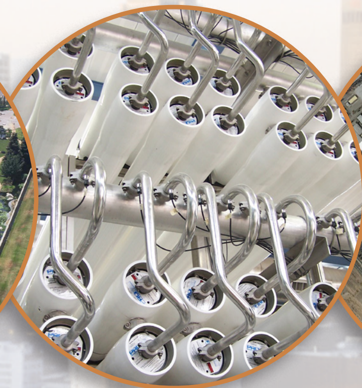
City of Los Angeles

Recycled Water Master Planning

Los Angeles Department of Water and Power
and
Department of Public Works



Groundwater Replenishment Master Planning Report

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Volume 2 of 3: Appendices A-G
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Appendix A

Post-Treatment Alternatives Evaluation

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Technical Memorandum

Title:	**Groundwater Replenishment Master Planning Document** **Appendix A – Post-Treatment Alternatives Evaluation**
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A. Post-Treatment Alternatives Evaluation

This appendix summarizes the post-treatment alternative evaluation and recommendation that is used as the basis for the Groundwater Replenishment (GWR) Master Planning Report.

A.1 Introduction

The product water from the Advanced Water Purification Facility (AWPF) will be pumped to the spreading grounds in the East San Fernando Valley. Injection wells are also being considered by the City to address spreading ground availability issues during wet years. Key design criteria for the product water quality must address the following requirements:

- Non-Potable Reuse (NPR) irrigation users
- NPR industrial users, such as Valley Generating Station (VGS) power plant cooling towers: Minimize total dissolved solids (TDS)
- Injection wells: Minimize turbidity, membrane fouling index (MFI), and TDS
- Spreading basins: Compatibility with the aquifer water at the percolation basins without causing scaling, corrosion, or solubilization (Minimize TDS)
- Conveyance pipeline: Minimize corrosion of the 54-inch ductile iron pipe with double cement mortar lining (Achieve target Langelier Saturation Index (LSI) range)
- Pumping equipment: Minimize corrosion of the product water pumping equipment (Achieve target LSI range)

A.1.1 Reverse Osmosis Permeate Quality

RO permeate water quality is primarily a function of using high rejection membranes driven to reduce salinity and dissolved organics. The resulting RO permeate will have a very low level of TDS in the range of 20-30 mg/L and corresponding low levels of calcium, magnesium, alkalinity and pH. The dissolved carbon dioxide (CO_2) present in the feed water passes through the RO membranes and typically causes the permeate to have a pH less than pH 6.0. These characteristics cause the RO permeate to be corrosive requiring further treatment. Corrosion resistant pipeline materials and equipment lining may also be considered, however, these would not address leaching concerns in the percolation basins or regulatory requirements that the product water be non-aggressive.

A.1.2 Balanced or "Ideal" Product Water Quality

There are several indices that can be applied to evaluate if the product water has a corrosive or scaling tendency. The LSI, also named Saturation Index (SI), is commonly used. **Table A-1** summarizes the product water stabilization goals for the AWPF product water.

Table A-1: AWPF Product Water Post-Treatment/Stabilization Goals

Constituent	Design Criteria
pH	7.5 to 8.5
Hardness	> 20 mg/L as $CaCO_3$
LSI	-0.5 to 0.5
MFI [1]	< 3

Notes:
1) MFI is only applicable if injection wells are used.

A.1.3 Typical Product Water Stabilization Treatment Processes

A major goal of the AWPF post-treatment is to achieve a LSI between -0.5 to 0.5 in the product water. An LSI in this range is typically equated with a non-aggressive water. Since high rejection membranes remove 99 percent of all ions, the typical RO permeate is nearly depleted of anions and cations. Most RO systems for potable water take advantage of this very low overall dissolved minerals concentration in RO permeate and blend it with other water sources of higher mineral concentrations, especially alkalinity and hardness to stabilize the water. Blending in this manner is not typically allowed for RO treatment of wastewater; since the physical barrier afforded by the RO system is necessary to meet regulatory requirements. Therefore, additional post-treatment, other than blending, and pH adjustment is required for the AWPF.

Stabilization of the product water will include increasing the pH and adding hardness. To increase the pH, the following treatment could be utilized:

- Removing dissolved CO_2 by stripping the water with a counter current flow of air in degasifiers, or
- Adding sodium hydroxide (caustic soda (NaOH)), or
- Adding a calcium based product, such as limestone (calcium carbonate, $CaCO_3$), quicklime (calcium oxide, CaO), or hydrated lime (calcium hydroxide, $Ca_2(OH)_2$).

To add hardness, the following processes could be utilized:

- Adding a calcium based product, such as limestone, quicklime, or hydrated lime; or
- Adding calcium chloride.

A.1.3.1 Decarbonation

Decarbonation, or degasification, is the most inexpensive and simplest-to-operate method to increase the pH. However, decarbonation alone will be insufficient for product water stabilization, as it does not provide the necessary hardness to the water. Also decarbonation is incapable of achieving a product water pH higher than 7.5 to 8.0 standard units, depending on the pH of the pre-decarbonation water.

A limitation of decarbonation is that by reducing the CO_2 content of the water, the total carbonate species, which are needed for a stable product water, are also being reduced. An RO permeate that has been stripped of CO_2 through decarbonation will not have enough remaining carbonate to produce the desired alkalinity. To address this limitation, a portion of the RO permeate should be bypassed around the decarbonators, ensuring that the blended product water has a total carbonate content in the target range.

Degasification reduces the CO_2 to levels in the 2-10 mg/L range, while at the same time increasing the pH value by 0.6-1.2 units. Because decarbonation in itself cannot complete the pH adjustment, further increase of the pH is accomplished by adding calcium compounds or sodium compounds. Calcium compounds have the obvious advantage that they will not only provide the needed alkalinity but, at the same time, the required calcium hardness. Sodium compounds, such as caustic soda, provide the most simplified chemical feed system, but does not address the need for hardness addition.

A.1.3.2 Calcium Hydroxide (Hydrated Lime)

Hydrated lime can be either delivered to the site as a solid dry chemical or by tanker truck as aqueous slurry. A saturated lime solution would be prepared in a lime saturator. Use of hydrated lime involves the challenges of stable operation through a lime saturator.

A.1.3.3 Caustic Soda

The addition of the caustic soda to the RO permeate will result in a stable pH, simplified chemical injection, and sufficient alkalinity. However, in order to provide the necessary hardness for a stable product water, addition of some type of calcium product, such as lime or calcium chloride, would also be required.

A.1.3.4 Calcium Chloride

Calcium chloride can be purchased in liquid form, with solution concentrations up to 38 percent. Calcium chloride can be used to achieve the necessary hardness because it adds the lowest amount of anions to the water.

A.1.4 Post-Treatment Approaches Used at Other AWPFs

The post-treatment processes utilized at other AWPFs were researched. **Table A-2** summarizes the benefits and drawbacks of the post-treatment approaches utilized at other AWPFs.

Table A-2: Benefits and Drawbacks of Post-Treatment Approaches used at Other AWPFs

Facility Name	OCWD Groundwater Replenishment System (OCWD GWR System)	West Basin Water Recycling Facility (West Basin WRF)	Vander Lans Water Treatment Plant (Vander Lans WTP)	Terminal Island Water Reclamation Plant (TIWRP)
Process	Decarbonators + Lime Saturators	Lime Saturators	Caustic Soda + Blending	Lime + Calcium Chloride
Benefits	Low operating cost. Only one chemical to feed.	Low operating cost. Only one chemical to feed.	No lime storage and feed facilities.	Greater control of calcium levels than with pure lime system. Liquid calcium chloride does not add turbidity.
Drawbacks	Lime carry-over has been problematic (high turbidity in product water). Difficult to adjust dose after flow change. Difficult to operate.	Similar challenges to Orange County, with higher breakthrough of turbidity.	Cannot meet LSI requirements at plant, since blending occurs at well.	Requires two chemical systems. Calcium chloride relatively costly. Does not eliminate lime.

As shown in **Table A-2**, there are benefits and drawbacks associated with each of the different post-treatment processes. Based on this research, different combinations of post-treatment processes utilizing decarbonators, lime, calcium chloride, and caustic soda were evaluated. However, a post-treatment process similar to the one utilized at Vander Lans WTP, utilizing blending with potable water to add hardness, will not be evaluated since blending with potable water is not a viable option for the AWPF at DCTWRP.

A.2 Post-Treatment Alternatives

The following four post-treatment alternatives were evaluated:

- Alternative 1 – Decarbonation and Lime Addition
- Alternative 2 – Decarbonation, Lime Addition, and Calcium Chloride Addition
- Alternative 3 – Carbon Dioxide Addition, Calcium Chloride Addition, and Caustic Soda Addition
- Alternative 4 – Carbon Dioxide Addition, Decarbonation, Lime addition, and Caustic Soda Addition

Alternative 1 is the same treatment process used at the OCWD GWR System. Alternative 2 is a treatment process modified from TIWRP.

Table A-3 summarizes the source water quality, RO permeate water quality, chemical doses added, and product water quality (based on RTW model) for the OCWD GWRS System, TIWRP system, and the four post-treatment alternatives for the AWPF at DCTWRP. The RTW model is used to show how the post-treatment approach for the OCWD GWR System and TIWRP meet the product water quality objectives. The RTW model is then used to predict how DCTWRP AWPF will react to the four post-treatment alternatives.

Table A-3: Post-Treatment Chemical Addition to Achieve Target Water Quality

Flow Stream	Parameter	OCWD GWRS	TIWRP	DCT AWPF Alt 1	DCT AWPF Alt 2	DCT AWPF Alt 3	DCT AWPF Alt 4
Source Water	pH	7.8	7.3	7.1	7.1	7.1	7.1
	Alkalinity (mg/L)	313	227	130	130	130	130
	Calcium (mg/L)	117	101	45	45	45	45
RO Permeate	pH	6.7	5.6	6.4	6.4	6.4	6.4
	Alkalinity (mg/L)	12.5	4.8	5.4	5.4	5.4	5.4
	Calcium (mg/L)	0.10	1.8	0.13	0.13	0.13	0.13
Chemical Addition (Average Dose)	Lime (mg/L)	25	20	4.6	3.6	N/A	12
	$CaCl_2$ (mg/L)	N/A	60	N/A	45	18.5	N/A
	CO_2 (mg/L)	-34	N/A	-0.4	-0.4	15	15
	NaOH (mg/L)	N/A	N/A	N/A	N/A	18	5
AWPF Product Water	pH	8.5	7.8	**9.3**	8.5	8.5	8.5
	Alkalinity (mg/L)	44	32	12	10	28	28
	Calcium (mg/L)	8.6	34	24	18	6.8	6.8
	LSI	-0.1	-0.5	-0.5	-0.5	-0.5	-0.5

As shown in **Table A-3**, Alternatives 2, 3, and 4 are capable of meeting the product water quality goals. However, Alternative 1, the same treatment process used at the OCWD GWR System, cannot be used at DCT to meet the product water quality goals. This is due to the source water alkalinity and hardness that is significantly lower than the source water at OCWD. Therefore, Alternative 1 is eliminated from further evaluation.

A.2.1 Alternative 2: Decarbonation + Lime + Calcium Chloride

Alternative 2 involves decarbonation to increase pH, addition of lime to increase pH and hardness, and addition of calcium chloride to increase hardness. **Figure A-1** shows the process flow diagram for post-treatment alternative 2. **Table A-4** summarizes the chemical addition doses and relative effect on pH, hardness and LSI.

Figure A-1: Post-Treatment Alternative 2 Process Flow Diagram

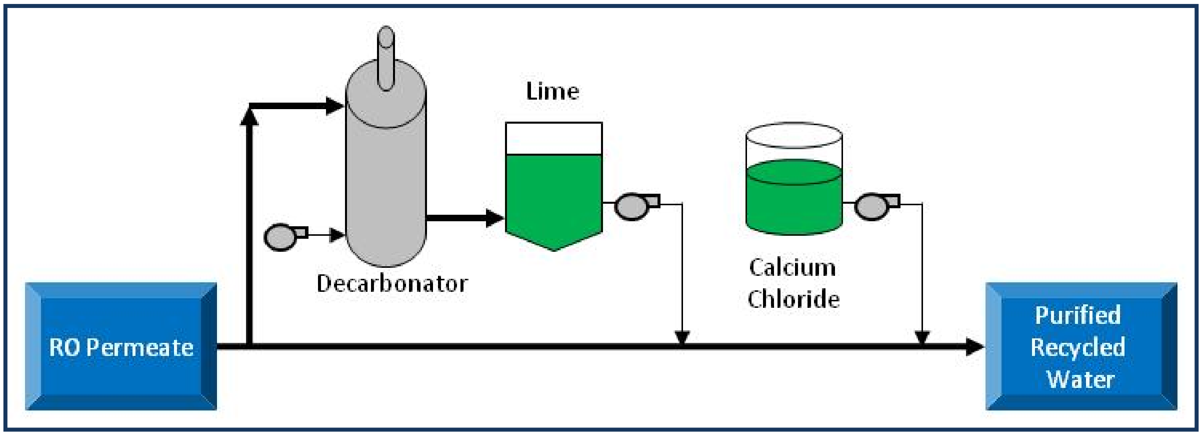

Table A-4: Alternative 2 Post-Treatment System Chemical Addition

Chemical	Dose	pH	Hardness	LSI
Decarbonation (CO_2)	-0.4 mg/L	↑	-	↑
Lime Dose	3.6 mg/L	↑	↑	↑
Calcium Chloride Dose	45 mg/L	-	↑	↑

This alternative utilizes calcium chloride, in addition to lime, to increase the hardness in the product water without further increasing the pH. However, the high concentrations of calcium needed in the product water would also result in the addition of considerable concentrations of chloride, which could reach 45 mg/L, degrading the high quality of water produced by the RO membranes.

Table A-5 summarizes the design criteria for the decarbonation system, lime system, and calcium chloride system for Alternative 2. The equipment required for Alternative 2 would not fit with the AWPF at the DCT SW location.

Table A-5: Alternative 2 Post-Treatment System Design Criteria

	Phase 1	Phase 2
AOP Product Flow, Design	17,360 gpm = 25.0 mgd	24,300 gpm = 35.0 mgd
AOP Product Flow, Minimum	3,470 gpm = 5.0 mgd	3,470 gpm = 5.0 mgd
DECARBONATION SYSTEM		
Design Flow	1,740 gpm	2,430 gpm
Target CO_2	2 to 10 mg/L	2 to 10 mg/L
Air to Water Ratio	3 scfm/gpm	3 scfm/gpm
Tower		
No. of Decarbonators	1 Duty, 1 Standby	1 Duty, 1 Standby
Flow per Unit	2,400 gpm	2,400 gpm
Hydraulic Loading rate	34.7 gpm/sf	34.7 gpm/sf
Tower Dimensions, each (Length x Width)	8.3 ft x 8.3 ft	8.3 ft x 8.3 ft
Media Depth	10 ft	10 ft
Blowers		
No. of Blowers	1 Duty, 1 Standby	1 Duty, 1 Standby
Capacity, each	7,000 scfm	7,000 scfm
Motor, each	5 hp	5 hp
LIME SYSTEM		
Chemical	Calcium Hydroxide (Hydrated Lime)	Calcium Hydroxide (Hydrated Lime)
Concentration	93%	93%
Bulk Density	25.0 lb/cf	25.0 lb/cf
Demand		
Dose, Design	3.6 mg/L	3.6 mg/L
Daily Demand (as 100%)	750 lb/day	1,050 lb/day
Daily Demand (bulk)	0.65 tons/day	0.91 tons/day
Storage Silos		
No. of Storage Tanks	2 Duty, 1 Standby	2 Duty, 1 Standby
Days of Storage	30 days	30 days
Total Storage Volume Required	19 tons	27 tons
Storage Volume, each Silo	2,290 cf	2,290 cf
Silo Diameter	9 ft	9 ft
Silo Overall Height	46 ft	46 ft

Table A-5: Alternative 2 Post-Treatment System Design Criteria (Continued)

	Phase 1	Phase 2
Solid Feeders to Slurry Tanks		
No. of Pumps	2 Duty, 1 Standby	2 Duty, 1 Standby
Feed Range, each	10 to 39 lb/hr	10 to 39 lb/hr
Pump Type	TBD	TBD
Slurry Preparation Tanks		
Slurry Concentration	7%	7%
Lime Slurry Density	8.91 lb/gal	8.91 lb/gal
No. of Tanks	2 Duty, 1 Standby	2 Duty, 1 Standby
Detention Time	5 min	5 min
Tank Volume Required, each	5 gal	5 gal
Tank Volume Provided, each	145 gal	145 gal
Tank Diameter	3 ft	3 ft
Tank Type	HDPE	HPDE
Slurry Transfer Pumps to Saturators		
No. of Pumps	2 Duty, 1 Standby	2 Duty, 1 Standby
Feed Range, each	0.3 to 1.2 gph	0.3 to 1.2 gph
Pump Type	Hose Pumps	Hose Pumps
Lime Saturators		
Saturated Lime Solution Concentration	0.165%	0.165%
No. of Saturators	2 Duty, 1 Standby	2 Duty, 1 Standby
Type of Saturator	High Rate Clarifier with Integrated Mixer	High Rate Clarifier with Integrated Mixer
Loading Rate, Maximum	0.82 lb $Ca(OH)_2$/sf/hr	0.82 lb $Ca(OH)_2$/sf/hr
Rise Rate, Maximum	1.05 gpm/sf	1.05 gpm/sf
Dilution Water Flow	34 gpm	34 gpm
Saturator Volume, each	1,800 gal	1,800 gal
Saturator Diameter, each	6 ft	6 ft
Saturator Sidewater Depth, each	12 ft	12 ft
Average Detention Time, each	59 min	59 min
Polymer System		
Chemical	Anionic Polymer	Anionic Polymer
Dose, Design	8 mg/L	8 mg/L
Daily Demand	1.8 gpd	2.5 gpd

Table A-5: Alternative 2 Post-Treatment System Design Criteria (Continued)

	Phase 1	Phase 2
Blend/Feed Unit		
No. of Units	2 Duty, 1 Standby	2 Duty, 1 Standby
Feed Range, each	0.01 to 0.08 gph	0.01 to 0.08 gph
Storage		
No. of Tanks	1 Duty, 0 Standby	1 Duty, 0 Standby
Tank Volume Required, each	54 gal	75 gal
Tank Volume Provided, each	150 gal	150 gal
Tank Diameter	3 ft	3 ft
Tank Type	HDPE	HDPE
CALCIUM CHLORIDE SYSTEM		
Concentration	34.7%	34.7%
Specific Gravity	1.35	1.35
Demand		
Dose, Design	45 mg/L	45 mg/L
Daily Demand (as 100%)	9,380 lb/day	13,100 lb/day
Daily Demand	2,400 gpd	3,360 gpd
Storage		
No. of Storage Tanks	3 Duty, 0 Standby	5 Duty, 0 Standby
Days of Storage	30 days	30 days
Total Storage Volume Required	33,600 gal	47,100 gal
Tank Volume, each	12,150 gal	12,150 gal
Tank Diameter	12 ft	12 ft
Tank Type	Vertical HDPE	Vertical HDPE
Pumps		
No. of Pumps	2 Duty, 1 Standby	3 Duty, 1 Standby
Pump Capacity, each	51.9 gph	51.9 gph
Pump Type	Diaphragm Metering	Diaphragm Metering

A.2.2 Alternative 3: Carbon Dioxide + Calcium Chloride + Caustic Soda

Alternative 3 involves addition of calcium chloride to increase hardness, and addition of caustic soda to increase pH. Carbon dioxide, which lowers the pH and LSI, is also added first for better control of the pH and LSI. **Figure A-2** shows the process flow diagram for post-treatment alternative 3. **Table A-6** summarizes the chemical addition doses and relative effect on pH, hardness and LSI.

Figure A-2: Post-Treatment Alternative 3 Process Flow Diagram

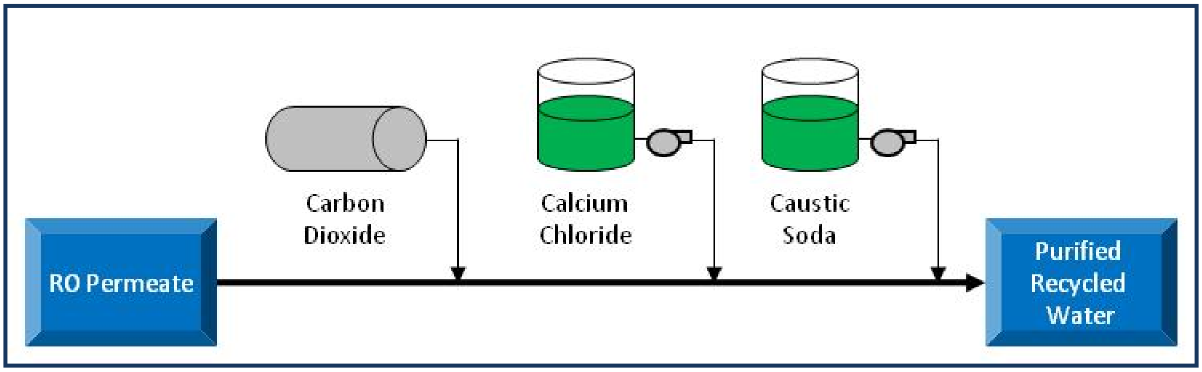

Table A-6: Alternative 3 Post-Treatment System Chemical Addition

Chemical	Dose	pH	Hardness	LSI
Carbon Dioxide Dose	7.5 mg/L	↓	-	↓
Calcium Chloride Dose	27 mg/L	-	↑	↑
Caustic Soda Dose	11 mg/L	↑	-	↑

This alternative allows operators to control hardness and pH independently, producing a stable product water that can be matched to any desired combination of pH, hardness, and alkalinity. Furthermore, the addition of carbon dioxide, which lowers the pH and LSI, ahead of calcium chloride and caustic soda addition decreases the overall demand of calcium chloride, and also enables better overall control of water quality.

The chemical addition for post-treatment/stabilization will be automated. The carbon dioxide and calcium chloride feeds will be flow paced based on the AOP product flow rate. The caustic soda feed will be flow paced based on the AOP product flow rate and trimmed based on the product water pH.

Table A-7 summarizes the design criteria for the carbon dioxide system, calcium chloride system, and caustic soda system for Alternative 3. The equipment required for Alternative 3 would fit with the AWPF at the DCT SW location.

Table A-7: Alternative 3 Post-Treatment System Design Criteria

	Phase 1	Phase 2
AOP Product Flow, Design	17,360 gpm = 25.0 mgd	24,300 gpm = 35.0 mgd
AOP Product Flow, Minimum	3,470 gpm = 5.0 mgd	3,470 gpm = 5.0 mgd
CARBON DIOXIDE SYSTEM		
Chemical	Carbon Dioxide	Carbon Dioxide
Demand		
Dose, Design	15 mg/L	15 mg/L
Daily Demand (as 100%)	3,130 ppd	4,380 ppd
Storage		
No. of Storage Tanks	2 duty, 1 standby	2 duty, 1 standby
Days of Storage	30 days	30 days
Total Storage Volume Required	47 ton	66 ton
Tank Capacity, each	34 ton	34 ton
Tank Volume, each	12,000 gallons	12,000 gallons
Tank Diameter	8 ft	8 ft
Tank Type	Stainless Steel	Stainless Steel
Vaporizer		
No. of Units	2 duty, 1 standby	2 duty, 1 standby
Condenser		
No. of Units	2 duty, 1 standby	2 duty, 1 standby
CALCIUM CHLORIDE SYSTEM		
Chemical	Calcium Chloride	Calcium Chloride
Concentration	34.7%	34.7%
Specific Gravity	1.35	1.35
Demand		
Dose, Design	18.5 mg/L	18.5 mg/L
Daily Demand (as 100%)	3,860 ppd	5,400 ppd
Daily Demand	990 gpd	1,380 gpd
Storage		
No. of Storage Tanks	3 Duty, 0 Standby	4 Duty, 0 Standby
Days of Storage	30 days	30 days
Total Storage Volume Required	29,600 gal	41,500 gal
Tank Volume, each	12,150 gal	12,150 gal
Tank Diameter	12 ft	12 ft
Tank Type	Vertical HDPE	Vertical HDPE

Table A-7: Alternative 3 Post-Treatment System Design Criteria (Continued)

	Phase 1	Phase 2
Pumps		
No. of Pumps	2 Duty, 1 Standby	3 Duty, 1 Standby
Pump Capacity, each	21.3 gph	21.3 gph
Pump Type	Diaphragm Metering	Diaphragm Metering
CAUSTIC SODA SYSTEM		
Chemical	Caustic Soda	Caustic Soda
Concentration	50%	50%
Specific Gravity	1.53	1.53
Demand		
Dose, Design	11 mg/L	11 mg/L
Daily Demand (as 100%)	3,750 ppd	5,250 ppd
Daily Demand	590 gpd	820 gpd
Storage		
No. of Storage Tanks	2 Duty, 0 Standby	3 Duty, 0 Standby
Days of Storage	30 days	30 days
Total Storage Volume	17,600 gal	24,700 gal
Tank Volume, each	9,100 gal	9,100 gal
Tank Diameter	10 ft	10 ft
Tank Type	Horizontal Steel	Horizontal Steel
Pumps		
No. of Pumps	2 Duty, 1 Standby	3 Duty, 1 Standby
Pump Capacity, each	12.7 gph	12.7 gph
Pump Type	Diaphragm Metering	Diaphragm Metering

A.2.3 Alternative 4: Carbon Dioxide + Decarbonation + Lime + Caustic Soda

Alternative 4 involves decarbonation to increase pH, addition of lime to increase pH and hardness, and addition of caustic soda to increase pH. Carbon dioxide, which lowers the pH and LSI, is also added first for better control of the pH and LSI. **Figure A-3** shows the process flow diagram for post-treatment alternative 4. **Table A-8** summarizes the chemical addition doses and relative effect on pH, hardness and LSI.

Figure A-3: Post-Treatment Alternative 2 Process Flow Diagram

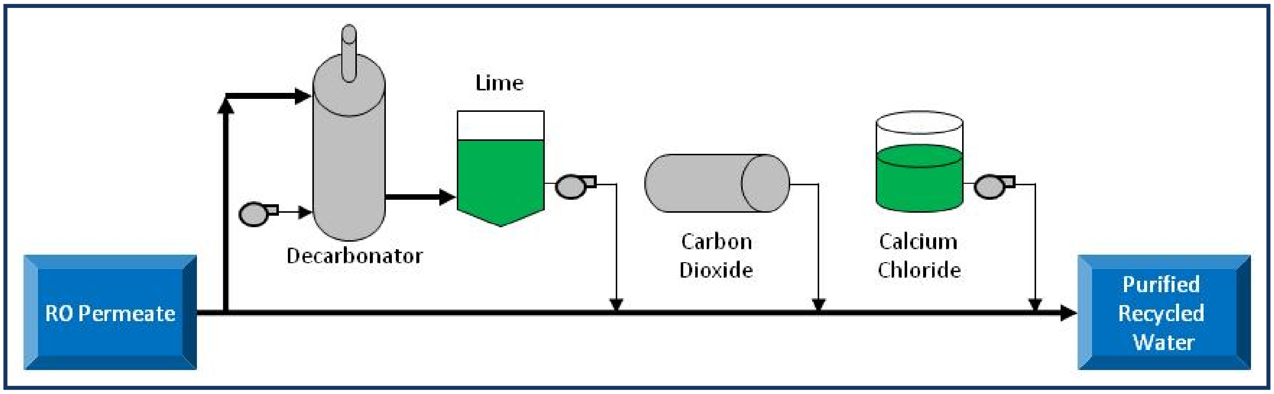

Table A-8: Alternative 4 Post-Treatment System Chemical Addition

Chemical	Dose	pH	Hardness	LSI
Carbon Dioxide Dose	15 mg/L	↓	-	↓
Decarbonation (CO_2)	-0.4 mg/L	↑	-	↑
Lime Dose	12 mg/L	↑	↑	↑
Caustic Soda Dose	5.0 mg/L	↑	-	↑

The addition of caustic soda to supplement lime addition would allow automatic control to maintain a constant product water pH, allow for a constant flow through the lime saturators, and provide the ability to bypass flows around the decarbonators. Using lime to add hardness, rather than calcium chloride, would also prevent the TDS addition associated with calcium chloride and reduce the dose of caustic soda required. While this alternative would still require a lime saturator and dry chemical feed facilities for the lime, flow through the saturator could be kept constant, while diurnal flow variations are addressed using automatic control of the caustic feed system. This approach is similar to the operation of many brackish water desalination facilities, where caustic soda is used for final pH adjustment to adapt to varying hardness and carbonate concentrations in blended product water. Furthermore, the addition of carbon dioxide ahead of calcium chloride and caustic soda addition will enable better control of pH and LSI.

