFY	1.95 TAFY	3 TAFY	2 TAFY

CBP TAKE Alternatives 3, 4a, 4b, 4c, 6a, and 6b assume that one of the wellhead treatment facilities is located at the City of Chino Hills Booster 9. For a product water capacity of 3 TAFY, approximately 4,900 gpd of brine concentrate will require disposal. The size and alignment for the proposed brine line is the same for TAKE Alternatives 3, 4a, 4b, 4c, 6a, and 6b. The elements of the proposed connection are as follows:

- Connection
  - Brine concentrate would be conveyed through a 6,800-foot 8-inch HDPE brine line.
  - The new brine line would exit the south side of the facility and connect to existing manhole SST-018 on the IEBL, located at the intersection of Eucalyptus Avenue and Monte Vista Avenue.
  - To cross the 71 Highway and Chino Creek, approximately 300 feet of the brine line would need to be installed using jack and bore.
- Capacity
  - At the proposed connection, the existing IEBL pipeline is a 12-inch VCP with a capacity of 3.5 CFS (2.3 mgd).
  - The current flow at this location is 22,000 gpd and the purchased capacity is 43,000 gpd.
  - It has been verified that the existing IEBL infrastructure would be able to accommodate the brine stream at the point of connection and downstream.
  - One Agency CU would need to be purchased for TAKE Alternatives 3, 4a, 4b, 4c, 6a, and 6b.
- Hydraulics
  - Constant flow through the brine line is not feasible since a very small pipe diameter is needed to meet the velocity design criteria. To promote full pipe flow, a pressure sustaining valve is recommended at the connection to the IEBL.
  - At the proposed connection, flow will transition from pressurized to gravity.

The brine disposal for the City of Chino Hills wellhead example In-Lieu Local project is summarized in Table 2-10 and shown in Figure 2-5.

Table 2-10. Example In-Lieu Local Project (City of Chino Hills Wellhead Treatment Facility) Brine Disposal	
Parameter	**Description**
Brine Stream Characteristics	
Flow	4,900 gpd
COD[1]	10 ppd, dry
TSS[1]	1 ppd, dry
Connection	
Disposal System	IEBL
Pipeline	6,800 ft (8-inch)
No. of Crossings	1 (jack and bore 300 ft beneath 71 Highway and Chino Creek)
Agency CU Required	1 (TAKE Alt 3, 4a, 4b, 4c, 6a, 6b)
Capacity	
IEBL Capacity	1.9 mgd (12-inch)
Current Flow	22,000 gpd
Purchased Capacity	43,000 gpd
Hydraulics	
Design Velocity	5 fps

1. Values are estimated

Figure 2-5. City of Chino Hills Wellhead Treatment Facility Brine Line

2.4 Disposal Fees and Estimated Disposal Costs

This section presents the NRWS, EWL, and IEBL disposal fees and the estimated initial and annual disposal fees for the potential new North NRWS connections and the potential new IEBL connection.

2.4.1 NRWS, EWL, and IEBL Disposal Fees

Disposal fees for the NRWS are outlined in the corresponding IEUA resolutions. The resolutions are updated annually. Disposal fees for the NRWS pipeline are summarized in Table 2-11, for the EWL are summarized in Table 2-12, and for the IEBL are summarized in Table 2-13.

Table 2-11. NRWS Disposal Fees

Description	Cost	Unit
NRWSCU Acquisition (initial)[1]	$4,172	Per NRWSCU
Volumetric Charges	$940	Per million gallons
Peak Flow Charges	$357	Per million gallons
Strength Charges, COD	$166	Per 1,000 lb (dry)
Strength Charges, TSS	$470	Per 1,000 lb (dry)
Agency Operations and Maintenance (O&M) Charges (monthly)	$20.25	Per NRWSCU
Agency Capital Improvement Program (CIP) Charges (monthly)	$8	Per NRWSCU

1. Optionally, NRWSCU can be leased on an annual basis for 5 percent of the purchase rate per year.

2. NRWS pipeline disposal fees are per IEUA Resolution No. 2019-6-3 (see Source No.4 in Table 1-1).

Table 2-12. EWL Disposal Fees

Description	Cost	Unit
EWLCU Acquisition (initial)	$215,000	Per EWLCU
Capacity Charges (monthly)[1]	$80	Per EWLCU
Capital Improvements Program Charges (monthly)	$90	Per EWLCU
Volumetric Charges[1,2]	$760	Per million gallons
Strength Charges, COD[1]	$135	Per 1,000 lb (dry)
Strength Charges, TSS[1]	$380	Per 1,000 lb (dry)

1. Agency CIP and O&M Charges of 50% will be added to the cost shown.

2. The minimum Volumetric Charge for discharge of 100,000 gallons or less per EWLCU per month is $97.90 per EWLCU per month.