Table A-9 summarizes the design criteria for the carbon dioxide system, decarbonation system, lime system, and caustic soda system for Alternative 4. The equipment required for Alternative 4 would not fit with the AWPF at the DCT SW location.

Table A-9: Alternative 4 Post-Treatment System Design Criteria

	Phase 1	Phase 2
AOP Product Flow, Design	17,360 gpm = 25.0 mgd	24,300 gpm = 35.0 mgd
AOP Product Flow, Minimum	3,470 gpm = 5.0 mgd	3,470 gpm = 5.0 mgd
DECARBONATION SYSTEM		
Design Flow	1,740 gpm	2,430 gpm
Target CO_2	2 to 10 mg/L	2 to 10 mg/L
Air to Water Ratio	3 scfm/gpm	3 scfm/gpm
Tower		
No. of Decarbonators	1 Duty, 1 Standby	1 Duty, 1 Standby
Flow per Unit	2,400 gpm	2,400 gpm
Hydraulic Loading rate	34.7 gpm/sf	34.7 gpm/sf
Tower Dimensions, each (Length x Width)	8.3 ft x 8.3 ft	8.3 ft x 8.3 ft
Media Depth	10 ft	10 ft
Blowers		
No. of Blowers	1 Duty, 1 Standby	1 Duty, 1 Standby
Capacity, each	7,000 scfm	7,000 scfm
Motor, each	5 hp	5 hp
LIME SYSTEM		
Chemical	Calcium Hydroxide (Hydrated Lime)	Calcium Hydroxide (Hydrated Lime)
Concentration	93%	93%
Bulk Density	25.0 lb/cf	25.0 lb/cf
Demand		
Dose, Design	12 mg/L	12 mg/L
Daily Demand (as 100%)	2,500 lb/day	3,500 lb/day
Daily Demand (bulk)	2.19 tons/day	3.06 tons/day

Table A-9: Alternative 4 Post-Treatment System Design Criteria (Continued)

	Phase 1	Phase 2
Storage Silos		
No. of Storage Tanks	2 Duty, 1 Standby	3 Duty, 1 Standby
Days of Storage	30 days	30 days
Total Storage Volume Required	66 tons	92 tons
Storage Volume, each Silo	2,770 cf	2,770 cf
Silo Diameter	14 ft	14 ft
Silo Overall Height	46 ft	46 ft
Solid Feeders to Slurry Tanks		
No. of Pumps	2 Duty, 1 Standby	3 Duty, 1 Standby
Feed Range, each	33 to 130 lb/hr	33 to 130 lb/hr
Pump Type	TBD	TBD
Slurry Preparation Tanks		
Slurry Concentration	7%	7%
Lime Slurry Density	8.91 lb/gal	8.91 lb/gal
No. of Tanks	2 Duty, 1 Standby	3 Duty, 1 Standby
Detention Time	5 min	5 min
Tank Volume Required, each	17 gal	17 gal
Tank Volume Provided, each	145 gal	145 gal
Tank Diameter	3 ft	3 ft
Tank Type	HDPE	HPDE
Slurry Transfer Pumps to Saturators		
No. of Pumps	2 Duty, 1 Standby	3 Duty, 1 Standby
Feed Range, each	1 to 4 gph	1 to 4 gph
Pump Type	Hose Pumps	Hose Pumps

Table A-9: Alternative 4 Post-Treatment System Design Criteria (Continued)

	Phase 1	Phase 2
Lime Saturators		
Saturated Lime Solution Concentration	0.165%	0.165%
No. of Saturators	2 Duty, 1 Standby	2 Duty, 1 Standby
Type of Saturator	High Rate Clarifier with Integrated Mixer	High Rate Clarifier with Integrated Mixer
Loading Rate, Maximum	0.82 lb $Ca(OH)_2$/sf/hr	0.82 lb $Ca(OH)_2$/sf/hr
Rise Rate, Maximum	1.05 gpm/sf	1.05 gpm/sf
Dilution Water Flow	115 gpm	115 gpm
Saturator Volume, each	7,200 gal	7,200 gal
Saturator Diameter, each	12 ft	12 ft
Saturator Sidewater Depth, each	12 ft	12 ft
Average Detention Time, each	82 min	82 min
Polymer System		
Chemical	Anionic Polymer	Anionic Polymer
Dose, Design	8 mg/L	8 mg/L
Daily Demand	6.1 gpd	8.6 gpd
Blend/Feed Unit		
No. of Units	2 Duty, 1 Standby	2 Duty, 1 Standby
Feed Range, each	0.02 to 0.3 gph	0.02 to 0.3 gph
Storage		
No. of Tanks	1 Duty, 0 Standby	1 Duty, 0 Standby
Tank Volume Required, each	183 gal	258 gal
Tank Volume Provided, each	280 gal	280 gal
Tank Diameter	3 ft	3 ft
Tank Type	HDPE	HDPE
CARBON DIOXIDE SYSTEM		
Chemical	Carbon Dioxide	Carbon Dioxide
Demand		
Dose, Design	15 mg/L	15 mg/L
Daily Demand (as 100%)	3,130 lb/day	4,380 lb/day

Table A-9: Alternative 4 Post-Treatment System Design Criteria (Continued)

	Phase 1	Phase 2
Storage		
No. of Storage Tanks	1 duty, 1 standby	2 duty, 1 standby
Days of Storage	30 days	30 days
Total Storage Volume Required	47 ton	66 ton
Tank Volume, each	12,000 gallons	12,000 gallons
Tank Diameter	8 ft	8 ft
Tank Type	Stainless Steel	Stainless Steel
Pumps		
Type	Gas Feed	Gas Feed
CAUSTIC SODA SYSTEM		
Chemical	Caustic Soda	Caustic Soda
Concentration	50%	50%
Specific Gravity	1.53	1.53
Demand for Post-Treatment/Stabilization		
Dose, Design	5 mg/L	5 mg/L
Daily Demand (as 100%)	1,040 lb/day	1,460 lb/day
Daily Demand	160 gpd	230 gpd
Storage		
No. of Storage Tanks	1 Duty, 1 Standby	2 Duty, 0 Standby
Days of Storage	30 days	30 days
Total Storage Volume	2,300 gal	3,200 gal
Tank Volume, each	2,000 gal	2,000 gal
Tank Diameter	8 ft	8 ft
Tank Type	Horizontal Steel, FRP, or HDPE	Horizontal Steel, FRP, or HDPE
Pumps		
No. of Pumps	2 Duty, 1 Standby	3 Duty, 1 Standby
Pump Capacity, each	3.5 gph	3.5 gph
Pump Type	Diaphragm Metering	Diaphragm Metering

A.3 Opinion of Probable Costs

The capital cost, O&M cost, and lifecycle cost estimates for Alternatives 2, 3 and 4 are summarized in **Table A-10**.

Table A-10: Cost Comparison of Post-Treatment Alternatives

	DCTWRP Alt 2	DCTWRP Alt 3	DCTWRP Alt 4
Process	Decarbonation + Lime + Calcium Chloride	Carbon Dioxide + Calcium Chloride + Caustic Soda	Carbon Dioxide + Decarbonation + Lime + Caustic Soda
Capital Cost [2]	$11.2M	$2.03 M	$23.2M
Annual O&M Cost [3]	$830,000	$1,030,000	$915,000
Lifecycle Cost [4]	$58M	$49M	$85M

Notes:

1) All costs are in 2011 dollars.
2) Includes 30% contingency and 30% implementation cost.
3) Annual O&M costs include power cost, and chemical cost.
4) 50-year lifecycle cost is calculated from year 2015 to 2064. See Appendix B3 for detailed cost estimates.

A.4 Recommendation

The benefits and drawbacks of Alternatives 2, 3 and 4 are summarized in **Table A-11**.

Table A-11: Benefits and Drawbacks of Post-Treatment Alternatives

Facility Name	Alt 2	Alt 3	Alt 4
Process	Decarbonation + Lime + Calcium Chloride	Carbon Dioxide + Calcium Chloride + Caustic Soda	Carbon Dioxide + Decarbonation + Lime + Caustic Soda
Benefits	• Lowest chemical cost • Lowest O&M cost	• Simplest operation • Best overall control of water quality • Lowest capital cost • Lowest overall lifecycle cost	• N/A
Drawbacks	• Highest TDS in product water due to high $CaCl_2$ dose • Difficult to adjust to variations in plant flow rates due to lime system • Requires large footprint and does not fit at DCT SW location • Lime saturators can be difficult to operate	• Highest O&M cost	• Highest capital cost • Most amount of unit processes to operate • Requires large footprint and does not fit at DCT SW location • Lime saturators can be difficult to operate
Conclusion	Not recommended	Recommended	Not recommended

Based on the benefits and drawbacks described in **Table A-11**, Alternative 3, carbon dioxide addition, calcium chloride addition, and caustic soda addition, is recommended for the AWPF at DCTWRP.

Appendix B

Opinion of Probable Cost

B-1 Capital Cost

B-2 O&M Cost

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Groundwater Replenishment Master Planning Report
Conceptual-Level Capital Cost for AWPF Using UV/H2O2 with Trojan UV

Item No. [1]	Parameter	Phase 1	Phases 1+2
	AWPF		
1+2+3	MF System	$32,657,000	$42,212,000
8	MF/RO EQ Basin	$1,604,000	$1,604,000
4+9+10	RO System	$36,337,000	$47,753,000
5a+6a+7a	Two-Story MF/RO Building - UV Option	$42,727,000	$42,727,000
11+12	UV System	$8,192,000	$10,188,000
13+14	Chemical Systems	$3,170,000	$3,308,000
15	Balboa PS Modification	$0	$1,206,000
22	Primary Flow Equalization Basins	$0	$16,538,000
16+17+18+19 +20+21	Yard Piping	$3,236,000	$3,236,000
23+24+25+31 +32	Site Improvements	$1,468,000	$1,468,000
29	Adder for Protecting DWP Electrical Substation in Place	$337,000	$337,000
30	Adder for Relocation of Electrical Duct Banks	$1,687,000	$1,687,000
26+27+28	Demolition of Existing Service Buildings	$5,764,000	$5,764,000
	New Service Buildings	$30,000,000	$30,000,000
	Construction Subtotal	$167,179,000	$208,028,000
	30% Contingency	$50,154,000	$62,408,000
	Construction Total (Incl. 30% Contingency)	$217,333,000	$270,436,000
	30% Implementation	$65,200,000	$81,131,000
	Total Capital Cost (AWPF - UV Option)	**$283,000,000**	**$352,000,000**
	CONVEYANCE & REPLENISHMENT		
33	Modifications to Hansen Spreading Grounds (HSG)	$1,217,000	$1,217,000
34	Pipeline from 54" Pipeline to Pacoima Spreading Grounds (PSG)	$0	$14,734,000
	Construction Subtotal	$1,217,000	$15,951,000
	30% Contingency	$365,000	$4,785,000
	Construction Total (Incl. 30% Contingency)	$1,582,000	$20,736,000
	30% Implementation	$475,000	$6,221,000
	Total Capital Cost (Conveyance & Spreading)	**$2,060,000**	**$27,000,000**
35	Injection Wells	$0	$21,067,000
	Construction Subtotal	$0	$21,067,000
	30% Contingency	$0	$6,320,000
	Construction Total (Incl. 30% Contingency)	$0	$27,387,000
	30% Implementation	$0	$8,216,000
	Total Capital Cost (Injection Wells)	**$0**	**$35,600,000**
	Total Capital Cost (Excluding Injection Wells)	**$285,000,000**	**$379,000,000**
	Total Capital Cost (Including Injection Wells)	**$285,000,000**	**$415,000,000**

Notes: (1) Reference this number in Timberline Cost Estimates for Detailed Cost Estimate.

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Groundwater Replenishment Master Planning Report

Appendix B2 - Conceptual-Level Annual O&M Cost for AWPF Using UV/H_2O_2 with Trojan UV, Phase 1

Power cost	0.12	$/kWh
Hours of operation per day	24	hours
Days of operation per year	365	days
AWPF Online Factor	93%	

1) Equipment/Building Operations Power Cost							
#	**Load**	**BHP**	**kW**	**# Operating**	**Demand**	**Annual Power (kWh/yr)**	**Annual Cost ($/yr)**
1	MF Feed Pump	120	89	3	100%	2,183,022	$261,963
2	MF System Automatic Strainer	1	0	5	100%	15,214	$1,826
3	MF Backwash Pump	20	15	2	35%	85,199	$10,224
4	MF System Blower	30	22	3	35%	191,698	$23,004
5	MF System Air Compressor	30	22	2	100%	365,140	$43,817
6	MF System CIP Recirculation Pump	30	22	2	5.8%	21,008	$2,521
7	MF System CIP Tank Heater	24	18	2	46%	134,991	$16,199
8	RO Booster Pump	149	111	5	100%	4,531,720	$543,806
9	RO Feed Pump	413	309	5	100%	12,567,970	$1,508,156
10	RO Energy Recovery				100%		
11	RO Flush Pump	60	45	2	0.35%	2,536	$304
12	RO System CIP Recirculation Pump	40	30	2	0.48%	2,334	$280
13	RO System CIP Tank Heater	24	18	2	2.6%	7,500	$900
14	UV	149	111	3	71%	1,937,775	$232,533
15a	Product Water Pump (Proposed)	800	598	0	100%	0	$0
15b	Product Water Pump (Existing)	1000	747	2	100%	12,171,319	$1,460,558
16	Sodium Hypochlorite Feed Pump	0.50	0.37	2	100%	6,086	$730
17	Ammonium Hydroxide Feed pump	0.50	0.37	2	100%	6,086	$730
18	Sulfuric Acid Feed Pump	0.50	0.37	2	100%	6,086	$730
19	Antiscalant Feed Pump	0.50	0.37	2	100%	6,086	$730
20	Hydrogen Peroxide Feed Pump	0.50	0.37	5	100%	15,214	$1,826
21a	CO2 Vaporizer	20.1	15.0	2	100%	244,404	$29,328
21b	CO2 Condenser	10.0	7.5	2	100%	121,713	$14,606
21c	Carbon Dioxide Diffusers				100%		
22	Calcium Chloride Feed Pump	0.50	0.37	2	100%	5,868	$704
23	Caustic Soda Feed Pump	0.50	0.37	2	100%	5,868	$704
25	Sodium Hypochlorite Feed Pump MF MC	0.50	0.37	1	22%	666	$80
26	Sodium Hypochlorite Feed Pump MF CIP	0.50	0.37	1	1.4%	44	$5
27	Sodium Bisulfite Feed Pump MF CIP	0.50	0.37	1	1.4%	44	$5
28	Citric Acid Feed Pump for MF CIP	0.50	0.37	1	1.4%	44	$5
29	Caustic Soda Feed Pump MF CIP	0.50	0.37	1	1.4%	44	$5
30	Citric Acid Feed Pump RO CIP	0.50	0.37	1	0.16%	5	$1
31	Caustic Soda Feed Pump RO CIP	0.50	0.37	1	0.16%	5	$1
#	**Load**	**Area (SF)**	**Unit Power (kW/SF)**	**Total Power (kW)**	**Demand**	**Annual Power (kWh/yr)**	**Annual Cost ($/yr)**
32	MF/RO Building	58,500	0.01	556	100%	4,527,584	$543,310
	Power Cost Subtotal						**$4,699,592**

Groundwater Replenishment Master Planning Report

Appendix B2 - Conceptual-Level Annual O&M Cost for AWPF Using UV/H_2O_2 with Trojan UV, Phase 1

Power cost	0.12	$/kWh
Hours of operation per day	24	hours
Days of operation per year	365	days
AWPF Online Factor	93%	

2) Chemical Costs

#	Chemical	Usage (gal/day)		Usage (gal/yr)	Demand	Unit Cost ($/gal)	Annual Cost ($)
	Pre-/Post-Treatment						
1	Sodium Hypochlorite (Pre-treatment)	1054		384,725	100%	0.66	$236,144
2	Ammonium Hydroxide	226		82,535	100%	1.39	$106,379
3	Sulfuric Acid	344		125,454	100%	1.39	$162,174
4	Antiscalant	98		35,779	100%	6.49	$215,954
5	Hydrogen Peroxide	210		76,670	100%	4.94	$352,246
6	Calcium Chloride	987		360,315	100%	0.53	$178,265
7	Carbon Dioxide (ton/yr)	1.56		571	100%	100.00	$53,081
8	Caustic Soda	588		214,677	100%	2.35	$469,192
	Chemical Cost Subtotal						**$1,773,436**

*MF/RO CIP chemicals not included

3) Major Equipment Replacement Cost

#	Equipment	Units/ Modules	Unit Cost ($/unit)	Replacement (#/year)			Annual Cost ($)
1	MF Membrane Replacement	1,768	$3,000	0.14			$704,645
2	Cartridge Filter Replacement	10					$118,808
3	RO Element Replacement	5					$400,975
4	UV Lamp Replacement	1,296	$268	0.7			$220,727
5	UV Ballast Replacement	648	$636	0.14			$54,754
	Major Equipment Replacement Cost Subtotal						**$1,499,909**

4) Maintenance Cost

#	Equipment	Percentage	Equipment Cost				Annual Cost ($)
1	Maintenance Cost	1.7%	$108,666,500				$1,847,331
	Maintenance Cost Subtotal						**$1,847,331**

5) Labor Cost

#	Personnel	#				Labor Cost ($)	Annual Labor Cost ($)
1	W/WTR TRMT OPER I	5				$159,854	$799,271
2	W/WTR TRMT OPER II					$179,948	$0
3	W/WTR TRMT OPER III	5				$187,498	$937,488
4	W/WTR TRMT MECH I	2				$144,699	$289,398
5	W/WTR TRMT MECH II	2				$154,257	$308,514
6	INSTRUMENT MECH	2				$177,798	$355,596
7	W/WTR TRMT ELEC I					$150,289	$0
8	W/WTR TRMT ELEC II	1				$162,651	$162,651
9	Control Systems Engineer Assoc III	1				$175,229	$175,229
10	Environmental Engineer	1				$190,415	$190,415
	Labor Cost Subtotal	19					**$3,218,562**

*Labor cost estimate was prepared by BOS.

	Phase 1 Total Annual O&M Cost						**$13,040,000**

Groundwater Replenishment Master Planning Report

Appendix B2 - Conceptual-Level Annual O&M Cost for AWPF Using UV/H_2O_2 with Trojan UV, Phase 2

Power cost	0.12	$/kWh
Hours of operation per day	24	hours
Days of operation per year	365	days
AWPF Online Factor	93%	

1) Equipment/Building Operations Power Cost							
#	**Load**	**HP**	**kW**	**# Operating**	**Demand**	**Annual Power (kWh/yr)**	**Annual Cost ($/yr)**
1	MF Feed Pump	120	89	4	100%	2,910,696	$349,284
2	MF System Automatic Strainer	1	0	5	100%	15,214	$1,826
3	MF Backwash Pump	20	15	2	35%	85,199	$10,224
4	MF System Blower	30	22	3	35%	191,698	$23,004
5	MF System Air Compressor	30	22	2	100%	365,140	$43,817
6	MF System CIP Recirculation Pump	30	22	2	6%	21,008	$2,521
7	MF System CIP Tank Heater	24	18	2	46%	134,991	$16,199
8	RO Booster Pump	149	111	7	100%	6,344,408	$761,329
9	RO Feed Pump	413	309	7	100%	17,595,158	$2,111,419
10	RO Energy Recovery				100%		
11	RO Flush Pump	60	45	3	0%	3,804	$456
12	RO System CIP Recirculation Pump	40	30	2	0%	2,334	$280
13	RO System CIP Tank Heater	24	18	2	3%	7,500	$900
14	UV	149	111	4	100%	3,617,179	$434,062
15a	Product Water Pump (Proposed)	800	598	1	100%	4,868,528	$584,223
15b	Product Water Pump (Existing)	1000	747	2	100%	12,171,319	$1,460,558
16	Sodium Hypochlorite Feed Pump	0.50	0.37	3	100%	9,128	$1,095
17	Ammonium Hydroxide Feed pump	0.50	0.37	3	100%	9,128	$1,095
18	Sulfuric Acid Feed Pump	0.50	0.37	3	100%	9,128	$1,095
19	Antiscalant Feed Pump	0.50	0.37	3	100%	9,128	$1,095
20	Hydrogen Peroxide Feed Pump	0.50	0.37	7	100%	21,300	$2,556
21a	CO2 Vaporizer	20.1	15.0	2	100%	244,404	$29,328
21b	CO2 Condenser	10.0	7.5	2	100%	121,713	$14,606
21c	Carbon Dioxide Diffusers				100%		
22	Calcium Chloride Feed Pump	0.50	0.37	3	100%	9,128	$1,095
23	Caustic Soda Feed Pump	0.50	0.37	3	100%	9,128	$1,095
25	Sodium Hypochlorite Feed Pump MF MC	0.50	0.37	1	22%	666	$80
26	Sodium Hypochlorite Feed Pump MF CIP	0.50	0.37	1	1.4%	44	$5
27	Sodium Bisulfite Feed Pump MF CIP	0.50	0.37	1	1.4%	44	$5
28	Citric Acid Feed Pump for MF CIP	0.50	0.37	1	1.4%	44	$5
29	Caustic Soda Feed Pump MF CIP	0.50	0.37	1	1.4%	44	$5
30	Citric Acid Feed Pump RO CIP	0.50	0.37	1	0.16%	5	$1
31	Caustic Soda Feed Pump RO CIP	0.50	0.37	1	0.16%	5	$1
#	**Load**	**Area (SF)**	**Unit Power (kW/SF)**	**Total Power (kW)**	**Demand**	**Annual Power (kWh/yr)**	**Annual Cost ($/yr)**
32	MF/RO Building	58,500	0.01	556	100%	4,527,584	$543,310
	Power Cost Subtotal						**$6,396,576**

Groundwater Replenishment Master Planning Report

Appendix B2 - Conceptual-Level Annual O&M Cost for AWPF Using UV/H_2O_2 with Trojan UV, Phase 2

Power cost	0.12	$/kWh
Hours of operation per day	24	hours
Days of operation per year	365	days
AWPF Online Factor	93%	

2) Chemical Costs

#	Chemical	Usage (gal/day)		Usage (gal/yr)	Demand	Unit Cost ($/gal)	Annual Cost ($)
	Pre-/Post-Treatment						
1	Sodium Hypochlorite (Pre-treatment)	1476		538,616	100%	0.66	$330,602
2	Ammonium Hydroxide	317		115,550	100%	1.39	$148,930
3	Sulfuric Acid	481		175,636	100%	1.39	$227,044
4	Antiscalant	137		50,091	100%	6.49	$302,336
5	Hydrogen Peroxide	294		107,338	100%	4.94	$493,144
6	Calcium Chloride	1382		504,441	100%	0.53	$249,572
7	Carbon Dioxide (ton/yr)	2.19		799	100%	100.00	$74,314
8	Caustic Soda	823		300,547	100%	2.35	$656,869
	Chemical Cost Subtotal						**$2,482,811**

*MF/RO CIP chemicals not included

3) Major Equipment Replacement Cost

#	Equipment	Units/ Modules	Unit Cost ($/unit)	Replacement (#/year)			Annual Cost ($)
1	MF Membrane Replacement	2,475	$3,000	0.14			$986,503
2	Cartridge Filter Replacement	14					$166,331
3	RO Element Replacement	7					$561,365
4	UV Lamp Replacement	1,728	$268	0.7			$294,303
5	UV Ballast Replacement	864	$636	0.14			$73,006
	Major Equipment Replacement Cost Subtotal						**$2,081,507**

4) Maintenance Cost

#	Equipment	Percentage	Equipment Cost				Annual Cost ($)
1	Maintenance Cost	1.7%	$135,218,000				$2,298,706
	Maintenance Cost Subtotal						**$2,298,706**

5) Labor Cost

#	Personnel	#				Labor Cost ($)	Annual Labor Cost ($)
1	W/WTR TRMT OPER I	5				$159,854	$799,271
2	W/WTR TRMT OPER II					$179,948	$0
3	W/WTR TRMT OPER III	5				$187,498	$937,488
4	W/WTR TRMT MECH I	3				$144,699	$434,097
5	W/WTR TRMT MECH II	3				$154,257	$462,771
6	INSTRUMENT MECH	3				$177,798	$533,393
7	W/WTR TRMT ELEC I					$150,289	$0
8	W/WTR TRMT ELEC II	1				$162,651	$162,651
9	Control Systems Engineer Assoc III	1				$175,229	$175,229
10	Environmental Engineer	1				$190,415	$190,415
	Labor Cost Subtotal	22					**$3,695,316**

*Labot costs approximated from Miami-Dade example.