3. EWL disposal fees are per IEUA Resolution No. 2019-6-2 (see Source No. 3 in Table 1-1).

Table 2-13. IEBL Disposal Fees		
Description	Cost	Unit
Agency CU Acquisition (initial)	$215,000	Per Agency CU
Capacity Charges (monthly)[1]	$418.67	Per Agency CU
Capital Improvements Program Charges (monthly)	$90	Per Agency CU
Volumetric Charges[1,2]	$979	Per million gallons
Strength Charges, BOD[1]	$316	Per 1,000 lb (dry)
Strength Charges, TSS[1]	$442	Per 1,000 lb (dry)

1. Agency Administrative Charges of 50% will be added to the cost shown.

2. The minimum Volumetric Charge for discharge of 100,000 gallons or less per CU per month is $97.90 per CU per month.

3. EWL disposal fees are per IEUA Resolution No. 2019-6-4 (see Source No. 5 in Table 1-1).

2.4.2 Estimated Initial and Annual Disposal Costs

The initial and annual costs were calculated assuming the maximum CUs listed in Sections 2.2 and 2.3.

2.4.3 AWPF at RP-1

The following tables summarize the initial and annual costs for the potential connections to the North NRWS and IEBL. The information is presented in the following tables:

- Table 2-14 summarizes the annual costs to dispose of approximately 1.03 mgd of brine concentrate from the 15-TAFY AWPF at RP-1.
- Table 2-15 summarizes the annual costs to dispose of approximately 1.03 mgd of brine concentrate from the 15-TAFY AWPF at RP-4.
- Table 2-16 summarizes the annual costs to dispose of approximately 0.2 mgd of brine concentrate from the 3-TAFY AWPF at MVWD Plant 28.
- Table 2-17 summarizes the annual costs to dispose of approximately 4,900 gpd of brine concentrate from the 3-TAFY wellhead treatment facility (example In-Lieu Local project).

Table 2-14. RP-1 AWPF Annual Disposal Cost	
Description	Cost
NRWSCU Acquisition	$10,860,000
Volumetric Charges	$352,000
Peak Flow Charges	$134,000
Strength Charges, COD[1]	$16,000
Strength Charges, TSS[1]	$170
Agency O&M Charges	$633,000
Agency CIP Charges	$250,000

Table 2-14. RP-1 AWPF Annual Disposal Cost	
Description	**Cost**
TOTAL COST (INITIAL)	**$10,860,000**
TOTAL COST (ANNUAL)	**$1,385,000**

1. Values are estimated

Table 2-15. RP-4 AWPF Annual Disposal Cost	
Description	**Cost**
NRWSCU Acquisition	$10,860,000
Volumetric Charges	$352,000
Peak Flow Charges	$134,000
Strength Charges, COD[1]	$16,000
Strength Charges, TSS[1]	$170
Agency O&M Charges	$633,000
Agency CIP Charges	$250,000
TOTAL COST (INITIAL)	**$10,860,000**
TOTAL COST (ANNUAL)	**$1,385,000**

1. Values are estimated

Table 2-16. MVWD Plant 28 AWPF Annual Disposal Cost	
Description	**Cost**
EWLCU Acquisition	$2,150,000
Capacity Charges	$10,000
Capital Improvements Program Charges	$11,000
Volumetric Charges	$57,000
Strength Charges, COD[1]	$3,000
Strength Charges, TSS[1]	$30
Agency CIP and O&M Charges	$35,000
TOTAL COST (INITIAL)	**$2,150,000**
TOTAL COST (ANNUAL)	**$116,000**

1. Values are estimated

Table 2-17. City of Chino Hills Wellhead Treatment Facility Annual Disposal Cost	
Description	**Cost**
Agency CU Acquisition	$215,000
Capacity Charges	$5,000
Capital Improvements Program Charges	$1,000
Volumetric Charges	$2,000
Strength Charges, BOD[1]	$1,000
Strength Charges, TSS[1]	$200
Agency Administrative Charges	$4,000
TOTAL COST (INITIAL)	**$215,000**
TOTAL COST (ANNUAL)	**$13,000**

1. Values are estimated

2.5 Summary

Table 2-18 summarizes the new potential connections to the NRWS (diameter and length), the disposal system, and the CUs required.

Table 2-18. Summary of New Connections				
Brine Line	**Diameter (in)**	**Approximate Length (ft)**	**Disposal System**	**CUs Required**
RP-1 Brine Line	8	3,900	NRWS Pipeline	2,603 (PUT Alt 1, 2) 2,088 (PUT Alt 3)
RP-4 Brine Line	8	1,400	NRWS Pipeline	2,603 (PUT Alt 4, 5) 2,088 (PUT Alt 6)
MVWD Plant 28 Brine Line	4	900	EWL	10 (PUT Alt 3, 6)
City of Chino Hills Brine Line	8	6,800	IEBL	1 (TAKE Alt 3, 4a, 4b, 4c, 6a, 6b)

Section 3: Scaling Prevention and Mitigation Strategies

Scaling occurs when minerals precipitate out of a liquid stream and form deposits on surfaces within treatment processes or downstream distribution systems. Calcium carbonate and sulfate scales are the most common types of scale resulting from RO and IX systems. If not properly managed, scale can reduce capacity, cause water quality fluctuations, diminish treatment results, or lead to failure of piping and equipment. For applications susceptible to scaling, a water quality analysis should be performed, and an action plan implemented to minimize the effects of scaling on the system. This TM will discuss scaling prevention and mitigation strategies for brine conveyance pipelines.