	Phase 2 Total Annual O&M Cost						**$17,000,000**

Groundwater Replenishment Master Planning Report

Appendix B2 - Conceptual-Level Annual O&M Cost for AWPF Using UV/H_2O_2 with Calgon UV, Phase 1

Power cost	0.12	$/kWh
Hours of operation per day	24	hours
Days of operation per year	365	days
AWPF Online Factor	93%	

1) Equipment/Building Operations Power Cost							
#	**Load**	**HP**	**kW**	**# Operating**	**Demand**	**Annual Power (kWh/yr)**	**Annual Cost ($/yr)**
1	MF Feed Pump	120	89	3	100%	2,183,022	$261,963
2	MF System Automatic Strainer	1	0	5	100%	15,214	$1,826
3	MF Backwash Pump	20	15	2	35%	85,199	$10,224
4	MF System Blower	30	22	3	35%	191,698	$23,004
5	MF System Air Compressor	30	22	2	100%	365,140	$43,817
6	MF System CIP Recirculation Pump	30	22	2	5.8%	21,008	$2,521
7	MF System CIP Tank Heater	24	18	2	46%	134,991	$16,199
8	RO Booster Pump	149	111	5	100%	4,531,720	$543,806
9	RO Feed Pump	413	309	5	100%	12,567,970	$1,508,156
10	RO Energy Recovery				100%		
11	RO Flush Pump	60	45	2	0.35%	2,536	$304
12	RO System CIP Recirculation Pump	40	30	2	0.48%	2,334	$280
13	RO System CIP Tank Heater	24	18	2	2.6%	7,500	$900
14	UV	531	396	3	71%	6,913,142	$829,577
15a	Product Water Pump (Proposed)	800	598	0	100%	0	$0
15b	Product Water Pump (Existing)	1000	747	2	100%	12,171,319	$1,460,558
16	Sodium Hypochlorite Feed Pump	0.50	0.37	2	100%	6,086	$730
17	Ammonium Hydroxide Feed pump	0.50	0.37	2	100%	6,086	$730
18	Sulfuric Acid Feed Pump	0.50	0.37	2	100%	6,086	$730
19	Antiscalant Feed Pump	0.50	0.37	2	100%	6,086	$730
20	Hydrogen Peroxide Feed Pump	0.50	0.37	5	100%	15,214	$1,826
21a	CO2 Vaporizer	20.1	15.0	2	100%	244,404	$29,328
21b	CO2 Condenser	10.0	7.5	2	100%	121,713	$14,606
21c	Carbon Dioxide Diffusers				100%		
22	Calcium Chloride Feed Pump	0.50	0.37	2	100%	5,868	$704
23	Caustic Soda Feed Pump	0.50	0.37	2	100%	5,868	$704
25	Sodium Hypochlorite Feed Pump MF MC	0.50	0.37	1	22%	666	$80
26	Sodium Hypochlorite Feed Pump MF CIP	0.50	0.37	1	1.4%	44	$5
27	Sodium Bisulfite Feed Pump MF CIP	0.50	0.37	1	1.4%	44	$5
28	Citric Acid Feed Pump for MF CIP	0.50	0.37	1	1.4%	44	$5
29	Caustic Soda Feed Pump MF CIP	0.50	0.37	1	1.4%	44	$5
30	Citric Acid Feed Pump RO CIP	0.50	0.37	1	0.16%	5	$1
31	Caustic Soda Feed Pump RO CIP	0.50	0.37	1	0.16%	5	$1
#	**Load**	**Area (SF)**	**Unit Power (kW/SF)**	**Total Power (kW)**	**Demand**	**Annual Power (kWh/yr)**	**Annual Cost ($/yr)**
32	MF/RO Building	58,500	0.01	556	100%	4,527,584	$543,310
	Power Cost Subtotal						**$5,296,637**

Groundwater Replenishment Master Planning Report

Appendix B2 - Conceptual-Level Annual O&M Cost for AWPF Using UV/H_2O_2 with Calgon UV, Phase 1

Power cost	0.12	$/kWh
Hours of operation per day	24	hours
Days of operation per year	365	days
AWPF Online Factor	93%	

2) Chemical Costs							
#	**Chemical**	**Usage (gal/day)**		**Usage (gal/yr)**	**Demand**	**Unit Cost ($/gal)**	**Annual Cost ($)**
	Pre-/Post-Treatment						
1	Sodium Hypochlorite (Pre-treatment)	1054		384,725	100%	0.66	$236,144
2	Ammonium Hydroxide	226		82,535	100%	1.39	$106,379
3	Sulfuric Acid	344		125,454	100%	1.39	$162,174
4	Antiscalant	98		35,779	100%	6.49	$215,954
5	Hydrogen Peroxide	210		76,670	100%	4.94	$352,246
6	Calcium Chloride	987		360,315	100%	0.53	$178,265
7	Carbon Dioxide (ton/yr)	1.56		571	100%	100.00	$53,081
8	Caustic Soda	588		214,677	100%	2.35	$469,192
	Chemical Cost Subtotal						**$1,773,436**

*MF/RO CIP chemicals not included

3) Major Equipment Replacement Cost							
#	**Equipment**	**Units/ Modules**	**Unit Cost ($/unit)**	**Replacement (#/year)**			**Annual Cost ($)**
1	MF Membrane Replacement	1,768	$3,000	0.14			$704,645
2	Cartridge Filter Replacement	10					$118,808
3	RO Element Replacement	5					$400,975
4	UV Lamp Replacement	39	$726	1.6			$42,710
5	UV Ballast Replacement	39	$4,264	0.14			$21,851
	Major Equipment Replacement Cost Subtotal						**$1,288,989**

4) Maintenance Cost							
#	**Equipment**	**Percentage**	**Equipment Cost**				**Annual Cost ($)**
1	Maintenance Cost	1.7%	$108,666,500				$1,847,331
	Maintenance Cost Subtotal						**$1,847,331**

5) Labor Cost							
#	**Personnel**	**#**				**Labor Cost ($)**	**Annual Labor Cost ($)**
1	W/WTR TRMT OPER I	5				$159,854	$799,271
2	W/WTR TRMT OPER II					$179,948	$0
3	W/WTR TRMT OPER III	5				$187,498	$937,488
4	W/WTR TRMT MECH I	2				$144,699	$289,398
5	W/WTR TRMT MECH II	2				$154,257	$308,514
6	INSTRUMENT MECH	2				$177,798	$355,596
7	W/WTR TRMT ELEC I					$150,289	$0
8	W/WTR TRMT ELEC II	1				$162,651	$162,651
9	Control Systems Engineer Assoc III	1				$175,229	$175,229
10	Environmental Engineer	1				$190,415	$190,415
	Labor Cost Subtotal	19					**$3,218,562**

*Costs approximated from Miami-Dade example.

	Phase 1 Total Annual O&M Cost						**$13,420,000**

Groundwater Replenishment Master Planning Report

Appendix B2 - Conceptual-Level Annual O&M Cost for AWPF Using UV/H_2O_2 with Calgon UV, Phase 2

Power cost	0.12	$/kWh
Hours of operation per day	24	hours
Days of operation per year	365	days
AWPF Online Factor	93%	

1) Equipment/Building Operations Power Cost							
#	**Load**	**HP**	**kW**	**# Operating**	**Demand**	**Annual Power (kWh/yr)**	**Annual Cost ($/yr)**
1	MF Feed Pump	120	89	4	100%	2,910,696	$349,284
2	MF System Automatic Strainer	1	0	7	100%	21,300	$2,556
3	MF Backwash Pump	20	15	2	35%	85,199	$10,224
4	MF System Blower	30	22	3	35%	191,698	$23,004
5	MF System Air Compressor	30	22	2	100%	365,140	$43,817
6	MF System CIP Recirculation Pump	30	22	2	6%	21,008	$2,521
7	MF System CIP Tank Heater	24	18	2	46%	134,991	$16,199
8	RO Booster Pump	149	111	7	100%	6,344,408	$761,329
9	RO Feed Pump	413	309	7	100%	17,595,158	$2,111,419
10	RO Energy Recovery				100%		
11	RO Flush Pump	60	45	3	0%	3,804	$456
12	RO System CIP Recirculation Pump	40	30	2	0%	2,334	$280
13	RO System CIP Tank Heater	24	18	2	3%	7,500	$900
14	UV	531	396	3	100%	9,678,398	$1,161,408
15a	Product Water Pump (Proposed)	800	598	1	100%	4,868,528	$584,223
15b	Product Water Pump (Existing)	1000	747	2	100%	12,171,319	$1,460,558
16	Sodium Hypochlorite Feed Pump	0.50	0.37	3	100%	9,128	$1,095
17	Ammonium Hydroxide Feed pump	0.50	0.37	3	100%	9,128	$1,095
18	Sulfuric Acid Feed Pump	0.50	0.37	3	100%	9,128	$1,095
19	Antiscalant Feed Pump	0.50	0.37	3	100%	9,128	$1,095
20	Hydrogen Peroxide Feed Pump	0.50	0.37	7	100%	21,300	$2,556
21a	CO2 Vaporizer	20.08	15.00	2	100%	244,404	$29,328
21b	CO2 Condenser	10.00	7.47	2	100%	121,713	$14,606
21c	Carbon Dioxide Diffusers				100%		
22	Calcium Chloride Feed Pump	0.50	0.37	3	100%	9,128	$1,095
23	Caustic Soda Feed Pump	0.50	0.37	3	100%	9,128	$1,095
25	Sodium Hypochlorite Feed Pump MF MC	0.50	0.37	1	22%	666	$80
26	Sodium Hypochlorite Feed Pump MF CIP	0.50	0.37	1	1.4%	44	$5
27	Sodium Bisulfite Feed Pump MF CIP	0.50	0.37	1	1.4%	44	$5
28	Citric Acid Feed Pump for MF CIP	0.50	0.37	1	1.4%	44	$5
29	Caustic Soda Feed Pump MF CIP	0.50	0.37	1	1.4%	44	$5
30	Citric Acid Feed Pump RO CIP	0.50	0.37	1	0.16%	5	$1
31	Caustic Soda Feed Pump RO CIP	0.50	0.37	1	0.16%	5	$1
#	**Load**	**Area (SF)**	**Unit Power (kW/SF)**	**Total Power (kW)**	**Demand**	**Annual Power (kWh/yr)**	**Annual Cost ($/yr)**
32	MF/RO Building	58,500	0.01	556	100%	4,527,584	$543,310
	Power Cost Subtotal						**$7,124,652**

Groundwater Replenishment Master Planning Report

Appendix B2 - Conceptual-Level Annual O&M Cost for AWPF Using UV/H_2O_2 with Calgon UV, Phase 2

Power cost	0.12	$/kWh
Hours of operation per day	24	hours
Days of operation per year	365	days
AWPF Online Factor	93%	

2) Chemical Costs							
#	**Chemical**	**Usage (gal/day)**		**Usage (gal/yr)**	**Demand**	**Unit Cost ($/gal)**	**Annual Cost ($)**
	Pre-/Post-Treatment						
1	Sodium Hypochlorite (Pre-treatment)	1476		538,616	100%	0.66	$330,602
2	Ammonium Hydroxide	317		115,550	100%	1.39	$148,930
3	Sulfuric Acid	481		175,636	100%	1.39	$227,044
4	Antiscalant	137		50,091	100%	6.49	$302,336
5	Hydrogen Peroxide	294		107,338	100%	4.94	$493,144
6	Calcium Chloride	1382		504,441	100%	0.53	$249,572
7	Carbon Dioxide (ton/yr)	2.19		799	100%	100.00	$74,314
8	Caustic Soda	823		300,547	100%	2.35	$656,869
	Chemical Cost Subtotal						**$2,482,811**

*MF/RO CIP chemicals not included

3) Major Equipment Replacement Cost							
#	**Equipment**	**Units/ Modules**	**Unit Cost ($/unit)**	**Replacement (#/year)**			**Annual Cost ($)**
1	MF Membrane Replacement	2,475	$3,000	0.14			$986,503
2	Cartridge Filter Replacement	14					$166,331
3	RO Element Replacement	7					$561,365
4	UV Lamp Replacement	54	$726	1.6			$59,794
5	UV Ballast Replacement	54	$4,264	0.14			$30,591
	Major Equipment Replacement Cost Subtotal						**$1,804,584**

4) Maintenance Cost							
#	**Equipment**	**Percentage**	**Equipment Cost**				**Annual Cost ($)**
1	Maintenance Cost	1.7%	$135,218,000				$2,298,706
	Maintenance Cost Subtotal						**$2,298,706**

5) Labor Cost							
#	**Personnel**	**#**				**Labor Cost ($)**	**Annual Labor Cost ($)**
1	W/WTR TRMT OPER I	5				$159,854	$799,271
2	W/WTR TRMT OPER II					$179,948	$0
3	W/WTR TRMT OPER III	5				$187,498	$937,488
4	W/WTR TRMT MECH I	3				$144,699	$434,097
5	W/WTR TRMT MECH II	3				$154,257	$462,771
6	INSTRUMENT MECH	3				$177,798	$533,393
7	W/WTR TRMT ELEC I					$150,289	$0
8	W/WTR TRMT ELEC II	1				$162,651	$162,651
9	Control Systems Engineer Assoc III	1				$175,229	$175,229
10	Environmental Engineer	1				$190,415	$190,415
	Labor Cost Subtotal	22					**$3,695,316**

*Labot costs approximated from Miami-Dade example.

	Phase 2 Total Annual O&M Cost						**$17,400,000**

Appendix C

Cost Estimating Basis for Recycled Water Master Planning TM

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Technical Memorandum

Title: **Cost Estimating Basis for Recycled Water Master Planning**

Date: March 2012

Table of Contents

Attachments

Tables

Figures

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1. Introduction

The purpose of this Technical Memorandum is to describe a cost estimating basis used for the analysis of options and alternatives being developed under the City of Los Angeles Department of Water and Power's (LADWP) Recycled Water Master Plan (RWMP) for Task 1 (Groundwater Replenishment), Task 2 (Non-Potable Reuse)[1], Task 4 (Maximizing Reuse), Task 5 (Satellite Treatment), and Task 6 (Existing System Reliability). Unit costs for the following types of facilities are included in this TM:

- Treatment
- Pipelines
- Pump Stations
- Storage
- Pressure Regulating Stations
- Groundwater Wells
- Water Purchases
- Land Acquisition

For components not included in the TM, a unit cost or other estimating tool was developed.

[1] The cost estimating assumptions for non-potable customer conversions were developed under a separate TM.

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2. Cost Estimating Criteria

2.1 Cost Estimate Class

The classes of cost estimates shown, and any resulting conclusions on project financial or economic feasibility or funding requirements, are prepared for guidance in project evaluation and implementation and use the information available at the time of the estimate. The final costs of the project and resulting feasibility will depend on a variety factors, including but not limited to, actual labor and material costs, competitive market conditions, actual site conditions, final project scope, implementation schedule, continuity of personal, engineering, and construction phases. Therefore, the final project costs will vary from the estimate developed using the information in this document. Because of these factors, project feasibility, benefit cost/ratios, alternative evaluations, project risks, and funding needs must be carefully reviewed, prior to making specific financial decisions or establishing project budgets, to help ensure project evaluation and adequate funding.

As described in *A Guide to the Project Management Body of Knowledge (PMBOK® Guide)* (PMI, 2008), cost estimates are a prediction based on information known at a given point in time and should be refined during the course of the project to reflect additional detail as it becomes available. The accuracy of the estimate should increase as the project progresses.

2.1.1 American National Standards Institute Standard Z94.0

In the late 1960s, the Association for the Advancement of Cost Engineering international (AACE) developed a guideline for cost estimate classification for the process industries. A three-part simplified version was adopted as an *American National Standards Institute (ANSI)* Standard Z94.0 in 1972. Those guidelines and standards enjoy reasonably broad acceptance within the engineering and construction communities and within the process industries. These cost estimate classes will be used for the financial and economic analysis (CH:CDM, 2003):

- Order of Magnitude Estimate
- Budget Level Estimate
- Definitive Estimate

Order of Magnitude Estimate. An order-of-magnitude estimate is made without detailed engineering data. An example includes an estimate based on cost-capacity curves.

Typically, an order-of-magnitude estimate is prepared during the design concept finalization phase, which represents a design at approximately 5 to 20 percent complete. In general, actual project costs can be expected to range from 50 percent more than to 30 percent less than the Order of Magnitude Cost Estimate.

Budget Level Estimate. The preparation of a budget estimate requires, at a minimum, the use of flow sheets, layouts, and major equipment quantity, type, and sizing details. Some examples include:

- An estimate using sketches or drawings to quantify specific facilities or processes
- An estimate using equipment cut sheets as the basis for vendor equipment quotes

- An estimate using lists of material quantities

Typically, a budget estimate is prepared at the end of the preliminary design phase, which represents a level of project definition at approximately 15 to 45 percent complete. Actual project cost can be expected to range from 30 percent more than to 15 percent less than the Budget Level Cost Estimate.

Definitive Estimate. A definitive estimate is prepared from very well defined engineering data. At a minimum, the estimator requires 85 to 95 percent complete plans and elevations, piping and instrumentation diagrams, one line electrical diagrams, equipment data sheets, vendor quotations, structural sketches, soil data, drawings of major foundations and buildings and a complete set of specifications. Some examples include:

- An estimate using equipment cut sheets as the basis for vendor equipment quotes
- An estimate using vendor or subcontractor quotes for equipment and services

Typically, a definitive estimate is prepared toward the end of the construction documents preparation (final design) phase. Actual project cost can be expected to range from 15 percent more than to 5 percent less than the Definitive Cost Estimate.

The accuracy range for each of the three cost estimate classes based on ANSI Standard Z94.0 are summarized in **Table 1**.

Table 1: ANSI Standard Z94.0 Estimate Accuracy Range

Category	Accuracy Range
Order of Magnitude	-30% to +50%
Budget Level	-15% to +30%
Definitive Cost Estimate	-5% to + 15%

Unit costs presented in this TM and RWMP cost estimates are generally Order of Magnitude estimates while Budget Level estimates will be prepared when sufficient information is available and the increased level of effort to prepare an estimate was appropriate. Unit costs developed for most of the expected project components are discussed below. In some cases, project definitions may require cost estimates for project components not identified in this TM and efforts will be made to develop a similar level of estimate based on the available information and within the scope of this study.

2.2 Cost Contingencies and Factors

2.2.1 Project Contingency

Project or program contingencies are defined as unknown or unforeseen costs. In general, higher contingencies should be applied to projects of high risk or with significant unknown or uncertain conditions. Such unknown and risk conditions for construction cost estimates could include project scope, level of project definition, occurrence of groundwater and associated dewatering uncertainties, unknown soil conditions, unknown utility conflicts, etc. Unknown conditions for operation and maintenance (O&M) cost estimates could include future energy or chemical costs.

The amount of contingency applied to an estimate is typically based on the level of project definition. For planning studies, typical project contingencies can range between 20 and 50 percent for construction cost estimates and up to 30 percent for O&M cost estimates.

It is recommend an additional 30 percent for contingencies be applied to construction cost estimates based on Budget Level and Order of Magnitude estimates. No contingencies are included for O&M cost estimates since they are based off of similar LADWP facilities in operation; although, the potential for future rise in energy costs should be noted.

2.2.2 Implementation Factors

Cost factors are included to try to capture the entire capital costs associated with the implementation of the project. While these costs can vary greatly from project to project and from component to component, it is most common to assume a standard factor on the estimated construction costs across all projects and project types when analyzing alternatives and project options. In addition, it is necessary to allow for many uncertainties associated with conceptual level project definitions by applying appropriate contingencies. The following defines the typical efforts and factors for these additional services and contingencies:

- **Planning, Environmental Documentation, and Permits.** These services include the early conceptual planning, environmental documentation and permits that are often required of capital improvement projects. This factor includes pre-construction fees that may be required. The amount of effort for such services can vary greatly depending on the type, scale, and location of the project. Typical costs for such services can vary from 2 to 10 percent of the construction costs.
- **Engineering Services (Pre-Construction).** Engineering design services cover the preliminary investigations, site and route surveys, foundation exploration, and preliminary and final design phases. These services also includes plan processing (agency review and approval), and may also include the preparation of detailed cost estimates and construction/phasing schedules. The typical costs for these services vary between 8 and 15 percent of the construction costs.
- **Engineering Services during Construction.** Engineering construction support services typically include submittal and shop drawing reviews as well as minor design modifications. The typical costs for these engineering construction support services vary between 5 and 10 percent of the construction costs.
- **Construction Management and Inspection.** Costs for these services can vary greatly with project size and whether an agency performs this work with in-house staff or through a consultant. Regardless of the staffing, the costs for these services should still be accounted for and applied to the overall capital costs of the project. Typical costs for such services can vary from 5 to 10 percent of the construction costs.
- **Legal and Administrative Services.** These costs include such items as legal fees, financing expenses, general administration, and interest during construction. Typical costs for these items can vary from 1 to 15 percent of the construction costs depending on the size, complexity, and type of project.

- **Field Detail Allowance**. The Field Detail Allowance is used to account for miscellaneous and small costs that are not otherwise included in a summary of major costs components for an estimate. This factor is a specific construction cost allowance that is often applied to a specific project component and not necessarily a project or program contingency. For the preliminary phases of a project, this factor can range from 5 to 15 percent, depending on the complexity of the project and the perceived number of individual construction components that cannot be individually accounted for at this level.
- **Market Adjustment Factor.** This factor is intended to account for the variable of cost estimating in volatile markets. This factor often varies in the same location for different type of work depending on the availability and work load for specialty contractors. Typical ranges for this factor are up to 10 percent. Issues that can affect the Market Adjustment Factor, include:
    - Busy contractors
    - Contractors selectively bidding jobs
    - Contractors selectively choosing which owners they want to do jobs for
    - Premium wages to keep skilled workers and management staff
    - Availability of crafts/trades
    - Immigration impacts and uncertainty
    - Abnormal fuel impacts and uncertainty
    - Public relations/communications, especially critical for recycled water projects
    - Availability of specialty equipment and materials
    - Local material supply availability or conditions
    - Prevailing wage/Project Labor Agreement requirements

Due to the variability in the project types, a wide range of costs is likely to exist. In addition, the services may vary from project to project depending on a variety of factors, including project complexity and need. Using the factors and contingencies listed previously, estimation of implementation costs could vary from as low as 25 percent of the estimated project construction cost to as high as 85 percent. For this study, a factor of 30 percent of the estimated project construction costs is used to account for these additional services, as summarized in **Table 2**.

Table 2: Non-Construction Cost Factor Summary

Type of Factor	Low Estimate	High Estimate
Planning, Environmental Documentation, and Permits	2%	10%
Engineering Services (Pre-Construction)	8%	15%
Engineering Services during Construction	5%	10%
Construction Management and Inspection	5%	10%
Legal and Administrative Services	1%	15%
Field Detail Allowance	5%	15%
Market Adjustment Factor	--	10%
Total	**26%**	**85%**

Type of Factor	Low Estimate	High Estimate
Recommended Implementation Factor	30%	

2.2.3 Other Costs

Several additional components may be needed to support the development of major recycled water supply facilities. Because most of these items are unique and project specific, they should be applied on a project-by-project basis. Therefore, no costs were included in the cost estimates identified above for the following items:

- **Maintenance Road Access.** The construction cost of maintenance roads greatly depends on the amount of cut and fill needed to complete grading and if new construction will be conducted at an existing site. Therefore, maintenance road costs should be considered if a new pump station or tank site is being developed.
- **Power Transmission Lines.** The cost of these to support a major pumping or treatment facility is often on a shared cost basis with the power utility.
- **Overall Program Management.** If the sheer magnitude of the capital cost program exceeds the capacity of agency or district staff to manage all of the work, then the services of a program management team may be required.
- **Public Information Program.** Depending on the relative public acceptability of a major facility or a group of facilities, there may be a need for a public information program, which could take many different shapes. Public Information Programs are typically handled by an agency or district's internal staff and therefore are often considered as an overhead expense. However, in some cases, outside consultants may be necessary to support a major program or project.
- **"Other" Costs.** These costs might be necessary on some projects and could include environmental mitigation and permitting costs; special legal, administrative, or financial assistance; easements or rights-of-way; expediting costs such as separate material procurement contracts. These "other" costs may be typically in the 5 to 15 percent of construction cost range.

In addition, some projects will require the purchase of land to site facilities but others are already to be located within City-owned property. For example, within the existing footprint of a treatment plant. For the RWMP, the cost to purchase land was based on recent (January 2011) sales records of vacant properties in the project area using Loopnet (www.loopnet.com). In general, a cost of $2.0 million per acre was applied if no other information was available. This was based on initial searches on Loopnet and consultation with LADWP staff. If appropriate, the LADWP Real Estate Division could provide more accurate estimates.

2.2.4 Application of Contingencies and Factors

Table 3 shows an example of how to apply the cost contingencies and markups.

Table 3: Example Application of Cost Factors

Items	Calculation	Planning Estimate
Capital Cost Factors		
A. Estimated Construction Cost Subtotal		$1,000,000
B. Construction Contingency Cost Factor (30%)	0.3 * (A)	$300,000
C. Total Construction Cost Subtotal	(A) + (B)	$1,300,000
D. Implementation Cost Factor (30%)	0.3 * (C)	$390,000
E. Total Capital Cost	**(C) + (D)**	**$1,690,000**

2.3 Engineering Economics

The following sections discuss the necessary engineering economic factors utilized as part of developing the unit costs and that will be used to analyze the estimated costs for each of the alternatives and project options. Items covered in this section are:

- ENR Index
- Inflation / Escalation
- Planning Period
- Project Financing and Discount Rate
- Useful Life of Facilities
- Lifecycle Cost Approach

2.3.1 ENR Index

To develop unit costs for the various project components, it is common to utilize previous unit cost information as well as recent project data for calibration of the derived cost curves. These historical cost data must be converted to current price levels to develop project cost estimates. The best available barometer of these changes is the *Engineering News Record's* (ENR) Construction Cost Index (CCI). This index is computed from prices of construction materials and labor and is based on a value of 100 in year 1913. Cost indices vary geographically and are dependent upon multiple variables, including labor and material markets. Los Angeles was the most applicable CCI for the RWMP. The costs in this report reflect the ENR Los Angeles CCI for January 2011 of 10,000.30.

Estimated project costs should be increased from this January 2011 dollar base to the appropriate year for future construction based on the inflation, interest, and discount rates described in the next sub-sections.

2.3.2 Inflation / Escalation

Escalation of capital and O&M costs is based on the average of annual Consumer Price Index for the last 10 years (2001 to 2011) for Los Angeles, Riverside, and Orange County, California as noted on the Bureau of Labor Statistics website on January 2011, at 2.8 percent. Escalation of recycled water purchase prices was assumed to be higher than the historical inflation rate due to several factors, including increasing scarcity and new capital investment requirements. The rates for these factors are shown in **Table 4**.

Table 4: Escalation Rates

Type of Factor	Rate
Capital and O&M Escalator	3.0%
Recycled Water Purchase Escalator	4.0%

2.3.3 Planning Period

Two planning periods are necessary for the RWMP: 1) near-term alternatives and 2) long-term alternatives. The planning period is assumed to be 50 years. The base year for near-term alternatives for the purposes of the calculations will be 2015, which is anticipated to be the start of implementation of near-term projects. The base year for long-term alternatives for the purposes of the calculations will be 2036, which is immediately after implementation of near-term projects is expected to be completed in 2035. **Table 5** summarizes the planning periods for the alternatives analysis.

Table 5: Planning Periods

Type	Duration	Period
Near-Term Alternatives	50	2015 - 2064
Long-Term Alternatives	50	2036 - 2085

2.3.4 Project Financing and Discount Rate

There are two different sets of project financing assumptions applied for near-term and long-term alternatives. The financing components include the rate to borrow money (interest rate), the payback period, and the discount rate.

Historically, LADWP has funded its recycled water projects without borrowing money. This is called the "pay-as-you-go" method that provides funding during each of the project's planning, design, and construction phases, and also for ongoing O&M costs. The near-term alternatives are also assumed to be financed by the pay-as-you-go method. No borrowing will be necessary and, therefore, there is no interest rate or payback period. However, recently LADWP decided to consider funding a portion, if not a majority, of the costs for the potential NPR projects by borrowing money through long-term financing. This will allow LADWP to leverage borrowed money to fund the program that could potentially reduce impacts to the LADWP customer's water rates. For long-term alternatives, LADWP's typical financing rate of 5.5 percent over 25 years will be applied.

The discount rate is used to bring future dollars back to a present value, reflecting the time value of money. The discount rate is generally equal to the borrowing interest rate when projects require debt financing. Since near-term alternatives require no borrowing, the discount rate was set to equal inflation only. For long-term alternatives the discount rate was set to equal the borrowing interest rate since it is anticipated that debt financing will be needed. The financing terms for near-term and long-term alternatives are shown in **Table 6**.

Table 6: Financing Terms

Type of Estimate	Interest Rate	Payback Period	Discount Rate
Near-Term Alternatives[1]	N/A[1]	N/A[1]	3%[1]
Long-Term Alternatives	5.5%	25 years	5.5%

Note:

1. The near-term alternatives were evaluated by the pay-as-you-go method considering financing with borrowing. Therefore, there is no interest rate or payback period. The inflation rate (see Section 2.3.2) will be used as the discount rate since no borrowing will occur. However, LADWP is also considering financing near-term alternatives by borrowing money long-term. This is further discussed in the NPR and GWR Master Planning Reports.

2.3.5 Useful Life of Facilities

The useful life of facilities will vary based on several factors, including: type of facility, operating conditions, design life, and maintenance upkeep. Structural components of most facilities are typically designed to last 50 years or longer. However, mechanical and electrical components tend to have a much shorter lifespan and typically require replacement or rehabilitation at regular intervals. Based on typical operating conditions and maintenance practices, an estimated percentage for each facility type is used to distinguish between the structural portions (50-year) and the mechanical and electrical portions (20-year) typical of each facility type.

Based on the 50-year planning period for facilities, components with a 20-year useful life will be replaced at 20 and 40 years and at the end of the planning period will have 10 years of useful life remaining (20 years life expectancy minus 10 years remaining planning period). **Table 7** presents the assumed useful life period splits for each type of facility.

Table 7: Useful Life of Facilities

Type of Facility	% of Capital Cost for 50-Year Life (for Structural Components)	% of Capital Cost for 20-Year Life (for Mechanical and Electrical Components)
Treatment Plant	50%	50%
Pump Station	50%	50%
Storage	90%	10%
Pipeline	100%	--
Wells – Injection and Extraction	75%	25%
Pressure Reducer	50%	50%

Note: More refined estimates of the useful life of treatment plant facilities and wells were applied when reliable information was available

2.3.6 Lifecycle Cost Approach

It is important that the selection of an engineering alternative is not based solely on the lowest initial or capital cost, but also considers all future costs over the useful life of all projects in that alternative. Lifecycle costs analysis is a standard technique used in engineering economic analyses for comparing cost-effectiveness of alternatives. It reflects both capital and O&M costs over the useful life of the alternatives. It reflects not only future inflation, but the time value of money. Because of these factors, lifecycle costs analysis was selected as the economic method to compare the costs of the alternatives.

Costs of the various alternatives will be compared by using the calculated unit lifecycle costs, which is the present value (PV) of the capital plus O&M costs over the planning period divided by the project yield over the planning period. The steps described below are used to calculate the unit lifecycle cost. Note that near-term alternative and long-term alternative have different project financing assumptions so the lifecycle cost approach. An example lifecycle cost calculation for a near-term alternative and a long-term alternative can be found in Appendix A.

Step 1: Capital Expenditures

Capital costs are estimated based on the assumptions described in Section 3 and, if applicable, may include "other costs" described in Section 2.2.3. Next, the cost contingencies and implementation factors, described in Sections 2.2.1 and 2.2.2, respectively, are applied. Capital costs are then escalated from today's (2011) dollars to the year of expenditure at the assumed annual inflation rate of 3% (per Section 2.3.2).

For near-term alternatives, the capital costs for each alternative will be spread across the assumed construction period for each project that makes up the alternative.

To simplify the number of assumptions to be made for long-term alternatives, all of the initial capital costs are assumed to be financed in Year 1 (2031). The annual payments for the initial capital will occur as defined by the borrowing rate for 25 years.

Step 2: Finance

The capital costs are financed based on the applicable terms defined in Section 2.3.4. For near-term alternatives, there is no financing since all capital and O&M costs will paid when they occur (i.e., "pay-as-you-go"). For long-term alternatives, the standard DWP borrowing rate of 5.5% for 25 years. For long-term alternatives, annual payments for capital will be estimated using the formula (PMT formula in Excel):

$$PMT = P\,\frac{r(r+1)^n}{(1+r)^n - 1}$$

Where:
PMT is the annual payment
r is the annual interest rate (in decimals, not percent). Based on interest rate above, this is equal to 0.055
n is the number of periods, equal for us to 25

Note that, if applicable, pay-as-you-go may be applied for long-term alternatives instead of borrowing capital funds.

Step 3: Replacement of Facilities

For replacement of facilities after the end of useful life, escalate the cost of replacement to the year when it's needed and apply the applicable financing terms per Step 2 (Finance).

Step 4: O&M Costs

Escalate projected O&M costs annually at the escalation rate of 3% (defined in Section 2.3.2).

Step 5: Salvage Value

Include salvage value of capital facilities in Year 50. As discussed in Section 2.3.3, facilities with a 20-year useful life will have 10 years of useful life remaining at the end of a 50-year planning period, which is 50% of its useful life. Therefore, the salvage value will be 0.5 times the capital cost in Year 50. Salvage values will be discounted from the year they are estimated with the discount rate.

Step 6: Discount Costs

Discount all costs with the discount rate (defined in Section 2.3.2) of 3% for near-term alternatives and 5.5% for long-term alternatives.

Step 7: Present Value

Calculate the PV for the project. For the PV calculations, the following formula will be applied to the series of annual payments of capital and annual O&M separately (PV formula in Excel):

$$PV = \sum_{t=1}^{T} \frac{R_t}{(1+i)^t}$$

Where:
PV is the present value
i is the discount rate (in decimals, not percent). Based on rates above, this is equal to 0.03 for near-term alternatives and 0.055 for long-term alternatives that use capital financing.
t is the sequential number of year (i.e., 2011 = 1; 2012 = 2; 2013 = 3; etc.)
R is the annual amount (annual capital payment or annual O&M expenses)

Step 8: Project Yield

Project yield is the amount of recycled water recharged or reused over the planning period. Calculate the project yield by summing the annual yield over the planning period.

Step 9: Unit Lifecycle Cost

Unit lifecycle cost ($/AF) is the present value divided by the project yield and is calculated by the formula:

$$Unit\ Lifecycle = \frac{Present\ Value}{Total\ Yield}$$

3. Construction and O&M Unit Cost Basis

Construction costs are estimated for each component based on experience with similar projects as well as standard engineering planning cost curves. Where possible, unit costs have been calibrated with historical LADWP construction estimates and cost data. Definitions of the project components are derived from the capacity information, GIS data, hydraulic model results, and other preliminary engineering available at the time of the analysis and formation of the alternatives. Basic construction costs cover the materials, equipment, labor, and services necessary to build the proposed projects or components. In addition, all unit construction costs include contractor overhead and profit, bonds & insurance, and mobilization. Unit costs given herein are not intended to present the lowest prices that can be achieved for each type for work but rather are intended to represent median prices submitted by responsible bidders or the cost of installation by LADWP or BOS crews.

Operation and Maintenance (O&M) costs are derived from experience on similar projects and standard engineering planning methods and cost curves. Where possible, costs have been calibrated using existing City of Los Angeles Bureau of Sanitation (BOS) and LADWP data, including data on power costs, labor rates, etc. Operating costs are defined as labor, material, equipment, and outside services necessary for routine operating functions. Outside services include electric power and chemicals. Maintenance expenses include all costs associated with the routine servicing and repair of facilities required on an annual basis.

Unit costs for the following types of facilities are included in this TM:[2]

- Treatment Plants
  - Tertiary Treatment – Conventional Filtration
  - Tertiary Treatment – Membrane Bioreactor
  - Advanced Treatment – Microfiltration, Reverse Osmosis, Advanced Oxidation
  - Advanced Treatment After MBR – Reverse Osmosis, Advanced Oxidation
- Pipelines
- Pump Station
  - Product Water
  - Influent Wastewater
- Storage Facilities
  - Distribution System Tanks
  - Wastewater Equalization Basins
- Pressure Regulating Stations
- Groundwater Wells – Injection and Production
- Water Purchases - Imported and Recycled

[2] The cost estimating approach for non-potable customer conversions was developed under a separate TM.

All facilities are expected to be constructed under the traditional contracting approach of design-bid-build. Facilities constructed by LADWP crews would not require the bid step.

References for both construction and O&M costs are identified for each type of facility. A common resource throughout cost estimating was CDM Constructors, Inc. (CDMCI). CDMCI is the construction contracting arm of CDM. They employ estimators that have a database of costs from previous projects, quotes from vendors, etc.

3.1 Treatment Plants

Costs will be developed for expansion of existing facilities and construction of new tertiary treatment facilities with influent raw wastewater. For the purposes of the RWMP, expansion of existing facilities assume use of similar conventional filtration processes and construction of new (satellite) tertiary treatment plants assumes the use of membrane bioreactors (MBR). Tertiary treatment plant development assumes the intake of raw wastewater so the cost estimates include wastewater intake, primary treatment, and secondary treatment in addition to tertiary treatment.

Costs will be developed for expansion of existing and construction of new advanced water purification facilities (AWPF). For the purposes of the RWMP, an AWPF is assumed to take secondary or tertiary product and treat with microfiltration (MF) followed by reverse osmosis (RO), disinfection with ultraviolet light (UV), and advanced oxidation with hydrogen peroxide (AOP). If the AWPF source water is from MBR, then the MF step can be excluded.

Layouts for treatment plant expansions at existing City plants considered existing site constraints and, when appropriate, costs were added for items such as building demolition and multi-story facility construction. New treatment plants assumed the purchase of land. Land costs were discussed in Section 2.2.3.

Note that this section does not address product water pump stations and equalization storage.

3.1.1 Tertiary Treatment – Conventional Filtration

Construction Costs

The unit construction costs for the expansion of tertiary treatment plants primarily referenced the following:

- Novato Sanitary District (NSD) Treatment Plant bid results (2009): Upgrade existing 7 million gallon per day (mgd) wastewater treatment facilities. Upgrades included influent pump station, headworks, primary sedimentation, activated sludge process, UV disinfection, gravity belt thickeners, anaerobic digestion, odor control, electrical distribution system, and SCADA control system.

Expansion of existing tertiary treatment plants will use existing facilities to support new production capacity to the greatest extent possible. Therefore, cost estimates for the expansion will include line items for the necessary components to achieve new production capacity. These components include headworks, influent pump station, primary sedimentation tanks, aeration tanks and blowers, secondary clarifiers, tertiary media filtration, and UV disinfection. The processes are sized to be consistent with existing treatment plant operations. The primary unit construction cost basis for these estimates is the NSD Treatment Plant bid results.

O&M Costs

The conventional treatment plant O&M unit cost is based on the Los Angeles-Glendale WRP actual operating costs, escalated to January 2011, and is approximately $0.28 per gallon of production capacity.

3.1.2 Tertiary Treatment – Membrane Bioreactor

New satellite treatment plant construction assumes MBR technology. The construction costs for the new MBR plants primarily referenced CDMCI, which is the construction contracting arm of CDM.

Construction Costs

The unit cost of MBR varies based on size of the plant with economies of scale realized with bigger plants. Based on a survey of MBR construction costs and CDMCI, the following production capacity unit costs were developed for a satellite MBR plant:

- Less than 1 MGD: $12 per gallon
- Between 1 and 10 MGD: $10 per gallon
- Greater than 10 MGD: $8 per gallon

In addition, CDMCI will develop cost estimates for ancillary facilities such as buildings, yard piping, pumps, etc. when necessary on a project-specific basis.

O&M Costs

The MBR O&M costs are based on average costs of existing MBR plants from CDMCI, escalated to January 2011, which are approximately $0.30 per gallon of production capacity.

3.1.3 Advanced Treatment – Microfiltration, Reverse Osmosis, Advanced Oxidation

The unit costs estimates for the construction and operation of AWPFs or Advanced Water Treatment Facilities (AWTFs) (MF/RO/AOP) primarily referenced:

- Orange County Water District (OCWD) Groundwater Replenishment System (GWRS) Advanced Water Purification Facility (AWPF) bid results (March 2004): The AWPF produces up to 70 mgd of product water after treating secondary wastewater with MF/RO/UV. Referenced O&M costs were from 2008.
- Donald C Tillman Water Reclamation Plant (DCT) Advanced Treatment System Basis of Design Criteria and Cost Estimate TM (CH:CDM, June 2006): Prepared for a 15.6 mgd AWPF at DCT using the CH2M HILL Parametric Cost Estimating System.
- Terminal Island Water Reclamation Plant (TIWRP) Advanced Water Treatment Facility (AWTF) bid results (May 2001): The TIWRP AWTF receives tertiary water with higher than typical TDS (~3,000 mg/L) and applies MF/RO, lime, and chloramination. The design capacity is 5 mgd.

The cost references were used as applicable to the various proposed sites for AWPFs and AWTFs. For example, the DCT estimate was used for DCT AWPF alternatives and TIWRP estimate was applied for TIWRP AWTF alternatives.

Construction Costs

The OCWD GWRS AWPF bid results, escalated to January 2011, resulted in a unit cost of approximately $4.1 per gallon of product water capacity, excluding buildings, structural, architectural, excavation/backfill/ compaction items for buildings and structures. This estimate is the starting basis for new AWPFs at HTP.

The DCT Cost Estimate TM, escalated to January 2011, resulted in a unit cost of approximately $5.3 per gallon of product water capacity for a generic site layout. This estimate is the basis for new AWPF at DCT and VGS. Development of site-specific AWPFs at DCT and VGS may require the addition of building demolition, new buildings, and additional yard piping.

The TIWRP AWTF bid results excluding equalization, escalated to January 2011, resulted in a unit cost of approximately $7.4 per gallon of product water capacity. This estimate is used as the basis for expanding the AWTF at TIWRP. The unit construction cost was higher than the other estimates due to the need for deep foundations / vibroflotation and lack of economies of scale. To be conservative, the relatively high unit cost will be applied as the AWTF expansion unit cost until the initial AWTF components that could benefit an expanded TIWRP are identified.

CDMCI will develop cost estimates for ancillary facilities such as buildings, yard pipe, pumps, etc. that were not included in the referenced projects when necessary on a project-specific basis.

O&M Costs

The OCWD GWRS AWPF actual annual operating costs, escalated to January 2011, are approximately $0.54 per gallon of treatment capacity, which is equivalent to $1.61 per 1,000 gallons of product water assuming a 92 percent online factor. This estimate is used for the new AWPF at HTP and for expanding the AWTF at TIWRP.

The DCT Cost Estimate TM, escalated to January 2011, resulted in an annual O&M cost of approximately $0.40 per gallon of treatment capacity, excluding power costs, which is equivalent to $1.19 per 1,000 gallons of product water assuming a 92 percent online factor. This estimate is the basis for new AWPF at DCT and VGS. Once power costs were added to the base O&M costs, the total O&M is approximately $0.57 per gallon of treatment capacity, which is equivalent to $1.70 per 1,000 gallons of product water assuming a 92 percent online factor. O&M cost for the AWPF at VGS is slightly higher at $0.59 per gallon of treatment capacity, which is equivalent to $1.76 per 1,000 gallons of product water assuming a 92 percent online factor, due to higher levels of NMDA formation as a result of longer traveling time.

3.1.4 Advanced Treatment after MBR – Reverse Osmosis, Advanced Oxidation

Construction Costs

Construction costs for a satellite AWTF located downstream of an MBR facility are assumed to not include additional MF treatment since the MBR process already includes an MF step. Therefore, the

DCT Cost Estimate TM, excluding line items associated with MF, is used as the basis for satellite AWTF. This reduces the unit cost to $3.7 per gallon, which is approximately a 30% reduction compared to treating water from a secondary or conventional tertiary treatment plant.

O&M Costs

The DCT Cost Estimate TM is used as the O&M cost basis for satellite AWTF, which is $0.57 per gallon, which is equivalent to $1.70 per 1,000 gallons of product water assuming a 92 percent online factor. However, O&M cost should be lower than an AWPF facility with MF/RO/AOP since MF treatment is not required at the satellite AWTF because it is downstream of an MBR facility.

3.2 Pipelines

3.2.1 Construction Costs

Costs for pipe sizes ranging from 6 to 60 inches in diameter and 96 inches diameter and greater were developed for use in the study. The construction costs are estimated for a wide range of conditions that exist in the study area. Costs are developed for trenched pipelines (6" to 60" diameter) as well as tunneled pipelines (96" diameter and greater).

The unit costs represent both open-cut and trenchless pipelines constructed mostly in normal soils, with depths of cover typically less than 10 feet. They are consistent with construction that includes only minor surface restoration and minor surface and subsurface interference. These unit costs assume that the pipelines will be operating at pressures up to about 200 pounds per square inch (psi). These cost estimates include material and installation, normal appurtenances, and paving replacement.

Pipeline unit cost varies based on size with economies of scale realized with bigger pipes (in the range considered). Based on representative LADWP projects, the following unit costs were developed for pipeline installed via open-cut construction:

- $24/inch-diameter/LF for 6" and 8" diameter pipe
- $20/inch-diameter/LF for 10" and 12" diameter pipe
- $18/inch-diameter/LF for 16" and 20" diameter pipe
- $16/inch-diameter/LF for 24", 30", 36", 42", 54", and 60" diameter pipe

LADWP projects consist of both open-cut and trenchless construction methods (boring and jacking, directional drilling, and bridge hanging). Pipeline costs can be extremely varied depending on pipe size and site conditions. These costs include crossing of freeways, highways, major intersections, railroads, rivers, streams, and canals.

Tunneling is assumed for pipelines with 96" diameter or greater at a unit cost of $35/diameter inch/linear foot. Tunneling costs include casings as well as shafts. This unit cost is based on cost estimates from the East Bay Municipal Utility District's Wet Weather Infrastructure Improvements Studies TM (RMC/MWH, 2007).

Note that no land-acquisition costs are included as it is assumed that the pipelines would generally be constructed within the public street right-of-ways, which would not require any land acquisition.

3.2.2 O&M Costs

The O&M costs account only for the annual inspection and maintenance of the pipelines within the distribution system. The costs for pipelines up to 60″ diameter are estimated to be approximately $0.6 per LF on an annual basis based on representative LADWP projects.

Annual O&M costs for tunneling pipelines, greater than 90″ diameter, are assumed to be 0.5 percent of construction costs.

3.3 Pump Stations

3.3.1 Product Water Pump Station

Construction Costs

The pump stations cost curve shown in

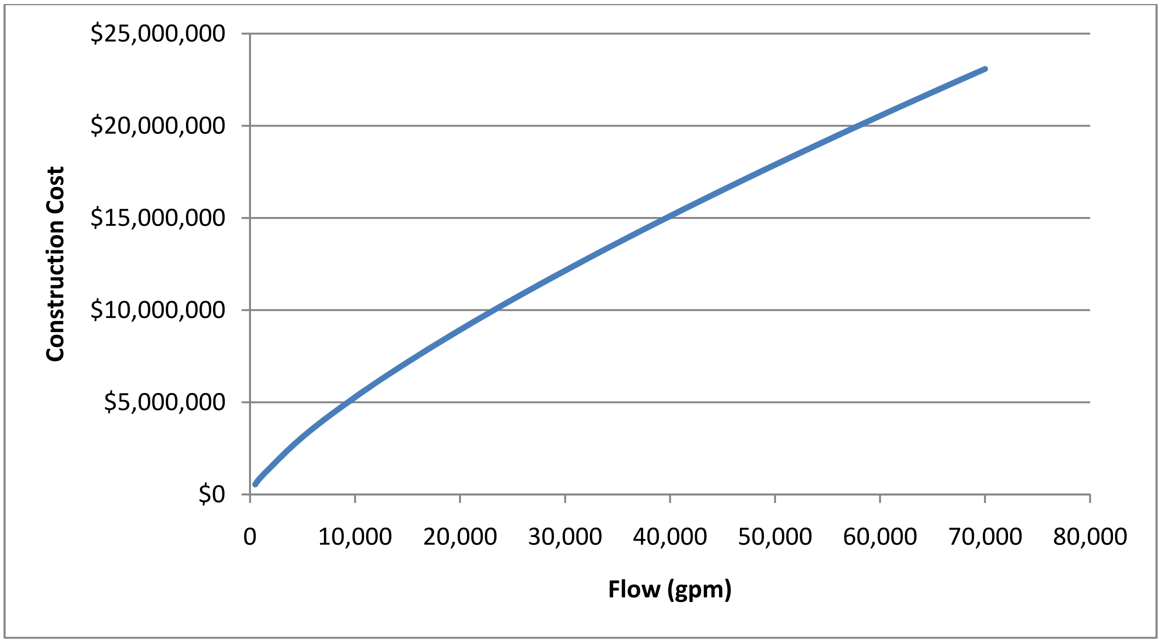
Figure *1* was developed using the construction cost curves from Pumping Station Design (Sanks et al., 1989). The original Sanks equation has a reference ENR CCI of 4,500 and was modified with an ENR factor of 10,000.3 to determine the estimated cost in January 2011 dollars. The curve was also adjusted based on recent engineering bids for representative LADWP Recycled Water projects.

Pump Station Project Cost ($) = 3.12 x 10^(0.7583*log(Q)+3.1951)

Where:
Q = Flow rate in gallons per minute (gpm); Maximum flow rate

Costs for stations can vary greatly depending on the architectural design, pump type, location, pumping head, and station capacity. As many of these factors will not be defined during this phase of the study, this unit cost curve will apply to all stations. However, note that land acquisition and easement costs are not included.

Figure 1: Pump Stations Construction Cost Curve



O&M Costs

O&M costs include labor, equipment replacement, and electrical power usage.

O&M Excluding Electricity

Annual expenditures for labor and equipment replacement are based on the initial construction cost of the pump station. The following equation is used to estimate the annual O&M labor and equipment replacement costs ($O\&M_{LE}$) for each pump station:

Annual $O\&M_{LE}$ = $10,000 + 5 percent of construction costs

Electrical Costs

Electrical costs for pumping are estimated by applying the average flow for the network over a 24-hour period of operation. Many of the demands are landscaping areas where water is applied during the night hours when electrical rates are lower. In addition, some demands, like surface reservoirs, groundwater basins, and large industrial users, would receive water on a continuous basis throughout the day. Electrical costs are computed assuming an electricity cost of $0.12/kilowatt-hour (kw-hr) and by using the following equations:

Annual electrical cost = $$\$0.12 \times hp_{ave} \times 24hrs/day \times 365days/year \times 0.7457 \frac{kw-hr}{hp}$$

Where:

hp_{ave} = the average brake horsepower = $$\frac{Q_{avg}\left[AFY\right]/1.613 \times (H)}{3956} \times \frac{1}{0.75}$$

Where:

Q_{avg} = annual average flow in AFY
H = total head (including friction loss) in feet

3.3.2 Influent Wastewater Pump Station

Construction Costs

Construction costs for an influent wastewater pump station were estimated using the Novato Sanitary District Wastewater Facility Upgrade influent pump station 95 percent cost estimate. The influent pump station was designed for a peak flow capacity of 47 mgd with a discharge head of 42 feet. Total construction costs of $1.8M includes site work, concrete, metals, finishes, equipment, mechanical, and tax on materials. The total cost does not include contractor's overhead/profit, construction staging contingency, or design contingency. This cost estimate was prepared using January 2005 ENR CCI.

Based on this reference cost, escalated to January 2011, the unit cost is $41,000 per MG of capacity.

O&M Costs

For the purposes of the RWMP, annual O&M costs for influent pump stations are assumed to be the same as product water pump station. Refer to the O&M Costs section under Section 3.3.1 for influent pump stations O&M costs.

3.4 Storage Facilities

3.4.1 Distribution System Tank

Construction Costs

Typical recycled water storage capacities range from 0.50 million gallons (MG) to 5 MG. Based on representative LADWP projects, the following unit costs were developed for storage:

- Less than 0.75 MG: $4 per gallon
- Between 0.75 and 1.5 MG: $3 per gallon
- Greater than 1.5 MG: $2 per gallon

LADWP projects include mobilization, architectural features, structural components, coatings, concrete foundation, typical site improvements including minor grading, and mechanical, electrical, and instrumentation requirements. Tanks are assumed to be concrete and partially buried. Costs due to extensive grading, blasting, rock removal, and special construction related to unusual seismic conditions are not included and should be considered as part of the project contingencies without further information.

3.4.2 O&M Costs

Annual O&M costs for diurnal storage tanks are estimated to be approximately $75,000 per tank based on representative LADWP projects.

3.4.3 Wastewater Equalization Basins

Construction Costs

The cost for wastewater equalization basins was estimated as $1.50 per gallon based on cost estimates from East Bay Municipal Utility District's Wet Weather Infrastructure Improvements Studies TM (RMC/MWH, 2007). This includes mobilization, excavation, sheeting and shoring, dewatering, cast in place concrete, piles, piping/appurtenances, pump station, 84" force main and traffic control.

The size, shape, and depth of the storage basins were pre-designed and costs included excavation, concrete, and mechanical costs from several recent bids. Costs assume a structural load bearing roof to allow parking, etc.

3.4.4 O&M Costs

Annual O&M costs for equalization basins are assumed to be 0.5 percent of construction costs.

3.5 Pressure Regulating Stations

3.5.1 Construction Costs

Unit construction costs for pressure regulating stations were based on professional experience since no comparable estimates were available from LADWP and are shown in **Table 8**. These costs include the station vault, grading, miscellaneous piping and valves, fencing, landscaping, instrumentation, controls and the pressure regulating valve.

Table 8: Unit Construction Costs for Pressure Regulating Stations

Sizes by Diameter (in)	$/Station
8 or less	$220,000
9 to 12	$300,000
13 to 24	$350,000
25 to 32	$600,000

3.5.2 O&M Costs

The O&M costs account only for the annual inspection and maintenance of the pressure regulating stations. These costs are estimated to be approximately $20,000 per year based on representative LADWP projects.

3.6 Groundwater Wells

Construction and O&M costs were developed for both groundwater injection and production wells.

3.6.1 Construction Costs

The construction costs for groundwater injection production wells were estimated at $2 million per well for a depth of 1,000 feet and capacity of 1,000 gpm. Construction costs includes drilling the new well, installing pumping equipment, pressure reducing valves, pump control and relief valves, and flow meters. The estimate is based on professional experience and was substantiated by Water Replenishment District staff. LADWP has not installed any wells recently so unit costs were not available from that organization.

3.6.2 O&M Costs

A traditional well rehabilitation/redevelopment includes the following steps: pulling and inspecting the pump; video log; spinner log; zone sample; mechanical rehabilitation; chemical rehabilitation; pump to waste; another video log; re-install the original pump; disinfection; and waste disposal. Costs can be highly variable, from several tens of thousands of dollars to over $100,000, depending on the amount of rehabilitation (WRD, 2005).

Based on professional experience and comparison with recently installed facilities, injection wells are assumed to have a pump maintenance cost of $75,000 per well every ten years and a redevelopment cost of $100,000 per well every five years. A pump is needed in the injection wells to regularly pump waste and clean the well. This is usually performed once a day to once a week and is necessary to maintain injection rates. As a result of this usage, injection wells have a frequent redevelopment schedule of once every five years.

Based on professional experience and comparison with recently installed facilities, production wells are assumed to have a pump maintenance cost of approximately $100,000 every 10 years and a redevelopment cost of $100,000 per well every ten years.

3.7 Water Purchases

Water purchase costs were developed for imported water from Metropolitan Water District of Southern California (MWD) and for recycled water from purveyors outside of the City. In addition, revenues from the sale of recycled water to purveyors outside the City were developed. The estimated costs are described in the following sections.

3.7.1 Imported Water Purchases

LADWP purchases imported water from MWD under both Tier 1 and Tier 2 treated water rates. MWD sells a limited amount of Tier 1 imported water to each of its contractors (such as LADWP) and, once this allotment is met, the contractor must purchase more expensive Tier 2 supplies. Based on LADWP's Urban Water Management Plan (UWMP) (May 2011), LADWP plans to stay within their Tier 1 allotment throughout the projected period (through 2035). As a result, the three alternatives for expanding recycled water to 50,000 AFY were compared to the cost of MWD Tier 1 imported water and subsequently to achieve the UWMP goals of 59,000 AFY. For the purpose of this comparison, LADWP developed water purchase costs for MWD Tier 1 imported water.

MWD rates have increased significantly over the last 10 years. The increases are highly volatile, ranging from a low of 2.3% to a high of over 21%. This makes estimating rates into the future very difficult. Additionally, MWD only provides rate forecasts to 2020 and we need to plan well beyond that, into the 2060s.

Recent discussions between LADWP and MWD established that the most realistic estimate of future costs of MWD water, beyond current MWD rate projections through 2020, would escalate an average of 5%. This then established a present value unit cost of $1,370 per AF for near-term projects and $1,800/af for long-term projects.

3.7.2 Recycled Water Purchases

Table 9 presents the costs to purchase or acquire recycled water from other agencies that are being considered as part of the alternatives analysis. These costs shown are the current known costs for year 2010 only. Purchase water costs for LADWP from many of these agencies could increase in the future, depending on contract terms and conditions.

Table 9: Recycled Water Purchase Costs

Entity	Treatment Plant	Unit Cost ($/AF)	Notes
Burbank WP	Burbank WRP	$0	Based on LADWP purchase agreement with Burbank Water and Power; includes exchange of groundwater rights
Central Basin MWD	San Jose Creek WRP	$500	Based on preliminary meetings between LADWP and Central Basin WMD staff
Las Virgenes MWD	Tapia WRF	$500	Based on preliminary pending discussions with Las Virgenes MWD regarding service conditions and the need for facility upgrades / additions
West Basin MWD – Nitrified	Carson Regional WRF	$800	Based on LADWP purchase agreement with West Basin MWD
West Basin MWD – Tertiary	Edward Little WRF	$728	Based on West Basin MWD FY 2010-11 Water Rates and Charges

4. Summary Tables

Table 10 and **Table 11** summarize the unit construction and O&M costs.