3.1 Scaling Potential

The scaling process starts with nucleation, which is the early stages of crystal formation. Subsequent crystal formation will quicken once nucleation has started. Nucleation can only occur in saturated or supersaturated solutions. There are two types of nucleation:

- Homogenous nucleation
  - Crystal growth within a solution. Clusters of ions, known as seed crystals, can form and grow until they are large enough to precipitate out of the solution, forming scale deposits.
  - More likely to occur as the degree of supersaturation increases.
  - Typically prevented by adding scale inhibitors (inhibits nucleation), distorting agents (alters and weakens crystal structure), and dispersants (cause crystals to repel each other).
- Heterogenous nucleation
  - Crystal growth on an existing surface. The interaction between the solution and the existing surface will form seed crystals and lead to scale deposits.
  - More likely to occur at irregularities on the existing surface such as pipe joints, defects, valves, and meters.
  - Typically prevented by altering the physical properties of the piping or equipment. Minimizing homogenous nucleation will also reduce heterogenous nucleation by maintaining a smoother pipe free of scale deposits.

RO systems typically inject scale inhibitors upstream of the treatment process to facilitate a higher recovery rate; thus, it is expected that the brine concentrate from the proposed AWPF(s) would be supersaturated. Brine concentrate from the IX system at the City of Chino Hills wellhead treatment facility is expected to be saturated since scale inhibitors are typically not injected upstream of the treatment process.

3.2 Mitigation Strategies

Scale inhibitors are a viable strategy to prevent scaling within treatment processes; however, since the effects are temporary, additional strategies are recommended to prevent scaling within downstream distribution systems. The treatment recovery rate, pH, alkalinity, physical properties of interacting surfaces, and flow regime largely influence the tendency of brine to form scale. Table 3-1 summarizes the factors affecting scaling potential and lists applicable mitigation strategies.

Table 3-1. Factors Affecting Scaling Potential		
Parameter	**Description**	**Mitigation Strategy**
Treatment Recovery Rate	For RO systems, higher recovery rates will lead to brine with higher salt concentrations since less water is wasted.	Confirm that anti-scalant residuals are present in RO system brines.
Degree of Saturation	Higher degrees of saturation will increase the rate of homogenous and heterogenous nucleation.	Inject scale inhibitors or dispersants to prevent crystal growth, or inject distorting agents so that scale is easier to clean.
pH	The solubility of carbonate increases with acidity.	Lower the pH to reduce the scaling potential in the brine line (through chemical injection)
Alkalinity	Results from the presence of hydroxides, carbonates, and bicarbonates.	Reduce the alkalinity to directly reduce the scaling potential (acid addition).
Physical Properties of Interacting Surfaces	Roughness, shape, and material of the piping or equipment can catalyze heterogenous nucleation.	Select materials resistant to scale, minimize irregularities, and frequently perform maintenance.
Flow Regime	Free water surfaces will lead to scaling at the interacting surface. Free water surfaces will also experience evaporation, causing the salt concentration to increase.	Brine conveyance pipelines should be designed to promote full pipe flow.

3.3 Recommendations

Heterogenous nucleation is more likely to occur than homogenous nucleation in brine conveyance pipelines. The most economical strategies for preventing scale are physical properties and flow regime. The following should be considered:

- HDPE is recommended because the pipe interior is smooth.
- The fusion-weld beads resulting from HDPE installation should be removed from the interior using a mandrel.
- The pipeline design should promote full-pipe flow. Air release valves are likely needed and should be easily accessible and resistant to scale. To promote full-pipe flow, a pressure sustaining valve could be used at the connection to the North NRWS or IEBL.
- The velocity should not exceed 5 fps because turbulent flow will induce scaling.

Chemical treatment and pH adjustment should also be considered. Since RO systems utilize scale inhibitor upstream of the process, it is a feasible option to inject additional scale inhibitor into the brine concentrate leaving the system. Since IX systems do not utilize scale inhibitors, it would be more economical to inject sulfuric acid into the brine concentrate to dissolve calcium carbonate by suppressing the pH. A water quality analysis for the brine concentrate is recommended to determine the optimal strategy to prevent scaling.

It is recommended that the brine lines are inspected regularly as a preventive measure. If scale formation is detected, then cleaning through chemical treatment (acid) should be undertaken before scaling becomes extensive. Long radius bends should be installed to facilitate pipe pigging in the future, if required. Additionally, installing parallel brine lines at each facility is recommended to allow for continuous operation during maintenance. The second brine line would be drained and flushed when not in use.

References

IEUA, *Ordinance No. 99*, June 18, 2014.

IEUA, *Ordinance No. 106*, September 19, 2017.

IEUA, *Resolution No. 2019-6-2*, June 19, 2019.

IEUA, *Resolution No. 2019-6-3*, June 19, 2019.

IEUA, *Resolution No. 2019-6-4*, June 19, 2019.

LACSD, *Amended and Restated Wastewater Capacity Agreement*, May 26, 2010.

LACSD, *Discharge Limits*.

SAWPA, *Resolution No. 2017-11*, September 19, 2017