Table 10: Construction Costs Summary

Category		Item	Unit Construction Cost
Treatment Plants			
	Tertiary - Conventional Filtration	To be developed by component	
	Tertiary - MBR	< 1 MGD	$12/gallon
		1 - 10 MGD	$10/gallon
		> 10 MGD	$8/gallon
	AWTF (MF/RO/AOP)	DCT Reference	$5.2/gallon
		OCWD Reference	$4.1/gallon
		TIWRP Reference	$7.4/gallon
	AWTF (RO/AOP)	Downstream of MBR	$3.7/gallon
Pipelines			
	By Diameter	6” and 8”	$24/in-dia/LF
		10” and 12”	$20/in-dia/LF
		16” and 20”	$18/in-dia/LF
		24”, 30”, 36”, 42”, 54”, 60”	$16/in-dia/LF
		96” and greater	$35/in-dia/LF
Pump Stations			
	Product Water	Cost based on formula (Section 3.2)	
	Influent Wastewater	Capacity (mgd)	$40,900/mgd
Storage Facilities			
	Distribution System Tanks	< 0.75 MG	$4/gallon
		0.75 – 1.5 MG	$3/gallon
		> 1.5 MG	$2/gallon
	Wastewater Equalization Basin		$1.5/gallon
Pressure Regulating Stations			
		8” or less	$220,000/Station
		9” to 12”	$300,000/Station
		13” to 24”	$350,000/Station
		25” to 32”	$600,000/Station
Groundwater Wells			
	Injection Well		$2M/well
	Production Well		$2M/well
Water Purchases			N/A
Land Acquisition			$2M/acre

Note: All costs are in January 2011 dollars

Table 11: O&M Costs Summary

Category	Unit O&M Cost	
Treatment Plants		
Tertiary – Conventional Filtration	$0.28/gallon of treatment capacity	
Tertiary – MBR	$0.30/gallon of treatment capacity	
AWTF (MF/RO/AOP)	$0.54 to $0.59/gallon of treatment capacity	
AWTF (RO/AOP)	$0.57/gallon of treatment capacity	
Pipelines		
Up to 60" Diameter	$0.6/LF	
Tunneling (≥ 96" Diameter)	0.5% of construction costs	
Pump Stations		
O&M	$10,000 + 5% of construction costs	
Electricity	$0.12/KW-hr	
Storage Facilities		
Distribution System Tanks	$75,000 per tank	
Wastewater Equalization Basin	0.5% of construction costs	
Pressure Regulating Stations		
All sizes	$20,000 per station	
Groundwater Wells	Injection Wells	Production Wells
Pump Maintenance	$75,000 every 10 yrs	$100,000 every 10 yrs
Redevelopment of Wells	$100,000 every 5 yrs	$100,000 every 10 yrs
Water Purchases		
Imported Water	(See Section 3.7.1)	
Recycled Water	(See Section 3.7.2)	
Land Acquisition	N/A	

Note: All costs are in January 2011 dollars

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<u>Attachment A</u>

Example Lifecycle Cost Calculations

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ASPECT: **Near-Term Alternatives Evaluation** Date: January 18, 2012

DESCRIPTION: **Net Present Value Estimate**

SUPPLY: **EXAMPLE FOR COST ESTIMATING BASIS TM**

Annual Yield
9,650

Item	Qty	Units	Unit Cost	Cost
Capital Costs				
Capital Facilities				
AWTF				
NPR Pump Station				$ 5,400,000
NPR Storage				$ 14,600,000
NPR Pipeline				$ 95,500,000
NPR Customers				$ -
			Construction Subtotal	**$ 115,500,000**
		Contingency Costs	30%	$ 34,700,000
			Construction Total	**$ 150,200,000**
		Implementation Costs	30%	$ 45,100,000
			Total Capital Cost (January 2011)	**$ 195,300,000**
20-Year Useful Life				
AWTF			estimated	
NPR Pump Station			50%	$ 2,700,000
NPR Storage			10%	$ 1,460,000
			Construction Subtotal	**$ 4,160,000**
		Contingency Costs	30%	$ 1,200,000
			Construction Total	**$ 5,360,000**
		Implementation Costs	30%	$ 1,600,000
			Total Capital Cost (January 2011)	**$ 6,960,000**
Post-Construction O&M Costs ($ / Year)				
AWTF				
NPR				$ 1,400,000
GWR Groundwater Extraction	15,000	AFY	$0	$ -
GWR GW Extraction & Treatment	15,000	AFY	$0	$ -
			O&M Cost Subtotal	**$ 1,400,000**
		Contingencies	0%	$ -
			Total O&M	**$ 1,400,000**
Recycled Water Purchase ($ / Year)				
			Purchase Cost Total	**$ 3,100,000**

PV Calculations			
Inflation / Discount Rate		50-Year Life	$ 188,140,000
Construction Escalator	3.0%	20-Year Life	$ 6,960,000
Water Purchase Escalator	4.0%		
Discount Rate	3.0%	Annual O&M	$ 1,400,000
Financing Costs		Annual Purchase	$ 3,100,000
Interest Rate	**PAY-GO**	Annual Yield (AFY)	9,650
Period	50	Total Yield (AF)	381,175

No.	Calendar Year	Capital Finance 1	O&M Cost	Purchase Cost	Total Cost	Total Yield (AF)
0	2011	0	0	0	0	0
9	2020	25,456,125	0	0	25,456,125	0
10	2021	26,219,809	188,148	458,876	26,866,833	965
11	2022	27,006,403	387,585	954,462	28,348,450	1,930
12	2023	27,816,595	598,820	1,488,960	29,904,374	2,895
13	2024	28,651,093	822,379	2,064,691	31,538,163	3,860
14	2025	29,510,626	1,058,813	2,684,098	33,253,537	4,825
15	2026	30,395,944	1,308,693	3,349,755	35,054,392	5,790
16	2027	31,307,823	1,572,612	4,064,369	36,944,804	6,755
17	2028	32,247,057	1,851,189	4,830,793	38,929,040	7,720
18	2029	33,214,469	2,145,066	5,652,028	41,011,563	8,685
19	2030	0	2,454,908	6,531,232	8,986,141	9,650
20	2031	0	2,528,556	6,792,482	9,321,037	9,650
21	2032	0	2,604,412	7,064,181	9,668,593	9,650
22	2033	0	2,682,545	7,346,748	10,029,293	9,650
23	2034	0	2,763,021	7,640,618	10,403,639	9,650
24	2035	0	2,845,912	7,946,243	10,792,155	9,650
25	2036	0	2,931,289	8,264,093	11,195,382	9,650
26	2037	0	3,019,228	8,594,656	11,613,884	9,650
27	2038	0	3,109,805	8,938,443	12,048,247	9,650
28	2039	0	3,203,099	9,295,980	12,499,079	9,650
29	2040	0	3,299,192	9,667,820	12,967,011	9,650
30	2041	0	3,398,167	10,054,532	13,452,700	9,650
31	2042	0	3,500,112	10,456,714	13,956,826	9,650
32	2043	0	3,605,116	10,874,982	14,480,098	9,650
33	2044	18,460,253	3,713,269	11,309,981	33,483,504	9,650
34	2045	0	3,824,667	11,762,381	15,587,048	9,650
35	2046	0	3,939,407	12,232,876	16,172,283	9,650
36	2047	0	4,057,590	12,722,191	16,779,781	9,650
37	2048	0	4,179,317	13,231,079	17,410,396	9,650
38	2049	0	4,304,697	13,760,322	18,065,019	9,650
39	2050	0	4,433,838	14,310,735	18,744,572	9,650
40	2051	0	4,566,853	14,883,164	19,450,017	9,650
41	2052	0	4,703,858	15,478,491	20,182,349	9,650
42	2053	0	4,844,974	16,097,630	20,942,604	9,650
43	2054	0	4,990,323	16,741,535	21,731,859	9,650
44	2055	0	5,140,033	17,411,197	22,551,230	9,650
45	2056	0	5,294,234	18,107,645	23,401,879	9,650
46	2057	0	5,453,061	18,831,950	24,285,012	9,650
47	2058	0	5,616,653	19,585,228	25,201,881	9,650
48	2059	0	5,785,153	20,368,638	26,153,790	9,650
49	2060	0	5,958,707	21,183,383	27,142,090	9,650
50	2061	0	6,137,468	22,030,718	28,168,187	9,650
51	2062	0	6,321,592	22,911,947	29,233,540	9,650
52	2063	0	6,511,240	23,828,425	30,339,665	9,650
53	2064	(180,253,641)	6,706,577	24,781,562	(148,765,501)	9,650
	PV	**$ 159,642,718**	**$ 53,689,320**	**$ 165,581,250**	**$ 378,913,289**	**381,175**

Total PV	**$ 378,913,289**
Project Yield (AF)	**381,175**
Unit Cost ($/AF)	**$990**

ASPECT:	**Long-Term Project Concepts Evaluation**			Date:	January 18, 2012	
DESCRIPTION:	**Net Present Value Estimate**				**Annual Yield**	
SUPPLY:	**EXAMPLE FOR COST ESTIMATING BASIS TM**				50,000	

Item		Qty	Units	Unit Cost	Cost	Notes
Capital Costs						
Capital Facilities						
Treatment (Product Water)						
HTP (Phase 1-2 completed)		50,000	AFY	$5,200	$ 260,000,000	
EQ Storage		0	gallons	$1.5	$ -	
Distribution Storage						
No Tank is needed		0	MG	$0	$ -	
Conveyance	Diam (in)	Length (ft)				
HTP to WCB	54	31,680	in-dia*LF	$16	$ 27,400,000	
Pump Station						
Pump Station at HTP		31,000	gpm	formula	$ 12,400,000	
Pump Station at WCB Wells		31,000	gpm	formula	$ 12,400,000	
Land Purchase		0.5	acres	$2,000,000	$ 1,000,000	Land purchase assumed for all off-site PS
Groundwater Recharge						
Injection Wells at WB		35	wells	$2,000,000	$ 70,000,000	
Land Purchase		4.0	acres	$2,000,000	$ 8,100,000	
Production Wells						
Production Wells at WB		35	wells	$2,000,000	$ 70,000,000	
Land Purchase		4.0	acres	$2,000,000	$ 8,100,000	
Well Head Treatment		50,000	AFY	$0	$ -	
Distribution	Diam (in)	Length (ft)				
WCB Wells later	10	35,000	in-dia*LF	$20	$ 7,000,000	
WCB to DWP	54	21,120	in-dia*LF	$16	$ 18,200,000	
				Construction Subtotal	**$ 494,600,000**	
			Contingency Costs	30%	$ 148,400,000	
				Construction Total	**$ 643,000,000**	
			Implementation Costs	30%	$ 192,900,000	
				Total Capital Cost (Jan 2011)	**$ 835,900,000**	
20-Year Useful Life						
Treatment (Product Water)				63%	$ 164,400,000	
EQ Storage				10%	$ -	
Conveyance				0%	$ -	
Pump Station				50%	$ 12,400,000	
Groundwater Recharge Equipment				25%	$ 17,500,000	
Production Wells Equipment				25%	$ 17,500,000	
Distribution				0%	$ -	
				Construction Subtotal	**$ 211,800,000**	
			Contingency Costs	30%	$ 63,500,000	
				Construction Total	**$ 275,300,000**	
			Implementation Costs	30%	$ 82,600,000	
				Total 20-year Capital Cost (Jan 2011)	**$ 357,900,000**	
O&M Costs						
Annual O&M Costs ($/Year)						
Treatment (Product Water)						
HTP (Phase 1-2 completed)		50,000	AFY	$480	$ 24,000,000	
EQ Storage		$0	LS	0.5%	$ -	
Distribution Storage		0	LS	$75,000	$ -	
Conveyance		31,680	LF	$0.60	$ 19,000	
Pump Station						
Pump Station at HTP		$10,000	LS	5.0%	$ 630,000	
Electrical Cost		5,577,100	kWh (Qavg)	$0.12	$ 669,000	
Pump Station at WCB Wells		$10,000	LS	5.0%	$ 630,000	
Electrical Cost		2,466,300	kWh (Qavg)	$0.12	$ 296,000	
Groundwater Recharge Land Cost						*See 10 Year Periodic below*
Production Wells Land Cost						
Power West Coast		50,000	AFY	$102	$ 5,117,000	Pumps to 100 psi (tb confirmed)
Distribution						
WCB Wells lateral		35,000	LF	$0.60	$ 21,000	
WCB to DWP		21,120	LF	$0.60	$ 13,000	
				Total Annual O&M	**$ 31,400,000**	

Item	Qty	Units	Unit Cost	Cost	Notes
10-Year Periodic O&M Costs ($/Year)					
Groundwater Recharge					
Pump Maintenance	35	wells	$75,000	$ 2,625,000	
Production Wells					
Pump Maintenance	35	wells	$100,000	$ 3,500,000	
Redevelopment of Wells	35	wells	$100,000	$ 3,500,000	
			Total 10-Year O&M	**$ 9,625,000**	
5-Year Periodic O&M Costs ($/Year)					
Groundwater Recharge					
Redevelopment of Wells	35	wells	$100,000	$ 3,500,000	
			Total 5-Year O&M	**$ 3,500,000**	
Recycled Water Purchase ($ / Year)					Assumes no blend requirement at project startup
	50,000		**Purchase Cost Total**	**$ -**	

NPV Calculations

Inflation / Discount Rate		Initial Capital Cost	$ 835,900,000
Construction/O&M Escalator	3.0%	20-Year Life	$ 357,900,000
Water Purchase Escalator	4.0%	Annual O&M	$ 31,400,000
Discount Rate	5.5%	10-Year O&M	$ 9,625,000
Financing Costs		5-Year O&M	$ 3,500,000
Interest Rate	**5.5%**	Annual Purchase	$ -
Period	25	Annual Yield (AFY)	50,000
Yield Period	50	Total Yield (AF)	2,500,000

No.	Calendar Year	Capital Finance 1	Capital Finance 2	Capital Finance 3	O&M Annual Cost	O&M 10-Year Cost	O&M 5-Year Cost	Total Cost
1	2011	$ -	$ -	$ -	0	0	0	0
25	2035	$ -	$ -	$ -	0	0	0	0
26	2036	$ 134,389,719	$ -	$ -	67,716,966	0	0	202,106,685
27	2037	$ 134,389,719	$ -	$ -	69,748,475	0	0	204,138,194
28	2038	$ 134,389,719	$ -	$ -	71,840,929	0	0	206,230,648
29	2039	$ 134,389,719	$ -	$ -	73,996,157	0	0	208,385,876
30	2040	$ 134,389,719	$ -	$ -	76,216,042	0	0	210,605,761
31	2041	$ 134,389,719	$ -	$ -	78,502,523	0	8,750,281	221,642,523
32	2042	$ 134,389,719	$ -	$ -	80,857,599	0	0	215,247,318
33	2043	$ 134,389,719	$ -	$ -	83,283,326	0	0	217,673,045
34	2044	$ 134,389,719	$ -	$ -	85,781,826	0	0	220,171,545
35	2045	$ 134,389,719	$ -	$ -	88,355,281	0	0	222,745,000
36	2046	$ 134,389,719	$ -	$ -	91,005,939	27,895,929	10,143,974	263,435,562
37	2047	$ 134,389,719	$ -	$ -	93,736,118	0	0	228,125,837
38	2048	$ 134,389,719	$ -	$ -	96,548,201	0	0	230,937,920
39	2049	$ 134,389,719	$ -	$ -	99,444,647	0	0	233,834,366
40	2050	$ 134,389,719	$ -	$ -	102,427,987	0	0	236,817,706
41	2051	$ 134,389,719	$ -	$ -	105,500,826	0	11,759,646	251,650,192
42	2052	$ 134,389,719	$ -	$ -	108,665,851	0	0	243,055,570
43	2053	$ 134,389,719	$ -	$ -	111,925,827	0	0	246,315,546
44	2054	$ 134,389,719	$ -	$ -	115,283,601	0	0	249,673,320
45	2055	$ 134,389,719	$ -	$ -	118,742,109	0	0	253,131,828
46	2056	$ 134,389,719	$ 103,924,493	$ -	122,304,373	37,489,796	13,632,653	411,741,033
47	2057	$ 134,389,719	$ 103,924,493	$ -	125,973,504	0	0	364,287,716
48	2058	$ 134,389,719	$ 103,924,493	$ -	129,752,709	0	0	368,066,921
49	2059	$ 134,389,719	$ 103,924,493	$ -	133,645,290	0	0	371,959,502
50	2060	$ 134,389,719	$ 103,924,493	$ -	137,654,649	0	0	375,968,861
51	2061	$ -	$ 103,924,493	$ -	141,784,288	0	15,803,981	261,512,762
52	2062	$ -	$ 103,924,493	$ -	146,037,817	0	0	249,962,310
53	2063	$ -	$ 103,924,493	$ -	150,418,952	0	0	254,343,444
54	2064	$ -	$ 103,924,493	$ -	154,931,520	0	0	258,856,013
55	2065	$ -	$ 103,924,493	$ -	159,579,466	0	0	263,503,958
56	2066	$ -	$ 103,924,493	$ -	164,366,850	50,383,151	18,321,146	336,995,639
57	2067	$ -	$ 103,924,493	$ -	169,297,855	0	0	273,222,348
58	2068	$ -	$ 103,924,493	$ -	174,376,791	0	0	278,301,284
59	2069	$ -	$ 103,924,493	$ -	179,608,095	0	0	283,532,587
60	2070	$ -	$ 103,924,493	$ -	184,996,337	0	0	288,920,830
61	2071	$ -	$ 103,924,493	$ -	190,546,228	0	21,239,229	315,709,949
62	2072	$ -	$ 103,924,493	$ -	196,262,614	0	0	300,187,107
63	2073	$ -	$ 103,924,493	$ -	202,150,493	0	0	306,074,986
64	2074	$ -	$ 103,924,493	$ -	208,215,008	0	0	312,139,500
65	2075	$ -	$ 103,924,493	$ -	214,461,458	0	0	318,385,951
66	2076	$ -	$ 103,924,493	$ 187,699,194	220,895,302	67,710,741	24,622,088	604,851,817
67	2077	$ -	$ 103,924,493	$ 187,699,194	227,522,161	0	0	519,145,847
68	2078	$ -	$ 103,924,493	$ 187,699,194	234,347,825	0	0	525,971,512
69	2079	$ -	$ 103,924,493	$ 187,699,194	241,378,260	0	0	533,001,947
70	2080	$ -	$ 103,924,493	$ 187,699,194	248,619,608	0	0	540,243,295
71	2081	$ -	$ -	$ 187,699,194	256,078,196	0	28,543,748	472,321,138
72	2082	$ -	$ -	$ 187,699,194	263,760,542	0	0	451,459,736
73	2083	$ -	$ -	$ 187,699,194	271,673,358	0	0	459,372,552
74	2084	$ -	$ -	$ 187,699,194	279,823,559	0	0	467,522,753
75	2085	$ -	$ -	$ (1,454,869,554)	288,218,266	0	0	(1,166,651,288)
	NPV	**$ 472,727,293**	**$ 125,289,118**	**$ 13,959,713**	**$ 496,173,513**	**$ 11,742,741**	**$ 9,721,820**	**$ 1,129,614,198**
								$450

Appendix D

DCT Data Summary TM

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Summary of Modifications to "DCT Data Summary TM" since Initial Publication on September 1, 2009

The Recycled Water Master Planning (RWMP) effort has spanned three years (April 2009 to March 2012). As is the nature of a planning project, assumptions are typically modified and refined as a project is further developed. The most recent assumptions related to the Groundwater Replenishment (GWR) master planning effort are presented in the GWR Master Planning Report. Assumptions and conclusions presented in this report supersede assumptions included in this technical memorandum (TM). The following table summarizes the modifications applicable to all RWMP TMs and those specifically applicable to this TM are described in the following sections.

Assumption	Modified	Original
Applicable to all RWMP TMs		
Recycled Water Goal	59,000 AFY by 2035 This goal reflects the 2010 LADWP Urban Water Management Plan that was adopted in early 2011, after the original RWMP goals were drafted	50,000 AFY by 2019
Name for Project and Master Planning Reports	Recycled Water Master Planning Documents GWR Master Planning Report NPR Master Planning Report	Recycled Water Master Plan GWR Master Plan NPR Master Plan
Introduction Section	This is superseded by the Introduction Sections in the NPR Master Planning Report.	This section was included in all initial TMs but the terms described have been replaced by the Introduction Section for the NPR Master Planning Report.
NPR Projects Terminology	To avoid confusion related to LADWP's water rate structure, the terms "Tier 1" and "Tier 2" are superseded with the terms "planned" and "potential," respectively. Both planned and potential projects would be considered for implementation by 2035.	"Tier 1" for NPR projects that were originally planned for design and construction by the year 2015. "Tier 2" for NPR projects that were originally being evaluated in the NPR Master Planning Report for potential future implementation after the year 2015.
Name for MF/RO/AOP treatment plant	Advanced water purification facility (AWPF)	Advanced water treatment facility (AWTF)
Name for water produced by AWPF	Purified recycled water	Advanced treated recycled water, highly purified recycled water, etc.
Treatment Plant Acronyms	DCTWRP LAGWRP	DCT LAG
GWR Project Phases	Phase 1 = 15,000 AFY annual recharge goal and 25 mgd AWPF product water capacity Phase 2 = 30,000 AFY annual recharge goal and 35 mgd AWPF product water capacity	Phase 1 = 20 mgd AWPF product water capacity Phase 2 = 40 mgd AWPF product water capacity

The following modifications are specific to this TM.

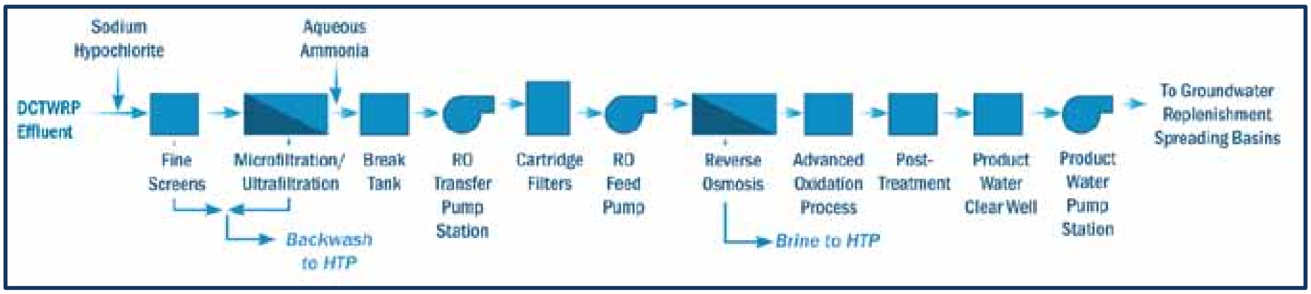
TM References

Throughout this TM there are references to preliminary TMs that were prepared at the onset of the RWMP effort. Relevant information from these TMs has been updated and incorporated into the four RWMP documents: GWR Master Planning Report; NPR Master Planning Report; TIWRP Barrier Supplement and NPR Concepts Report; and Long-Term Concepts Report.

Section 2.2 Treatment Processes for New AWTP

Figure 2-5 was updated to show that the RO brine would be conveyed to Hyperion Treatment Plant (HTP) only, not to a separate ocean outfall.

Figure 2-5: Process Flow Diagram for the AWTP (Revised)



Section 3.2.4 In-plant Reuse

DCTWRP has capacity to treat up to 80 mgd, of which approximately 29 mgd is for in-plant reuse, Lake Balboa, Wildlife Lake, Japanese Gardens, and the Los Angeles River. BOS staff indicated the in-plant reuse demand is approximately 2 mgd at an influent wastewater flow of 80 mgd.

Section 6.1 Tertiary Filter Upgrades

The new cloth media filters came on-line in December 2009.

In the DCTWRP Maximum Flow Assessment TM, the amount of tertiary effluent available for recycling was originally estimated to be 87% of the influent flow based on data from the sand filters (January 2005 through December 2008). As part of the development of the GWR Master Planning Report the estimate of tertiary effluent production was updated since the cloth media filters have fewer losses than the sand filters. Based on data from December 2009 through August 2011, the tertiary effluent available for recycling was estimated to be 92% of the influent flow. See the GWR Master Planning Report, Section 3.7, for more information.

Section 6.2 Wet-Weather Storage

Construction of the DCTWRP In-Plant Wet Weather Storage Project is expected to be complete in August 2012.

The original TM follows so these modifications should be considered when reading this TM.

City of Los Angeles

Recycled Water Master Plan

Technical Memorandum

Title:	**DCT Data Summary**
Prepared For:	**John Hinds, Project Manager, LADWP** **Doug Walters, Project Manager, BOS** **Brian Tan, Task 1a Lead, LADWP** **Hiddo Netto, Task 1a Co-Lead, BOS**
Prepared by:	**Jennifer Thompson, Task 1a Lead, CDM** **Eric Smith, CDM** **Andrew Swanton, CDM**
Reviewed by:	**Heather Boyle VanMeter, Deputy Project Manager, CDM** **Rob Morrow, Task 2a Project Engineer, RMC** **Evelyn You, Task 1a Project Engineer, CDM**
Date:	**January 29, 2010**
Reference:	**Task 1a Groundwater Replenishment Master Plan** **Task 1.2 DCT Data Review and Assessment**

1. Introduction

With imported water supplies becoming ever more unpredictable, the Los Angeles Department of Water and Power (LADWP) adopted the Mayor's vision of Securing LA's Water Supply in May 2008, calling for 50,000 acre-feet per year (AFY) of potable supplies to be replaced by recycled water by 2019. To meet this near-term challenge and plan for expanding reuse in the future, LADWP has partnered with the City of Los Angeles Department of Public Works to develop the Recycled Water Master Plan (RWMP). The RWMP includes seven major tasks: 1 Groundwater Replenishment (GWR) Master Plan, 2 Non-Potable Reuse (NPR) Master Plan, 3 Advanced Water Treatment (AWT) Pilot Study, 4 Maximum Reuse Concept Report, 5 Satellite Feasibility Concept Report, 6 Existing System Reliability Concept Report, and 7 Training.

The importance of additional water supply options for Los Angeles has become increasingly apparent with continuation of drought conditions, building contention for limited available water supplies both statewide and across the Southwest, and growing awareness of the critical nexus between quality of life/economic stability and available supplies of quality water. Significant attention has focused on the importance of indirect potable reuse given the multiple associated benefits, among them: local control; drought-resistant supplies; beneficial use of a critical, limited resource; sustained availability for future generations; existing infrastructure; lower investment and less environmental impact than other supply options; and demonstrated success nearby, across the nation and throughout the world.

1.1 Task Overview

The purpose of Task 1 is to develop an GWR Master Plan that includes a capital improvement program to implement an advanced water treatment plant (AWTP) and groundwater replenishment using highly purified water in the San Fernando Valley in the Hansen and possibly the Pacoima and Tujunga spreading basins. The AWTP will be fed with effluent from the Donald C. Tillman Water Reclamation Plant (DCT). The GWR Master Plan will plan for in-service dates no later than June 30, 2018 to meet the minimum indirect-potable reuse goal of 15,000 AFY by June 30, 2019.

Task 1a includes the preliminary evaluations for the GWR Master Plan, including developing a regulatory approach, completing preliminary evaluations about the DCT plant, developing preliminary groundwater replenishment strategies, completing a technology assessment for the AWTP, selecting a site for the AWTP, and determining the maximum wastewater flow available for treatment at DCT. Task 1b, the GWR Master Plan document, will commence when Task 1a is complete and will incorporate the work completed as part of Task 1a. Task 1a is subdivided into the following stand-alone tasks to complete the initial GWR studies:

- Task 1.1 – Regulatory Approach and Coordination: Provides a recommended approach for permitting the AWTP and groundwater replenishment with recycled water (Draft TM dated September 14, 2009).
- Task 1.2 – DCT Data Summary: Provides a summary of historical DCT flow and water quality data for use on the RWMP (this TM).

- Task 1.3 – Groundwater and Surface Water Assessment: Initial groundwater and surface water studies to develop groundwater replenishment operational scenarios (Draft TM dated December 22, 2009).
- Task 1.4 – Advanced Water Treatment Technology Assessment: Technology assessment for the treatment processes to be used in the AWTP (Draft TM dated September 1, 2009).
- Task 1.5 – Site Assessment: Comparison of potential sites for the AWTP with a goal of selecting a preferred site to be able to move forward with the GWR Master Plan (Draft TM dated January 5, 2010).
- Task 1.6 – DCT Maximum Flow Assessment: Evaluation of the maximum flows that could be routed to the DCT plan from the Tillman Service Area (TSA) to determine the quantity of water available for existing uses, GWR and NPR (Draft TM dated October 6, 2009).

1.2 TM Purpose

This TM, DCT Data Summary TM, is one of the preliminary tasks for the GWR Master Plan being completed as part of Task 1a. The purpose of this TM is to summarize DCT-related data and project information for future use in the RWMP. Water quality and flow data was provided by the Los Angeles Bureau of Sanitation (BOS) and drawings and information regarding future projects was provided by the Los Angeles Bureau of Engineering (BOE).

1.3 TM Overview

This TM is organized in the following sections:

- Section 1 – Introduction
- Section 2 – Overview of Treatment Processes
- Section 3 – Historic Plant Flows
- Section 4 – Historic Water Quality Data
- Section 5 – Drawings and Images
- Section 6 – Current and Future DCT Projects
- Section 7 – Operational Considerations for Expansion of Recycling
- Section 8 – Summary

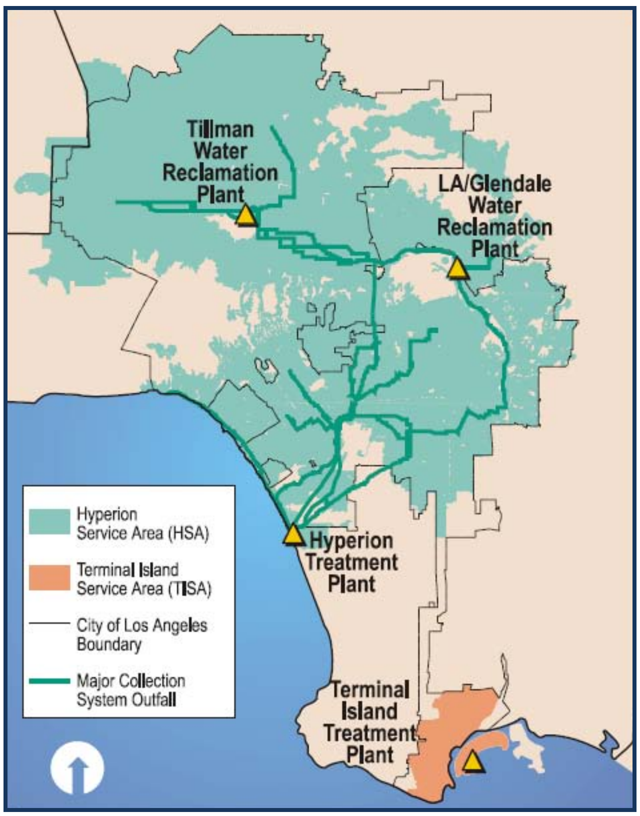
2. Overview of Treatment Processes

This section summarizes the current treatment processes at DCT, as well as the proposed treatment processes for the future AWTP.

2.1 Current Treatment Processes at DCT

DCT is located in the San Fernando Valley on a 91-acre site within the Sepulveda Flood Control Basin in Van Nuys. The plant site is south of Victory Boulevard, between Woodley Avenue and the San Diego Freeway (Interstate 405). DCT serves many of the communities in the San Fernando Valley as shown in Figure 2-1, including Canoga Park, Woodland Hills, Reseda, Panorama City, San Fernando, Sylmar, and Chatsworth, and has contractual arrangements with the Las Virgenes Municipal Water District, Triunfo County Sanitation District, and the City of San Fernando.

Figure 2-1: Location of DCT in Los Angeles County



DCT was originally constructed in 1985 to treat an average dry weather flow of 40 million gallons per day (mgd). This portion of the plant is now known as Phase I. The plant was expanded in 1991 to treat an additional average dry weather flow of 40 mgd, known as Phase II. These distinct phases have a combined dry weather treatment capacity of 80 mgd of Title 22 tertiary treated effluent. The rated Peak Wet Weather Flow (PWWF) is 160 mgd. The tertiary filters are currently being upgraded (see Section 6.1), which is limiting the plant flow to less than half capacity. The plant also has a limited winter flow capacity to provide emergency wet weather storage. The filter upgrades project is expected to finish in April 2010, at which point the plant is expected to return to the target seasonal flow rates (described in Section 3.1.2).

DCT provides preliminary, primary, secondary, and tertiary treatment with disinfection. The basic unit processes include the following:

- Preliminary treatment: Grit removal, influent pumping, and screening.
- Primary Treatment: Primary sedimentation (BOD, settleable solids and suspended solids removal), scum removal, and flow equalization.
- Secondary treatment: Aeration/Activated sludge and final sedimentation. The secondary treatment system was recently upgraded for nitrification denitrification (NdeN), which was placed into operation in July 9th, 2007.
- Tertiary treatment: Coagulation, filtration, disinfection, and dechlorination (except for Title 22 effluent for LADWP recycled water customers). The plant is currently undergoing tertiary filtration upgrades, which are described in Section 6.1.

The DCT site plan, aerial photo, and process flow diagram are shown in Figures 2-2, 2-3, and 2-4, respectively.

As shown in the process flow diagram (Figure 2-4), DCT adds polymer, ammonia and chlorine for both Phases I and II at several points in the process stream. Mannich polymer is added to the Return Activated Sludge (RAS) line to control foaming in the aeration basins. Mannich polymer is also added upstream of the tertiary filters, but a very low dosage rate. Ammonia and chlorine are added to the process stream between the tertiary filters and the chlorine contact tanks for chlorination.

DCT does not have solids handling and processing; all solids removed from the treatment processes are returned to the sewer system for treatment at Hyperion Treatment Plant (HTP).

The Title 22 effluent is currently supplied for the following reuse applications:

- Balboa Pump Station for distribution to LADWP recycled water customers
- Plant reuse in DCT's high-pressure effluent (HPE) and low-pressure effluent (LPE) systems
- Japanese Garden System
- Sepulveda Basin recreational site, including Lake Balboa and Wildlife Lake
- Los Angeles (LA) River

Any remaining effluent is discharged directly to the LA River along with overflow from Lake Balboa, Wildlife Lake and the Japanese Garden System. The end uses are described in more detail in Section 3.2.

Figure 2-2: DCT Site Plan

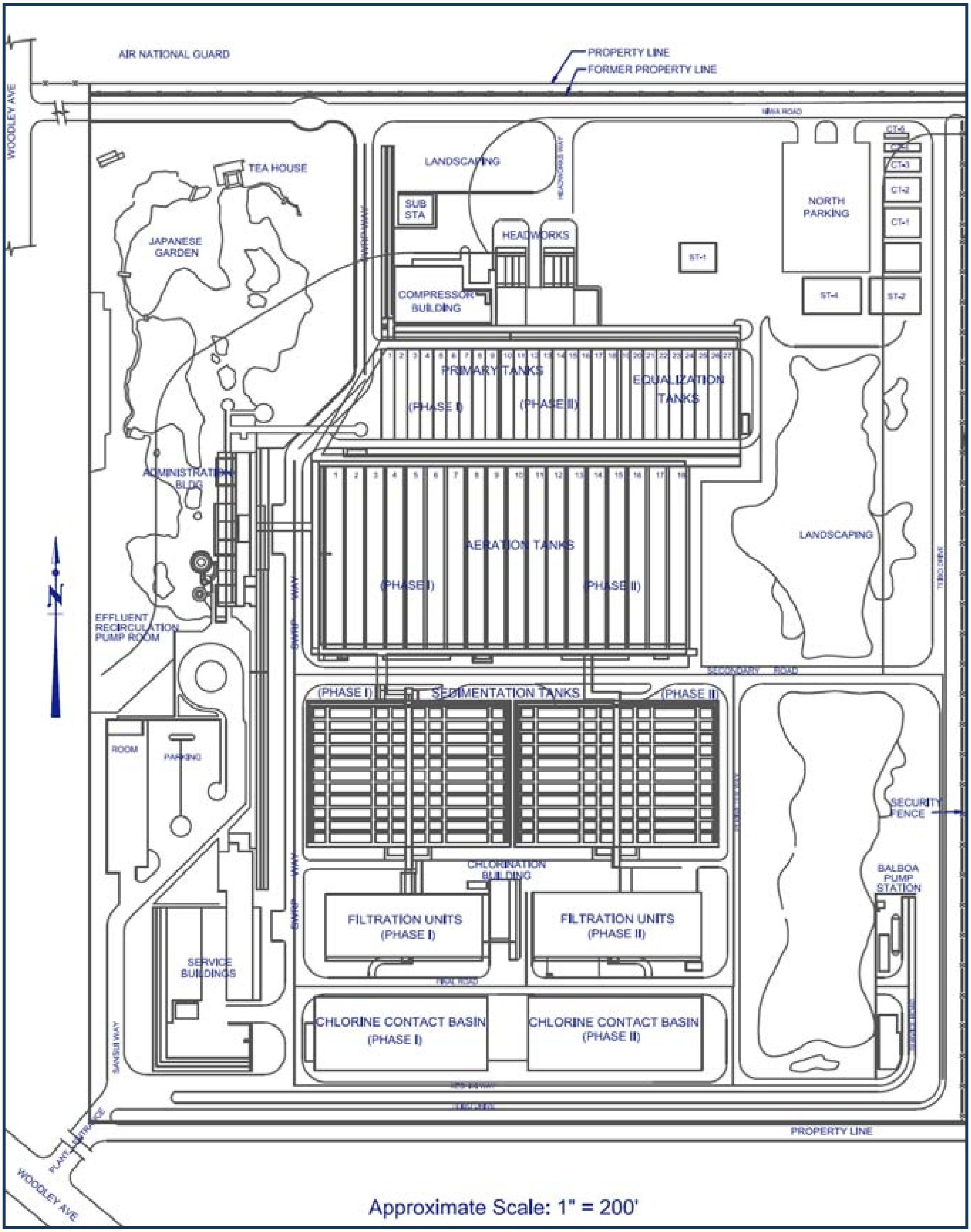


Figure 2-3: Aerial view of DCT

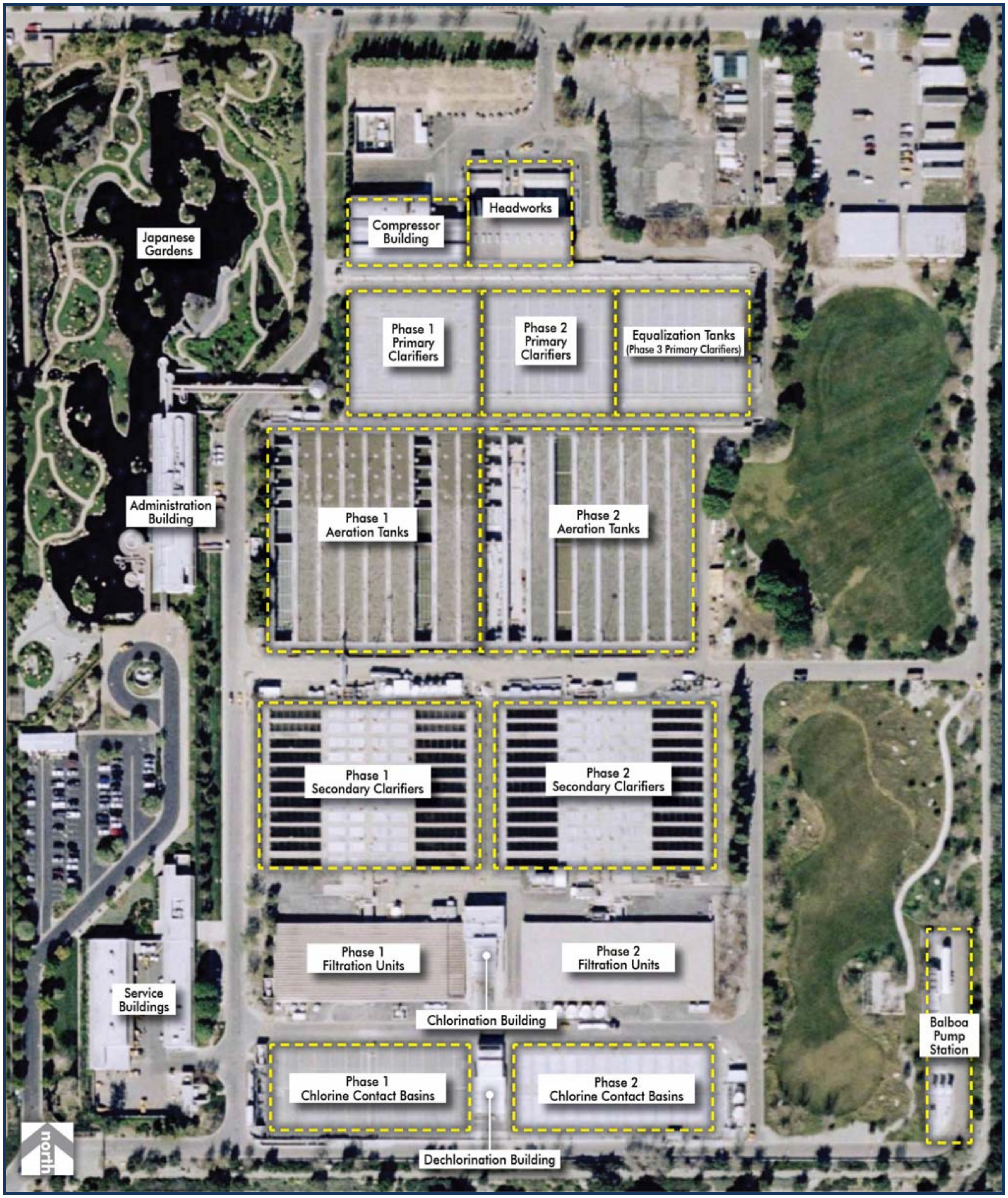
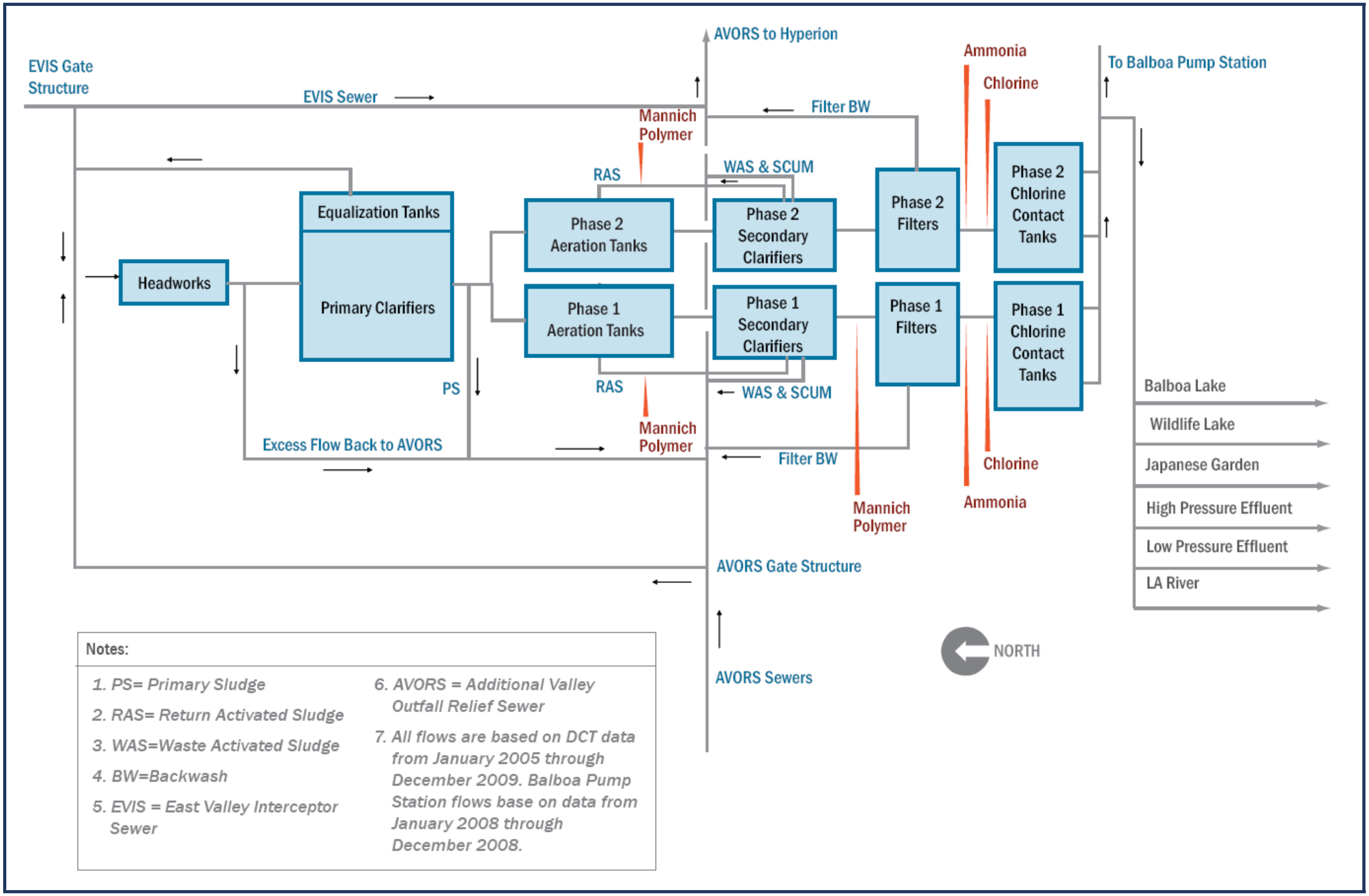


Figure 2-4: Process Flow Diagram for DCT



2.2 Treatment Processes for New AWTP

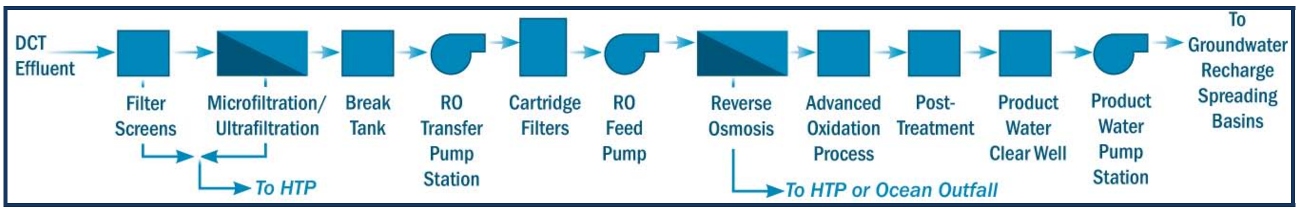
As part of the GWR Master Plan, a new AWTP will be implemented to produce high quality recycled water for groundwater replenishment at spreading grounds in the East San Fernando Valley.

The AWTP will treat either secondary effluent or tertiary effluent upstream of chloramination from DCT. The major components of the advanced water treatment processes include:

- Microfiltration/ultrafiltration (MF/UF)
- Reverse osmosis (RO)
- Advanced oxidation, using UV with hydrogen peroxide (H_2O_2) or ozone with H_2O_2
- Post-treatment/stabilization, using partial degasification, hydrated lime (using lime saturator), and sodium hydroxide

The proposed process flow diagram for the new AWTP is shown in Figure 2-5.

Figure 2-5: Process Flow Diagram for the AWTP



The location of the AWTP has not been determined, and the potential sites for the AWTP will be identified and evaluated in the Site Assessment TM (Task 1.5). DCT will be evaluated as one of the candidate sites and the current and future DCT projects that affect the availability of space at DCT for the potential location of the AWTP are discussed in Section 6.5 of this TM.

3. Historical Plant Flows

3.1 Influent Flows

3.1.1 DCT Tributary Sewers

DCT receives influent wastewater from the Additional Valley Outfall Relief Sewer (AVORS) and the East Valley Interceptor Sewer (EVIS), which combine just north of the DCT headworks. Figure 2-4 shows a schematic layout of these sewers around and through DCT. The flow to this point is controlled manually by two gate structures, one for each sewer, that control how much flow is routed to the plant and how much is bypassed.

AVORS collects wastewater from the western San Fernando Valley. The wastewater in AVORS travels easterly through the center of DCT between the aeration tanks and secondary clarifiers, continuing on its way toward either the HTP or the Los Angeles-Glendale Water Reclamation Plant (LAG). The AVORS diversion structure, located in the Japanese Gardens beneath what is known as Tortoise Island, contains two sluice gates: the plant feed gate and the diversion gate. Typical operation for both gate systems involves regulating the flow to the headworks by adjusting both the feed and bypass gates. The gates are not automated and are manually adjusted when the flows to the plant need to be adjusted.

EVIS collects wastewater from the northeastern areas of the San Fernando Valley. It is an 84-inch diameter sewer where it enters the northeast corner of DCT's property. The EVIS diversion structure contains three gates: plant feed gate, diversion gate, and maintenance bypass gate. The diversion gate sends wastewater southerly along the eastern plant boundary where it joins with the AVORS sewer, downstream of all plant waste stream returns. The feed gate diverts wastewater westerly, where it curves southward to join the AVORS sewer before entering the headworks influent channel.

3.1.2 DCT Plant Capacity

As discussed in Section 2, DCT is currently operating at less than 40 mgd while the tertiary filters are being upgraded. In order to provide wet weather storage during the wet season, the plant's current target flow rates are as follows:

- April 15 – October 15 (dry season): 80 mgd
- October 15 – April 15 (wet season): 40 mgd to reserve the Phase II primary clarifiers, aeration basins, and secondary clarifiers available for emergency wet weather storage.

Once the wet weather storage project (see Section 6.2) is constructed, then the plant flow can be increased to 80 mgd year round.

3.1.3 DCT Plant Influent Flow Control

As stated previously, the flow to the plant is controlled with manually positioned influent gate structures that control how much flow is routed to the plant and how much is bypassed.

Because the influent pumps operate at a constant flow rate of 32 mgd each, DCT takes in a greater flow through the headworks than is treated at the plant. The excess flow is bypassed back to AVORS after screening and before primary treatment. The flow treated through the plant is measured at the headworks, at the aeration tanks, and prior to the chlorine contact basins through multiple magnetic flowmeters.

3.1.4 Diurnal Flow Variation

The diurnal flow variation through the plant is important to determine if there will be sufficient flow for the existing and future non-potable recycled water uses and the future AWTP during low flow periods, which typically occur in the late evening/early morning. Since DCT is a scalping plant and the amount of influent flow is manually set, the measured, historical diurnal flows through the plant are not sufficient to use for planning.

The maximum flow tributary to DCT will be assessed as part of the DCT Maximum Flow Assessment TM being completed under Task 1.6. This assessment will be based on the City's sewer flow model and will include an assessment of the diurnal flow variation.

3.2 Effluent Flows

The tertiary recycled water produced at DCT is distributed between the following end uses:

- Balboa Pump Station for distribution to LADWP recycled water customers
- Plant reuse in DCT's high-pressure effluent (HPE) and low-pressure effluent (LPE) systems
- Japanese Garden System
- Sepulveda Basin recreational site, including Lake Balboa and Wildlife Lake
- LA River

Any remaining effluent is discharged directly to the LA River along with overflow from Lake Balboa, Wildlife Lake and the Japanese Garden System. The current DCT effluent flows to each of the end uses are summarized in Table 3-1. The complete DCT flow data tables are included in Attachment A.

3.2.1 Lake Balboa

Two 10-mgd pumps located in the South Effluent Collection Channel supply water to 27-acre Lake Balboa. A manual valve must be adjusted during the diurnal low flow period to ensure sufficient water remains in the Effluent Pump Plant (EPP) wetwell, which is supplied with dechlorinated effluent. Overflow from the lake is discharged into the LA River.

3.2.2 Wildlife Lake

The 11-acre Wildlife Lake is fed through a gravity line originating from the South Effluent Collection Channel. Overflow from the lake is discharged into the LA River.

Table 3-1: DCT Effluent Flow Summary

Text	Maximum Plant Flow			Average Plant Flow			Minimum Plant Flow		
	AFY	MGD	%[a]	AFY	MGD	%[a]	AFY	MGD	%[a]
Lake Balboa[b]	17,400	15.5	26	14,800	13.2	30	10,500	9.4	25
Wildlife Lake[b]	9,000	8.0	14	7,700	6.8	15	5,500	4.9	13
Japanese Garden[b]	5,800	5.2	9	4,700	4.2	9.4	3,600	3.2	6
High Pressure In-Plant Reuse[b]	2,300	2.0	4	1,800	1.6	3.6	600	0.5	2
Low Pressure In-Plant Reuse[b]	2,800	2.5	6	1,100	1.0	2.2	400	0.3	1
Balboa Pump Station[c] (LADWP)	3,000	2.7	7	1,500	1.4	3.1	200	0.2	0.5
LA River[b]	37,000	33.0	48	11,500	10.2	23.2	1,500	1.4	4.4

Footnotes:

a. Percentage of total plant flow, corresponding to the month in which the flow occurred.
b. Based on data from January 2005 through December 2008.
c. Based on data from January 2008 through August 2009.

3.2.3 Japanese Garden

The 6.5-acre Japanese Garden is located on the west side of the DCT, as shown in Figure 2-3. The Japanese Garden is supplied by Pump 6, which operates at 6,000 gallons per minute (gpm) and draws from the EPP wetwell. Water from the Japanese Garden Lake combines with plant effluent and discharges into the LA River.

3.2.4 In-plant Reuse

There are two in-plant reuse systems for tertiary effluent: high-pressure effluent (HPE) and low-pressure effluent (LPE). These uses are supplied by the EPP wetwell and are described below.

High-pressure Effluent (HPE)

Uses for the HPE include hose bibs located throughout the plant, cooling water for the process air blower heat exchangers, and seal water for various pumps. There are three HPE pumps, designated 1, 2, and 7. The system capacity totals 3,000 gpm at a typical operating pressure of 150 pounds per square inch (psi). Normal operation requires one pump to be on-line, while the second and third pumps are reserved as standby. A pipe network with several loops and a variety of isolation valves serves the various plant areas.

Low-pressure Effluent (LPE)

The LPE system provides water to the in-plant fire hydrants, the climber screen trash troughs, the primary tank inlet gate grit flushing lines, the aeration tanks for backfilling, and the foam sprays located in the aeration tanks, final tanks, and Channels 3 and 4. LPE also serves as the primary source for the Japanese Garden Lake. There are three LPE pumps, designated 3, 4, and 5. The system capacity is 5,350 gpm, and operates at a pressure of 40 to 50 psi. Pump 3 has a capacity of 3,100 gpm, Pump 4 has a capacity of 2,250 gpm, and Pump 5 has a capacity of 800 gpm. Typically, only one pump is on-line at a time.

3.2.5 Balboa Pump Station

LADWP supplies tertiary effluent (Title 22 recycled water) from DCT to non-potable customers using the Balboa Pump Station. This pump station serves a 54-inch trunk pipeline that extends 10.3 miles from DCT to the Valley Generating Station. Connections are made from this pipeline to reach Title 22 customers for both irrigation and industrial uses, including golf courses, parks, a sports complex, and the Valley Generating Station.

3.2.6 LA River

Plant effluent in excess of demands for recycled water flows through a 108-inch-diameter outfall to the LA River. From the DCT, the outfall routes in a southerly direction, then turns southeasterly parallel to the LA River, and passes under the Sepulveda Dam embankment to two special outlet structures where flow is discharged to the LA River, approximately 300 yards west of the Burbank Boulevard Bridge. The extension of this outfall outside the Sepulveda Basin was completed in 1993, and it allows the plant to maintain uninterrupted service during flood conditions that occasionally occur in the Sepulveda Basin.

In addition, the overflows from the Japanese Garden, Lake Balboa, and Wildlife Lake are discharged to the LA River.

4. Historic Water Quality Data

As noted in Section 2, the City modified the secondary treatment process at DCT to include NdeN in 2007. The nitrification portion of NdeN relies on aerobic biochemical action to convert nitrogen matter to ammonia, which is then converted to nitrite and nitrate, and then to nitrogen gas. The denitrification process takes place in anoxic conditions, where the nitrite and nitrate are converted to nitrogen gas, which is released to the atmosphere. Under both processes, bacteria are consumed. Because this new process improved the quality of the secondary effluent, the water quality of the secondary and tertiary effluent prior to NdeN conversion (before July 2007) is no longer relevant to the RWMP.

The DCT water quality data are presented in Attachments B, C, and D for influent, secondary effluent, and tertiary effluent, respectively. There are certain instances where a water quality constituent has not been sampled since September 2007. In these instances, the samples before September 2007 are included and the date of the sample is noted. For all water quality parameters that were not detected (ND), the detection limit was assumed for the purpose of summarizing the data.

Additional sampling needs are summarized in Section 4.4.

4.1 Influent Water Quality

Attachment B contains the raw and summarized water quality of the combined influent wastewater from AVORS and EVIS.

4.2 Secondary Effluent Water Quality

Attachment C contains the raw and summarized water quality of the secondary effluent. Secondary effluent is of interest because the feed water for the new AWTP could be either secondary effluent or tertiary effluent upstream of chloramination. The feed water for the new AWTP will be determined based on the results of the GWR pilot testing, which will be conducted as part of Task 3.

It is important to note that the NdeN system was not designed to fully nitrify the primary effluent under all conditions. During high ammonia loading periods, some ammonia bleeds through the NdeN process.

As noted above, the feedwater for the AWTP could either be secondary effluent or tertiary effluent upstream of chloramination. It is recommended that the DCT secondary effluent be sampled for all regulated constituents at the same time as the next round of tertiary effluent sampling. By doing a round of sampling for the secondary effluent, it will allow a comparison between secondary and tertiary data. There are many constituents that are not removed through tertiary filtration and the concentration will be the same before and after tertiary filtration, but it is recommended that all constituents be sampled to allow a complete comparison of data. The feedwater source selection is discussed further in the Advanced Water Treatment Technology TM (Task 1.4).

4.3 Tertiary Effluent Water Quality

Attachment D contains the raw and summarized water quality of the tertiary effluent. This data table also includes the existing regulatory limits for the AWTP. These include the drinking water maximum contaminant limits (MCL) and notification levels (NLs), the Basin Plan, and other permit levels for similar facilities, such as the Groundwater Replenishment (GWR) System.

Upon reviewing the available tertiary effluent data, there are 14 constituents with an MCL or NL for which there is no DCT tertiary effluent water quality data. These constituents should be sampled in the tertiary effluent. The additional sampling needs are summarized in Section 4.4.3.

4.4 Additional Sampling Needs

There are three areas of additional sampling that are recommended for the development of the GWR Master Plan, which include:

- NDMA sampling
- Secondary effluent sampling to compare secondary and tertiary effluent quality
- Tertiary effluent sampling for missing constituents with MCLs and NLs

4.4.1 NDMA Sampling

As discussed in the Advanced Water Treatment Technology TM (Task 1.4), N-nitrosodimethylamine (NDMA) is an emerging contaminant that will impact the sizing of the AWTP. The NDMA data for DCT is limited to a few tertiary effluent samples. Additional NDMA sampling is recommended to better determine where NDMA might be formed at the plant and support recommendations for operational modifications to limit NDMA formation, selection of the AWTP source water, and to size the AWTP advanced oxidation process (AOP).

The following NDMA sampling at DCT is recommended:

- Primary effluent/secondary influent – monthly
- Secondary effluent before polymer addition – weekly
- Tertiary effluent before ammonia and chlorine addition – weekly
- Tertiary effluent after chloramination - monthly

The two monthly samples should be taken at the same time as the weekly sample for tertiary effluent before ammonia and chlorine addition.

4.4.2 Secondary Effluent Sampling

Since the AWTP source water could either be secondary effluent or tertiary effluent upstream of chloramination, it is recommended that the DCT secondary effluent be sampled for all regulated constituents at the same time as the next round of tertiary effluent sampling. This will allow a comparison between secondary and tertiary effluent that, in conjunction with the pilot testing results, would be used to select the AWTP source water. The source water selection for the AWTP is discussed further in the Advanced Water Treatment Technology TM (Task 1.4).

4.4.3 Tertiary Effluent Sampling

There are 14 constituents that have MCLs or an active NL that should be sampled in the tertiary effluent. These constituents are summarized in Table 4-1.

Table 4-1: Additional Sampling Needs

Pollutant	MCL	Active NL
tert-Butylbenzene, ug/L		260
Bromate, ug/L	10	
Chlorite, ug/L	1,000	
Ethylene Dibromide, ug/L[a]	0.05	
HMX, ug/L		350
Methyl isobutyl ketone (MIBK), ug/L		120
Propachlor, ug/L		90
RDX, ug/L		0.3
Tertiary butyl alcohol (TBA), ug/L		12
2,4,6-Trinitrotoluene (TNT), ug/L		1
Specific Conductance, uS/cm	900-2,200[b]	
Combined Radium - 226+228, pCi/L	5	
Tritium, pCi/L	20,000	
Uranium, pCi/L	20	

Footnotes:

a. This compound is the same as 1,2-Dibromoethane.
b. Secondary MCL recommended range.

5. Drawings and Images

5.1 Site Plan

The DCT site plan is shown in Figure 2-2.

5.2 Aerial Photo

The most recent DCT aerial photo is shown in Figure 2-3. Note that this aerial photo does not show the recently constructed blower building, which is located east of the headworks and north of the equalization tanks.

5.3 Record Drawings

Record drawings for the construction of DCT unit processes are available at the City of Los Angeles's vault website: http://engvault.lacity.org/apps/vault/index/htm. Under the "Advance Search," drawings can be referenced by the drawing numbers. Table 5-1 summarizes the relevant drawing numbers with respect to each project. LADWP has provided drawings of the Balboa Pump Station. The team will use these record drawings for the GWR Master Plan and pilot study.

Table 5-1: Record Drawing Reference Chart

Project Name	Design Date	As-Built Date	D-# Reference
Sepulveda Water Reclamation Plant (Phase 1)	1973	1980	23221, 23222, 23223, 23224, 23225, 23226, 23227, 23228, 23229, 23230, 23231, 23232, 23233, 23234, 23235, 23236
Tillman Water Reclamation Plant Phase II	1988	1993	29081, 29082, 29083, 29084, 29085, 29086, 29087, 29088, 29089, 29090, 29091, 29092, 29093, 29094, 29095
D.C. Tillman Water Reclamation Plant 6141-Nitrogen Conversion removal	2003	2007	32335, 32365, 32360, 32366, 32332, 32331, 32364
D.C. Tillman Water Reclamation Plant 6158-NdeN Blower Facility	2005		32812, 32813, 32814, 32815, 32816
D.C. Tillman Water Reclamation Plant 6174-Filter Pilot Test		2007	33383
Nitrogen Removal Conversion 6153-Phase 1-Final Sedimentation Basin Mods		2008	32256
D.C. Tillman Water Reclamation Plant 6150-Filter Replacement Installation	2008		33680, 33681, 33682

6. Current and Future DCT Projects

There are two ongoing projects at DCT that are of importance to the RWMP: the tertiary filter upgrades that are currently under construction and the wet weather storage project that is currently in the planning stage. There are two other projects at DCT that should not have any impact on the future AWTP: primary treatment odor control and emergency generator replacement and expansion. These projects, and their potential impact on the future AWTP (if sited at DCT), are described further below.

6.1 Tertiary Filter Upgrades

The original tertiary filtration units at DCT were shallow-bed sand filters, designed by Infilco Degramont (IDI). These filters were installed in two phases beginning in 1984. They eventually started experiencing deterioration and high maintenance costs and became less effective at removing turbidity, which affected the chlorine dosing. As a result of these shortcomings, the BOS and the BOE decided to replace the sand filtration units with AquaDiamond® chlorine resistant cloth media filter packages. These new cloth filters will use the same infrastructure and site as the sand filtration units.

For this upgrade, 16 sand filters (both Phase I and Phase II) will be replaced by eight AquaDiamond® cloth filters (four for each Phase), which is currently underway. Construction began in August 2007 and is expected to be completed by April 2010. During construction, water is filtered through temporary AquaDiamond® cloth filters, which have been installed between the secondary clarifiers and the filtration units. Because these temporary filters are not capable of treating the full flow through the plant, the plant has been running at slightly under half capacity (less than 40 mgd) during construction.

6.2 Wet Weather Storage

Because of the need to alleviate storm flows on the downstream sewers to prevent sewer surcharging, DCT only operates at half capacity during the wet season and only operates the Phase I facilities. This allows the Phase II facilities (primary clarifiers, aeration tanks, and secondary clarifiers) to be used for wet weather storage during peak flow conditions and alleviate peak flow conditions on the downstream sewers.

To allow DCT to operate at capacity (80 mgd) year round, while continuing to alleviate surcharging on the downstream sewers, BOE is designing wet weather, open, lined storage basins for wet weather storage. The basins are going to be constructed in the grassy area on the eastern side of DCT, adjacent to the existing equalization tanks and the Phase II Aeration Tanks and Secondary Clarifiers, as shown in Figure 6-1.

Figure 6-1: Location of Wet Weather Storage Basins

(Source: HDR, 2009)

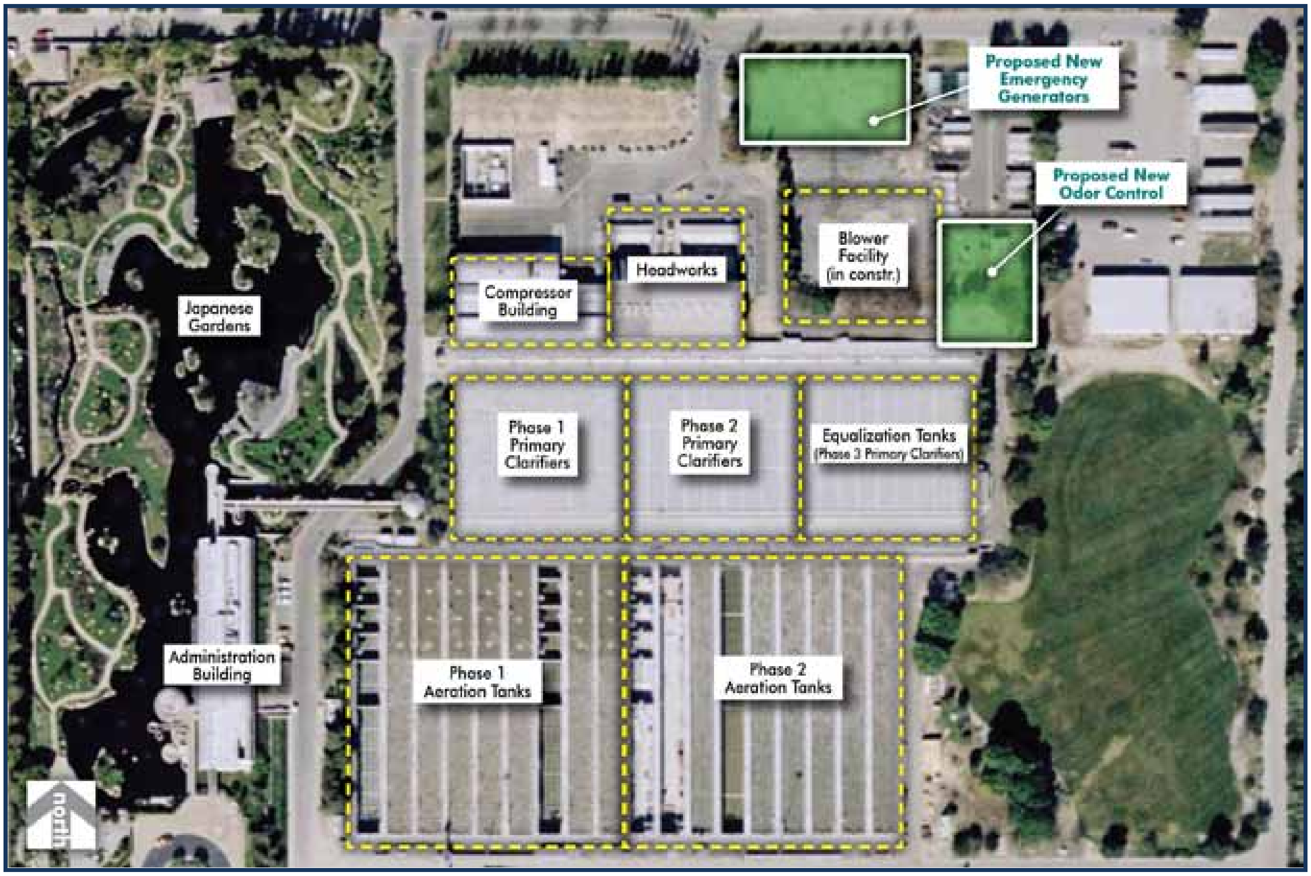
These basins are being constructed as part of a new design-build project in the planned location for future DCT expansion; in the future when the additional treatment capacity is desired, then the storage basins may be removed. The area east of the tertiary filters and chlorine contact basins and west of the Balboa Pump Station could be available for the AWTP. Additional siting considerations will be conducted in the Site Assessment TM.

The planned operation of the new wet weather storage basins will be as follows. During storm events, the excess flow from the primary clarifiers will flow into Basin 1 via a 54” pipe. Once Basin 1 is full, the water will overflow (via the designated spillway in Figure 3) into Basin 2. These basins will then be gravity drained to the AVORS pipeline via a manhole sewer connection, which is shown in Figure 6-1. The proposed basins will provide 15 MG of wet weather storage, which will help mitigate peak flows entering the effluent sewers from DCT.

6.3 Primary Treatment Odor Control

The City is considering a new project for primary treatment odor control. Foul air has historically been collected from the primary clarifiers and used for aeration air. This air stream has been shown to cause corrosion. Since the City recently installed a new blower building, the City is investigating building separate primary treatment odor control to avoid corrosion of the new blowers. This project is still in preliminary planning phase and the schedule is currently unknown. This project is anticipated to be constructed on the north end of the plant near the new blower building (shown in Figure 6-2) and would not impact the siting of the future AWTP.

Figure 6-2: Locations of Proposed New Odor Control and Emergency Generator Buildings



6.4 Emergency Generator Replacement and Expansion

The City is also considering implementing an emergency generator replacement and expansion project. The project would include adding 10 megawatts (MW) of emergency generating capacity to replace the existing 2 MW emergency generator system. A total of five 2 MW generators would be included in the project. The schedule of the project is unknown at this time. The approximate location of the project is indicated in Figure 6-2 and since it is located at the north end of the plant, it would not impact the AWTP if sited at DCT.

6.5 Affect of Current and Future Projects on AWTP Siting at DCT

The odor control and emergency generator projects will not affect the siting of the new AWTP, as both projects will be located on the northern side of the plant. However, the wet weather storage project does impact the space available for the AWTP. Figure 6-3 shows the space available for the AWTP based on the preliminary concepts for the wet weather storage basins. The layout of the wet weather storage basins (as shown in Figure 6-1 and Figure 6-3) extends to the northernmost edge of the filtration units. Therefore, if the AWTP is to be sited on the southeastern portion of DCT property, then it would need to fit between the wet weather storage basin and the southern access road, as well as between the access road adjacent to the Phase 2 filtration units and the Balboa Pumping Station. The AWTP site assessment will be conducted as part of Task 1.5.

Figure 6-3: Location of Potential Site of AWTP

7. Operational Considerations for Expansion of Recycling

7.1 Condition of Existing Plant Infrastructure

The existing plant infrastructure at DCT is considered in good condition and has been upgraded in recent years. In the mid-2000s the secondary system was completely rehabilitated and upgraded with the NdeN project, which was started-up in 2007. Currently, all tertiary filters are being upgraded from sand filters to cloth filters (See Section 6.1). Since the plant is in good condition, it is expected that the future operations of the AWTP, which will be fed by DCT effluent, will not be inhibited by future plant repairs.

7.2 Capacity of Existing Electrical Infrastructure

The existing electrical infrastructure contains dual plant feed, but is currently not equipped with a backup electrical system. Plans are underway to install an emergency generator in the northwest corner of the plant (see Figure 6-3). This project would provide backup power supply for the existing plant.

7.3 Potential Modifications to Plant Operations

DCT currently uses Mannich polymer in the aeration tanks for foam control. Since Mannich- based cationic polymer contributes small amounts of NDMA and substantially increases NDMA precursors, additional NDMA sampling may be required to determine the effects of the Mannich polymer. The AWT Technology TM recommended performing weekly NDMA sampling of primary effluent/secondary influent, secondary effluent, and tertiary effluent after chlorination. Using these results from these samples, BOS may decide to discontinue the use of Mannich polymer in the aeration tanks. The Los Angeles County Sanitation District (LACSD) has performed a test using magnesium hydroxide as an alternative to Mannich polymer for foam control (Neisses et al., 2003). This may be a viable alternative to use at DCT and should be investigated once LACSD's test results are available and after reviewing current NDMA sampling (recommended in Section 4.4.1).

7.4 Failsafe Disposal Methods

DCT has been designed with the following failsafe disposal methods for treatment plant effluent and solids:

- Tertiary effluent, within specifications: Any tertiary effluent not reused by Balboa Lake, Wildlife Lake, the Japanese Garden, HPE, LPE or by Title 22 customers (via the Balboa Pump Station) is discharged to the LA River. The plant is permitted to discharge plant capacity (80 mgd) to the LA River.
- Tertiary effluent, not within specifications: DCT has two online meters for the tertiary treated effluent, which are chlorine residual and turbidity. If the tertiary effluent does not meet specifications for chlorine residual or turbidity, then the plant flow is discharged into the AVORS and conveyed to HTP for treatment. DCT has the ability to divert flow from each unit process to the AVORS.
- Solids: All DCT solids are routed to the AVORS during normal and failsafe conditions.

If sited at DCT, the AWTP would be designed with the same failsafe disposal methods.

7.5 Permitting Constraints

The proposed advanced water treatment facilities will be designed in such a way to not impact the DCT permit, whether or not the AWTP is sited at DCT. A comprehensive evaluation of the existing permits and their expected renewal dates are discussed in the Regulatory Assessment TM.

8. Summary

8.1 Data Gaps, Future Work

As described in Section 4.4, there are additional DCT water quality data needs for the GWR Master Plan:

- NDMA sampling
- Secondary effluent sampling to compare secondary and tertiary effluent quality
- Tertiary effluent sampling for missing constituents with MCLs and NLs

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4. HDR, 2009, Task Order Solicitation 35 Open Lined Basin Evaluation, Technical Memorandum.
5. Neisses, L., Baird, R., Carr, S., Gute, J., Strand, J. and Young, C., 2003, Can N-nitrosomethylamine Formation be Affected by Polymer use during advanced wastewater treatment?, Proceedings of the 2003 WateReuse Research Symposium.
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7. Water Quality Data Files from BOS:
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   - DCT 2008 Annual Monitoring Report: Water Discharge Requirements for Title 22.pdf
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   - DCT Wisard 24 hr Inf Q – 090726.doc
   - Constituents with NL.xls
   - DCT 2007 Annual Eff Summary.xls
   - DCT 2008 Annual Eff Summary.xls
   - DCT 2009 Annual Eff Summary.xls
   - DCT Ba Sr Alk Fe MN 2005.xls
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   - DCT Flows 090723.xls
   - DCT Inf & Eff Temp – 2005 to Aug 2009.xls
   - DCT Inf BOD SS 090723.xls
   - DCT Metals 2005-09.xls
   - DCT Mg Ca Na K 2005.xls
   - DCT Mg Ca Na K 2006.xls
   - DCT Mg Ca Na K 2007.xls
   - DCT Mg Ca Na K 2008.xls
   - DCT MISC 2005-09.xls
   - DCT Pest PCB 2005-09.xls
   - DCT Phase 1 Sec Effluent – NH3 NO2 NO3 Lab Composite Data 070709 – 090729.xls
   - DCT Phenols 2005-09.xls
   - DCT Phosphorous 2005.xls
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   - DCT TOC DOC SO4 2005.xls
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   - DCT Turbidity – Fiscal 2007-08.xls
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   - DCT_WDR_Quarterly_2009_0201.xls
   - DCT-BOD_B_CL_pH_SO4_TSS_TDS.xls
   - LADWP Flow Recycled Q from DCT – Jan 08 to Aug 20 09.xls
   - Fluoride 2004 to present.xls
   - NDMA_1,4-Dioxane_2007 to present.xls
   - Total & Free Chlorine 2004 to present.xls

Attachments

Attachment A DCT Historical Plant Flow Data Summary

Attachment B Influent Water Quality Summary

Attachment C Secondary Effluent Water Quality Summary

Attachment D Tertiary Effluent Water Quality Summary

Attachment A
DCT Historical Plant Flow Data Summary

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Month/Year	PLANT INFLUENT	PRIMARY SLUDGE	AERATION		WAS		SCUM[a]		FILTER BW BACKWASH		SECONDARY EFFLUENT		BALBOA LAKE	WILDLIFE LAKE	JAPANESE GARDEN	HIGH PRESSURE EFFLUENT	LOW PRESSURE EFFLUENT	PLANT EFFLUENT WEIR TO LA RIVER	DWP USE	TOTAL PLANT FLOW
	IN PLANT FLOWS (MGD)												RECYCLED WATER USES (MGD)							
			Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2								
Jan 05	72.4	0.9	24.5	38.8	0.76	1.41	3.7	2.4	0.7	2.2	19.4	32.7	11.6	7.0	4.5	1.5	1.2	26.2		63.3
Feb 05	78.5	1.4	25.7	43.5	1.06	1.80	1.9	2.4	0.8	2.3	22.0	37.1	11.5	7.2	4.7	1.5	1.2	33.0		69.2
Mar 05	71.6	0.9	23.1	38.5	0.83	1.75	0.6	2.5	0.7	2.2	21.0	32.0	11.8	7.0	4.4	1.6	1.0	27.3		61.7
Apr 05	43.3	0.7	0.0	40.1	0.00	1.69	0.0	2.7	0.0	2.3	0.0	33.4	11.5	7.1	3.9	1.8	1.0	8.4		40.1
May 05	41.7	0.8	0.0	39.2	0.00	1.60	0.0	3.1	0.0	2.3	0.0	32.3	11.5	6.6	4.4	1.7	1.2	7.3		39.2
Jun 05	43.0	0.7	0.0	39.9	0.00	1.41	0.0	2.6	0.0	2.3	0.0	33.6	12.0	7.1	5.1	1.8	1.3	6.6		39.9
Jul 05	41.9	0.7	0.0	39.5	0.00	1.57	0.0	2.6	0.0	2.3	0.0	33.0	11.5	6.7	5.0	1.9	1.3	6.9		39.5
Aug 05	42.0	0.8	0.0	39.9	0.00	1.59	0.0	2.1	0.0	2.3	0.0	33.9	11.6	6.9	5.1	2.0	2.5	6.1		39.9
Sep 05	50.1	0.8	8.1	38.4	0.22	2.02	7.9	5.0	0.0	2.4	0.0	33.4	10.7	6.9	4.9	2.0	2.1	6.6		46.4
Oct 05	62.4	0.9	21.1	37.9	0.84	2.10	12.1	1.3	0.2	2.5	8.0	32.0	9.4	6.5	4.8	1.7	2.3	15.3		59.0
Nov 05	61.8	1.0	21.5	34.9	1.07	1.97	1.1	1.7	0.4	2.4	18.9	28.9	11.1	8.0	5.1	1.9	1.0 c	20.8		56.5
Dec 05	62.1	1.0	21.4	34.3	0.95	1.86	1.7	2.5	0.4	2.4	18.3	27.6	11.2	7.9	5.1	1.9	1.1 c	18.6		55.6
Jan 06	64.2	0.9	24.1	34.0	0.91	1.85	2.0 c	2.5	1.0	2.3	20.2 c	27.3	11.3	7.7	5.2	1.8	1.0 c	20.4		58.2
Feb 06	64.7	1.0	27.5	32.7	0.91	1.87	1.4	2.7	1.3	2.2	23.8	26.0	13.5	7.8	4.4	2.0	0.9	23.6		60.2
Mar 06	64.1 c	1.0	31.9	29.0	1.06	1.25	1.8 c	2.0	1.5	2.2	27.5 c	23.6	13.7	7.7	4.5	1.9	0.8	22.5		60.8
Apr 06	50.7	0.7	37.4	7.0	1.29	0.30	1.8 c	0.4	1.8	0.6	32.5 c	5.7	13.0	7.3	4.1	1.9	0.9	11.0		44.4
May 06	43.6	0.6	37.3	0.0	1.33	0.00	1.8 c	0.0	1.8	0.0	32.4 c	0.0	12.5	7.4	5.0	1.9	0.9	4.8		37.3
Jun 06	43.7	0.6	37.3	0.0	1.33	0.00	2.0 c	0.0	1.5	0.0	32.4 c	0.0	12.3	7.6	5.0	1.9	1.0	4.4		37.3
Jul 06	43.3	0.6	37.1	0.0	1.50	0.00	1.8	0.0	1.5	0.0	32.4	0.0	12.0	7.6	4.8	1.9	1.0	5.3		37.1
Aug 06	42.9	0.5	37.5	0.0	1.47	0.00	2.9	0.0	1.3	0.0	31.8	0.0	12.1	7.5	4.8	1.8	1.5	4.2		37.5
Sep 06	46.1	0.6	37.3	1.8	1.53	0.00	2.0	1.8	1.6	0.0	32.2	0.0	12.5	7.4	4.8	1.9	1.9	4.0		39.1
Oct 06	62.4	0.8	34.6	19.9	1.37	0.18	2.7	19.7	1.5	0.0	29.0	0.0	11.0	7.3	4.8	1.5	2.3	3.8		54.5
Nov 06	60.9	0.8	35.2	16.6	1.39	0.25	2.8	15.4	1.6	0.9	29.5	0.0	12.3	7.4	3.8	1.9	1.9	3.3		51.7
Dec 06	63.0	0.9	31.7	24.3	1.06	0.92	2.1	11.2	1.5	1.8	27.0	10.4	13.0	7.6	3.4	1.3	1.0	12.1		56.0
Jan 07	63.5	1.0	31.7	24.8	1.03	0.92	2.1	2.2 c	1.3	1.5	27.2	20.2 c	14.3	7.7	3.2	0.6	0.8	21.6		56.6
Feb 07	63.5	0.9	32.7	22.3	0.97	0.85	2.0	0.4	1.5	1.4	27.1	18.8	14.3	7.7	3.5	0.5	0.8	19.9		55.0
Mar 07	63.6	0.9	30.6	22.2	0.56	0.40	2.3	1.1	1.3	1.4	26.4	19.4	14.4	7.7	3.7	1.4	0.7	18.7		52.9
Apr 07	45.7	0.9	35.3	0.0	0.68	0.00	2.2	0.0	1.6	0.0	30.8	0.0	14.9	7.7	3.9	1.3	0.8	2.7		35.3
May 07	45.2	0.7	33.8	0.0	0.63	0.00	2.8	0.0	1.4	0.0	29.0	0.0	14.1	7.1	3.9	1.2	0.3	2.7		33.8
Jun 07	45.3	0.7	33.7	0.0	0.82	0.00	2.5	0.0	1.2	0.0	29.2	0.0	14.6	7.0	3.7	1.6	0.7	2.1		33.7
Jul 07	45.2	0.7	31.2	0.0	0.27	0.00	2.4	0.0	1.0	0.0	27.5	0.0	14.8	6.3	3.7	2.0	0.4	1.4		31.2
Aug 07	45.0	0.7	33.1	0.0	0.37	0.00	2.1	0.0	0.9	0.0	29.7	0.0	14.8	6.6	4.0	1.6	0.6	2.6		33.1
Sep 07	47.3	0.7	37.2	0.0	0.20	0.00	2.6	0.0	1.5	0.0	33.0	0.0	15.1	6.4	3.9	1.4	0.7	5.7		37.2
Oct 07	49.9	0.7	38.9	0.0	0.50	0.00	2.2	0.0	1.6	0.0	34.6	0.0	15.1	6.6 c	3.8	1.4	1.4	7.0		38.9
Nov 07	49.2	0.7	39.3	0.0	0.30	0.00	2.5	0.0	1.1	0.0	35.4	0.0	14.8	6.9	3.6	1.5	0.7	7.7		39.3
Dec 07	47.8	0.7	37.2	0.0	0.39	0.00	1.6	0.0	1.3	0.0	33.8	0.0	15.3	6.8	3.9	1.5	0.5	5.9		37.2
Jan 08	49.7	0.7	38.2	0.0	0.39	0.00	0.9	0.0	1.4	0.0	35.5	0.0	15.0	6.8	3.8	1.6	0.7	7.6	0.2	38.2
Feb 08	49.7	0.7	38.4	0.0	0.43	0.00	0.8	0.0	1.2	0.0	35.9	0.0	15.2	6.9	3.9	1.4	0.6	7.8	0.2	38.4
Mar 08	49.9	0.7	37.4	0.0	0.51	0.00	0.8 c	0.0	1.1	0.0	35.0 c	0.0	14.4	6.8	3.8	1.4	0.7	7.8	0.3	37.4
Apr 08	51.1	0.8	39.2	0.0	0.46	0.00	1.1 c	0.0	1.1	0.0	36.5 c	0.0	15.1	6.5	3.8	1.2	0.6	9.2	0.4	39.2
May 08	50.7	0.8	39.2	0.0	0.44	0.00	0.9 c	0.0	1.0	0.0	36.9 c	0.0	15.3	5.8	3.6	1.3	0.6	10.1	0.3	39.2
Jun 08	50.0	0.8	38.3	0.0	0.54	0.00	1.9	0.0	1.2	0.0	34.7	0.0	14.5	5.7	3.6	1.4	0.4	7.0	2.1	38.3
Jul 08	48.8	0.7	37.3	0.0	0.37	0.00	1.9	0.0	0.7	0.0	34.3	0.0	14.7	5.0	3.8	1.5	0.5	6.6	2.4	37.3
Aug 08	50.7	0.8	38.4	0.0	0.48	0.00	2.2	0.0	0.9	0.0	34.9	0.0	15.1	5.0	3.7	1.6	0.5	6.5	2.7	38.4
Sep 08	50.4	0.9	38.8	0.0	0.51	0.00	2.9	0.0	0.8	0.0	34.6	0.0	15.4	4.9	3.8	1.5	0.8	6.0	2.5	38.8
Oct 08	49.1	0.8	38.0	0.0	0.52	0.00	2.9	0.0	0.4	0.0	34.2	0.0	15.5	4.9	3.6	1.6	0.7	5.9	2.4	38.0
Nov 08	47.2	0.8	34.8	0.0	0.49	0.00	2.3	0.0	0.3	0.0	31.7	0.0	12.1	5.4	3.6	1.3	0.5	8.0	1.2	34.8
Dec 08	45.4	0.9	37.8	0.0	0.49	0.00	2.5	0.0	0.5	0.0	34.4	0.0	12.4	5.5	3.6	1.3	0.8	9.2	1.8	37.8
Jan 09	45.0	0.9	35.9	0.0	0.60	0.00	2.1	0.0	0.5	0.0	32.8	0.0	13.7	5.5	3.3	1.5	0.9	6.4	1.9	35.9
Feb 09	45.2	0.8	35.8	0.0	0.59	0.00	2.3	0.0	0.5	0.0	32.4	0.0	14.9	5.6	3.2	1.1	1.1	5.5	1.7	35.8
Mar 09	44.1	0.8	32.1	0.0	0.58	0.00	2.1	0.0	0.3	0.0	29.1	0.0	15.0	5.7	3.1	1.3	0.9	2.3	1.9	32.1
Apr 09	47.2	0.7	24.5	9.0	0.31	0.09	1.8	2.4 c	0.3	0.1	22.1	6.5 c	13.6	5.0	3.0	1.3	0.8	5.0	1.3	33.6
May 09	48.7	0.7	17.7	16.2	0.26	0.22	1.3	1.1 c	0.3	0.1	15.8	14.9 c	14.5	4.9	3.2	1.5	0.8	5.2	0.9	33.9
Jun 09	48.4	0.7	17.8	17.5	0.37	0.33	2.0 c	1.3 c	0.2 c	0.1	15.2 c	15.7 c	13.9	5.1	3.4	1.4	0.8	5.2	1.7	35.2
Jul 09	47.3	0.9	16.2	17.8	0.29	0.33	1.2 c	0.3	0.1 c	0.1	16.2	16.5	14.5	5.2	3.5	1.2	0.6	6.0	2.5	34.0
Aug 09																			2.6	
Average Flow January 2005 - December 2008[b]	52.6	0.8	29.7	14.6	0.7	0.6	2.1	1.9	1.0	0.8	25.8	11.3	13.2	6.8	4.2	1.6	1.0	10.2	1.4	44.3
Maximum Flow January 2005 -July 2009[b]	78.5	1.4	39.3	43.5	1.5	2.1	12.1	19.7	1.8	2.5	36.9	37.1	15.5	8.0	5.2	2.0	2.5	33.0	2.7	69.2
Minimum Flow January 2005 -July 2009[b]	41.7	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.4	4.9	3.2	0.5	0.3	1.4	0.2	31.2

Footnotes a. Scum flow is not directly metered, but is the calculated value remaining after all other metered sidestream flows are subtracted.
b. Data for the Balboa pump station is from January 2008 until August 2009
c. Estimated flow due to metering problems

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Attachment B
Influent Water Quality Summary

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	Summary					Regulatory Requirements				Raw Data																																
Pollutant	Units	Maximum	Monthly Average	No of Samples	Notes	Detection Level for ND Samples	MCL Requirements[a]	NLs[b]	Other Basin Plan Requiremets[c]	2009								2008												2007												Samples before Jan 2007
										Aug	Jul	Jun	May	Apr	Mar	Feb	Jan	Dec	Nov	Oct	Sep	Aug	Jul	Jun	May	Apr	Mar	Feb	Jan	Dec	Nov	Oct	Sep	Aug	Jul	Jun	May	Apr	Mar	Feb	Jan	
Inorganics																																										
Antimony	ug/L	1.01	1.01	1			6			--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.01	--	--	--	--	--	--	--	--	--	--	
Arsenic	ug/L	2.8	2.8	1			10			--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2.8	--	--	--	--	--	--	--	--	--	--	
Barium	mg/L	1.09	0.58	2	Samples from Jan & Feb 2005		1000			--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	Feb 05=1.09, Jan 05=0.073
Beryllium	ug/L	0.04	0.04	1		0.04	4			--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.04	--	--	--	--	--	--	--	--	--	--	
Cadmium	ug/L	0.6	0.6	1			5			--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.6	--	--	--	--	--	--	--	--	--	--	
Chromium (VI)	ug/L	2	2	1		2				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2	--	--	--	--	--	--	--	--	--	--	
Chromium Total	ug/L	1.81	1.81	1			50			--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.81	--	--	--	--	--	--	--	--	--	--	
Copper	ug/L	161	161	1			13000			--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	161	--	--	--	--	--	--	--	--	--	--	
Cyanide	ug/L	0.004	0.004	1		0.004	150			--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.004	--	--	--	--	--	--	--	--	--	--	
Lead	ug/L	3.7	3.7	1			15			--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3.7	--	--	--	--	--	--	--	--	--	--	
Mercury	ug/L	0.139	0.139	1			2			--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.139	--	--	--	--	--	--	--	--	--	--	
Nickel	ug/L	7.9	7.9	1			100			--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	7.9	--	--	--	--	--	--	--	--	--	--	
Selenium	ug/L	1.5	1.5	1			50			--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.5	--	--	--	--	--	--	--	--	--	--	
Thallium	ug/L	0.06	0.06	1			6.3			--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.06	--	--	--	--	--	--	--	--	--	--	
VOCs																																										
Benzene	ug/L	0.07	0.07	1		0.07				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.07	--	--	--	--	--	--	--	--	--	--	
Carbon Tetrachloride	ug/L	0.09	0.09	1		0.09				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.09	--	--	--	--	--	--	--	--	--	--	
1,2-Dichlorobenzene	ug/L	0.06	0.06	1		0.06				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.06	--	--	--	--	--	--	--	--	--	--	
1,4-Dichlorobenzene	ug/L	0.07	0.07	1		0.07				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.07	--	--	--	--	--	--	--	--	--	--	
1,1-Dichloroethane	ug/L	0.12	0.12	1		0.12				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.12	--	--	--	--	--	--	--	--	--	--	
1,2-Dichloroethane	ug/L	0.1	0.1	1		0.1				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.1	--	--	--	--	--	--	--	--	--	--	
1,1-Dichloroethylene	ug/L	0.12	0.12	1		0.12				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.12	--	--	--	--	--	--	--	--	--	--	
Trans-1,2-Dichloroethene	ug/L	0.07	0.07	1		0.07				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.07	--	--	--	--	--	--	--	--	--	--	
Dichloromethane	ug/L	0.12	0.12	1		0.12				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.12	--	--	--	--	--	--	--	--	--	--	
1,3-Dichloropropylene	ug/L	0	0	1						--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0	--	--	--	--	--	--	--	--	--	--	
1,2-Dichloropropane	ug/L	0.1	0.1	1		0.1				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.1	--	--	--	--	--	--	--	--	--	--	
Ethylbenzene	ug/L	0.08	0.08	1		0.08				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.08	--	--	--	--	--	--	--	--	--	--	
Monochlorobenzene	ug/L	0.06	0.06	1		0.06				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.06	--	--	--	--	--	--	--	--	--	--	
1,1,2,2-Tetrachloroethane	ug/L	0.11	0.11	1		0.11				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.11	--	--	--	--	--	--	--	--	--	--	
Tetrachloroethylene	ug/L	0.1	0.1	1		0.1				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.1	--	--	--	--	--	--	--	--	--	--	
Toluene	ug/L	0.66	0.66	1						--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.66	--	--	--	--	--	--	--	--	--	--	
1,2,4-Trichlorobenzene	ug/L	0.08	0.08	1		0.08				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.08	--	--	--	--	--	--	--	--	--	--	
1,1,1-Trichloroethane	ug/L	0.05	0.05	1		0.05				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.05	--	--	--	--	--	--	--	--	--	--	
1,1,2-Trichloroethane	ug/L	0.05	0.05	1		0.05				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.05	--	--	--	--	--	--	--	--	--	--	
Trichloroethylene	ug/L	0.08	0.08	1		0.08				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.08	--	--	--	--	--	--	--	--	--	--	
Vinyl Chloride	ug/L	0.07	0.07	1		0.07				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.07	--	--	--	--	--	--	--	--	--	--	
SOCs																																										
Benzo(a)pyrene	ug/L	0.13	0.13	1		0.13				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.13	--	--	--	--	--	--	--	--	--	--	--	
Chlordane	ug/L	0.02	0.02	1		0.02				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.02	--	--	--	--	--	--	--	--	--	--	
1,3-Dichlorobenzene	ug/L	0.05	0.05	1		0.05				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.05	--	--	--	--	--	--	--	--	--	--	
Bis-(2-Ethylhexyl)phthalate	ug/L	4	4	1						--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	4	--	--	--	--	--	--	--	--	--	--	
2,4-D	ug/L	0.8	0.8	1	Sample from August 2007	0.8				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.8	--	--	--	--	--	--	--	
Endrin	ug/L	0.005	0.005	1		0.005				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.005	--	--	--	--	--	--	--	--	--	--	
Heptachlor	ug/L	0.003	0.003	1		0.003				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.003	--	--	--	--	--	--	--	--	--	--	
Heptachlor Epoxide	ug/L	0.003	0.003	1		0.003				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.003	--	--	--	--	--	--	--	--	--	--	
Hexachlorobenzene	ug/L	0.07	0.07	1		0.07				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.07	--	--	--	--	--	--	--	--	--	--	
Hexachlorocyclopentadiene	ug/L	2.9	2.9	1		2.9				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2.9	--	--	--	--	--	--	--	--	--	--	
Methoxychlor	ug/L	0.003	0.003	1	Sample from August 2007	0.003				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.003	--	--	--	--	--	--	--	
Pentachlorophenol	ug/L	0.4	0.4	1		0.4				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.4	--	--	--	--	--	--	--	--	--	--	
Polychlorinated Biphenyls	ug/L	0	0	1						--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0	--	--	--	--	--	--	--	--	--	--	
Toxaphene	ug/L	0.02	0.02	1		0.02				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.02	--	--	--	--	--	--	--	--	--	--	
2,3,7,8-TCDD (Dioxin)	pg/L	1.37	1.37	1		1.37				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.37	--	--	--	--	--	--	--	--	--	--	
2,4,5-TP (Silvex)	ug/L	0.34	0.34	1	Sample from August 2007	0.34				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.34	--	--	--	--	--	--	--	
Compounds with an MCL																																										
Iron	ug/L	1180	970		Samples from Feb & Sept 2005					--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	Sep 05=760, Feb 05=1180
Manganese	ug/L	60	60		Sample from January 2005					--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	Jan 05=60
Silver	ug/L	7.9	7.9	1						--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	7.9	--	--	--	--	--	--	--	--	--	--	
Sulfate	mg/L	132	95	2	Samples from Jan 2006 - Feb 2007					--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	94.9	73.3	Monthly Aug 05-Dec 06, Ave=96.8
TDS	mg/L	774	597	2	Samples from Mar 2005 - Feb 2007					--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	530	484	Monthly Mar 05-Dec 06, Ave=606
Trans-1,3-Dichloropropene	ug/L	0.06	0.06	1		0.06				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.06	--	--	--	--	--	--	--	--	--	--	
Zinc	ug/L	179	179	1						--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	179	--	--	--	--	--	--	--	--	--	--	
Compounds with a NL																																										
Naphthalene	ug/L	0.13	0.13	1		0.13				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.13	--	--	--	--	--	--	--	--	--	--	--	
N-Nitrosodimethylamine (NDMA)	ug/L	0.17	0.17	1		0.17				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.17	--	--	--	--	--	--	--	--	--	--	
N-Nitroso-Di-N-Propylamine	ug/L	0.13	0.13	1		0.13				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.13	--	--	--	--	--	--	--	--	--	--	
Compounds with Federal Technology Based Standards																																										
BOD5	mg/L	401	338	23						--	280	332	336	348	335	303	344	342	366	335	340	326	329	317	326	395	365	341	352	401	350	310	290	--	--	--	--	--	--	--	--	
TSS	mg/L	354	264	23						--	262	258	244	247	251	241	232	239	299	271	272	247	232	220	245	306	354	282	242	307	303	268	246	--	--	--	--	--	--	--	--	
Compounds with a Basin Plant Limit																																										
pH	(unitless)	7.6	7.5	4					6.5-8.5[d]	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	7.6	7.6	7.5	7.4	--	--	--	--	--	--	--	--	
Temperature	F	82.9	77.3	24	Peak Day-84.1, 711 samples				86[d]	82.1	80.8	78	76.9	74.4	72.7	72.1	73.2	75.3	79.1	81.5	82.6	82.4	81.2	78.5	76.8	74.6	72.6	71	71.8	74.8	78.6	80.7	82.9	--	--	--	--	--	--	--	--	
Other Compounds[e]																																										
2,4,6-Trichlorophenol	ug/L	0.09	0.09	1		0.09				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.09	--	--	--	--	--	--	--	--	--	--	
2,4-Dichlorophenol	ug/L	0.09	0.09	1		0.09				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.09	--	--	--	--	--	--	--	--	--	--	
2,4-Dimethylphenol	ug/L	0.17	0.17	1		0.09				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.17	--	--	--	--	--	--	--	--	--	--	
2,4-Dinitrophenol	ug/L	0.21	0.21	1		0.21				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.21	--	--	--	--	--	--	--	--	--	--	
2,4-Dinitrotoluene	ug/L	0.08	0.08	1		0.08				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.08	--	--	--	--	--	--	--	--	--	--	
2,6-Dinitrotoluene	ug/L	0.022	0.022	1		0.022				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.022	--	--	--	--	--	--	--	--	--	--	
2-Chloroethylvinylether	ug/L	0.27	0.27	1		0.27				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.27	--	--	--	--	--	--	--	--	--	--	
2-Chloronaphthalene	ug/L	0.07	0.07	1		0.07				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.07	--	--	--	--	--	--	--	--	--	--	
2-Chlorophenol	ug/L	0.09	0.09	1		0.09				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.09	--	--	--	--	--	--	--	--	--	--	
2-Nitrophenol	ug/L	0.09	0.09	1		0.09				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.09	--	--	--	--	--	--	--	--	--	--	
3,3-Dichlorobenzidine	ug/L	0.11	0.11	1		0.11				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.11	--	--	--	--	--	--	--	--	--	--	
4,6-Dinitro-2-methylphenol	ug/L	0.4	0.4	1		0.4				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.4	--	--	--	--	--	--	--	--	--	--	
4-Bromophenyl phenyl ether	ug/L	0.07	0.07	1		0.07				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.07	--	--	--	--	--	--	--	--	--	--	

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Pollutant	Units	Summary: Maximum	Summary: Monthly Average	Summary: No of Samples	Summary: Notes	Regulatory Requirements: Detection Level for ND Samples	Regulatory Requirements: MCL Requirements[a]	Regulatory Requirements: NLs[b]	Regulatory Requirements: Other Basin Plan Requirements[c]	2009 Aug	2009 Jul	2009 Jun	2009 May	2009 Apr	2009 Mar	2009 Feb	2009 Jan	2008 Dec	2008 Nov	2008 Oct	2008 Sep	2008 Aug	2008 Jul	2008 Jun	2008 May	2008 Apr	2008 Mar	2008 Feb	2008 Jan	2007 Dec	2007 Nov	2007 Oct	2007 Sep	2007 Aug	2007 Jul	2007 Jun	2007 May	2007 Apr	2007 Mar	2007 Feb	2007 Jan	Samples before Jan 2007
4-Chloro-3-Methylphenol	ug/L	0.18	0.18	1		0.18				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.18	--	--	--	--	--	--	--	--	--	--	
4-Chlorophenyl phenyl ether	ug/L	0.04	0.04	1		0.04				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.04	--	--	--	--	--	--	--	--	--	--	
4-Nitrophenol	ug/L	0.06	0.06	1		0.06				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.06	--	--	--	--	--	--	--	--	--	--	
Acenaphthene	ug/L	0.13	0.13	1		0.13				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.13	--	--	--	--	--	--	--	--	--	--	--	
Acenaphthylene	ug/L	0.13	0.13	1		0.13				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.13	--	--	--	--	--	--	--	--	--	--	--	
Acrolein	ug/L	1.96	1.96	1		1.96				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.96	--	--	--	--	--	--	--	--	--	--	
Acrylonitrile	ug/L	0.08	0.08	1		0.08				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.08	--	--	--	--	--	--	--	--	--	--	
Aldrin	ug/L	0.003	0.003	1		0.003				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.003	--	--	--	--	--	--	--	--	--	--	
Alpha-BHC	ug/L	0.003	0.003	1		0.003				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.003	--	--	--	--	--	--	--	--	--	--	
Alpha-Endosulfan	ug/L	0.008	0.008	1		0.008				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.008	--	--	--	--	--	--	--	--	--	--	
Anthracene	ug/L	0.11	0.11	1		0.11				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.11	--	--	--	--	--	--	--	--	--	--	--	
Aroclor 1016 (PCB)	ug/L	0.03	0.03	1		0.03				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.03	--	--	--	--	--	--	--	--	--	--	
Aroclor 1221 (PCB)	ug/L	0.02	0.02	1		0.02				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.02	--	--	--	--	--	--	--	--	--	--	
Aroclor 1232 (PCB)	ug/L	0.06	0.06	1		0.06				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.06	--	--	--	--	--	--	--	--	--	--	
Aroclor 1242 (PCB)	ug/L	0.04	0.04	1		0.04				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.04	--	--	--	--	--	--	--	--	--	--	
Aroclor 1248 (PCB)	ug/L	0.07	0.07	1		0.07				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.07	--	--	--	--	--	--	--	--	--	--	
Aroclor 1254 (PCB)	ug/L	0.04	0.04	1		0.04				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.04	--	--	--	--	--	--	--	--	--	--	
Aroclor 1260 (PCB)	ug/L	0.03	0.03	1		0.03				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.03	--	--	--	--	--	--	--	--	--	--	
Azobenzene (1,2-Diphenylhydrazine)	ug/L	0.06	0.06	1		0.06				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.06	--	--	--	--	--	--	--	--	--	--	
Benzidine	ug/L	5	5	1		5				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5	--	--	--	--	--	--	--	--	--	--	
Benzo(a)anthracene	ug/L	0.14	0.14	1		0.14				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.14	--	--	--	--	--	--	--	--	--	--	--	
Benzo(b)fluoranthene	ug/L	0.14	0.14	1		0.14				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.14	--	--	--	--	--	--	--	--	--	--	--	
Benzo(g,h,i)perylene	ug/L	0.03	0.03	1		0.03				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.03	--	--	--	--	--	--	--	--	--	--	--	
Benzo(k)fluoranthene	ug/L	0.11	0.11	1		0.11				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.11	--	--	--	--	--	--	--	--	--	--	--	
Beta-BHC	ug/L	0.003	0.003	1		0.003				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.003	--	--	--	--	--	--	--	--	--	--	
Beta-Endosulfan	ug/L	0.007	0.007	1		0.007				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.007	--	--	--	--	--	--	--	--	--	--	
Bis-(2-chloroethoxy)methane	ug/L	0.05	0.05	1		0.05				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.05	--	--	--	--	--	--	--	--	--	--	
Bis-(2-Chloroethyl)ether	ug/L	0.09	0.09	1		0.09				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.09	--	--	--	--	--	--	--	--	--	--	
Bis-(2-Chloroisopropyl)ether	ug/L	0.05	0.05	1		0.05				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.05	--	--	--	--	--	--	--	--	--	--	
Bromodichloromethane	ug/L	2.71	2.71	1						--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2.71	--	--	--	--	--	--	--	--	--	--	
Bromoform	ug/L	0.07	0.07	1		0.07				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.07	--	--	--	--	--	--	--	--	--	--	
Bromomethane	ug/L	0.21	0.21	1		0.21				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.21	--	--	--	--	--	--	--	--	--	--	
Butylbenzyl Phthalate	ug/L	0.62	0.62	1						--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.62	--	--	--	--	--	--	--	--	--	--	
Calcium	mg/L	64.8	64.8	1	Sample from January 2005					--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	Jan 05=64.8
Chloroethane	ug/L	0.04	0.04	1		0.04				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.04	--	--	--	--	--	--	--	--	--	--	
Chloroform	ug/L	0.06	0.06	1		0.06				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.06	--	--	--	--	--	--	--	--	--	--	
Chloromethane	ug/L	0.16	0.16	1		0.16				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.16	--	--	--	--	--	--	--	--	--	--	
Chrysene	ug/L	0.12	0.12	1		0.12				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.12	--	--	--	--	--	--	--	--	--	--	--	
Cis-1,3-Dichloropropene	ug/L	0.07	0.07	1		0.07				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.07	--	--	--	--	--	--	--	--	--	--	
Delta-BHC	ug/L	0.003	0.003	1		0.003				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.003	--	--	--	--	--	--	--	--	--	--	
Demeton-O	ug/L	0.45	0.45	1	Sample from August 2007	0.45				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.45	--	--	--	--	--	--	--	
Demeton-S	ug/L	0.55	0.55	1	Sample from August 2007	0.55				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.55	--	--	--	--	--	--	--	
Dibenzo(a,h)anthracene	ug/L	0.02	0.02	1		0.02				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.02	--	--	--	--	--	--	--	--	--	--	--	
Dibromochloromethane	ug/L	4.58	4.58	1						--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	4.58	--	--	--	--	--	--	--	--	--	--	
Dieldrin	ug/L	0.005	0.005	1		0.005				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.005	--	--	--	--	--	--	--	--	--	--	
Diethylphthalate	ug/L	1.48	1.48	1						--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.48	--	--	--	--	--	--	--	--	--	--	
Dimethylphthalate	ug/L	0.27	0.27	1		0.27				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.27	--	--	--	--	--	--	--	--	--	--	
Di-N-butylphthalate	ug/L	0.7	0.7	1						--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.7	--	--	--	--	--	--	--	--	--	--	
Di-N-octylphthalate	ug/L	0.5	0.5	1		0.5				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.5	--	--	--	--	--	--	--	--	--	--	
Endosulfan II Sulfate	ug/L	0.002	0.002	1		0.002				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.002	--	--	--	--	--	--	--	--	--	--	
Endrin Aldehyde	ug/L	0.002	0.002	1		0.002				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.002	--	--	--	--	--	--	--	--	--	--	
Ethyl Parathion	ug/L	0.062	0.062	1	Sample from August 2007	0.062				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.062	--	--	--	--	--	--	--	
Fluoranthene	ug/L	0.02	0.02	1		0.02				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.02	--	--	--	--	--	--	--	--	--	--	--	
Gamma-bhc	ug/L	0.003	0.003	1		0.003				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.003	--	--	--	--	--	--	--	--	--	--	
Guthion	ug/L	0.85	0.85	1	Sample from August 2007	0.85				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.85	--	--	--	--	--	--	--	
Hexachlorobutadiene	ug/L	0.07	0.07	1		0.07				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.07	--	--	--	--	--	--	--	--	--	--	
Hexachloroethane	ug/L	0.07	0.07	1		0.07				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.07	--	--	--	--	--	--	--	--	--	--	
Indeno(1,2,3-CD)pyrene	ug/L	0.02	0.02	1		0.02				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.02	--	--	--	--	--	--	--	--	--	--	
Isophorone	ug/L	0.07	0.07	1		0.07				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.07	--	--	--	--	--	--	--	--	--	--	
Magnesium	ug/L	22200	22200	1	Sample fom January 2005					--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	Jan 05=22200
Malathion	ug/L	0.56	0.56	1	Sample from August 2007	0.56				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.56	--	--	--	--	--	--	--	
Mirex	ug/L	0.004	0.004	1	Sample from August 2007	0.004				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.004	--	--	--	--	--	--	--	
Nitrobenzene	ug/L	0.05	0.05	1		0.05				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.05	--	--	--	--	--	--	--	--	--	--	
N-Nitrosodiphenylamine	ug/L	0.09	0.09	1		0.09				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.09	--	--	--	--	--	--	--	--	--	--	
P,P-DDD	ug/L	0.004	0.004	1		0.004				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.004	--	--	--	--	--	--	--	--	--	--	
P,P-DDE	ug/L	0.004	0.004	1		0.004				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.004	--	--	--	--	--	--	--	--	--	--	
P,P-DDT	ug/L	0.003	0.003	1		0.003				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.003	--	--	--	--	--	--	--	--	--	--	
Phenanthrene	ug/L	0.01	0.01	1		0.01				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.01	--	--	--	--	--	--	--	--	--	--	--	
Phenol	ug/L	0.4	0.4	1		0.4				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.4	--	--	--	--	--	--	--	--	--	--	
Phosphate (Dissolved)	mg/L	3.66	3.05	12	Samples from September 2006					--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	12 Samples Sep 06=3.05
Phosphate (Total)	mg/L	8.18	6.54	12	Samples from September 2006					--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	12 Samples Sep 06=6.54
Potassium	mg/L	16.9	16.9	1	Sample from January 2005					--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	Jan 05=16.9
Pyrene	ug/L	0.02	0.02	1		0.02				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.02	--	--	--	--	--	--	--	--	--	--	--	
Sodium	mg/L	138	138	1	Sample from January 2005					--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	Jan 05=138
Sulfide (Dissolved)	mg/L	0.256	0.128	24						0.17	0.2325	0.092	0.13	0.1325	0.095	0.055	0.05	0.03	0.1775	0.24	0.256	0.1225	0.2075	0.162	0.105	0.132	0.1425	0.0325	0.062	0.0625	0.085	0.1475	0.1525	--	--	--	--	--	--	--	--	

Footnotes:
(shaded cell) Estimated value from a sample that was detected, but not quantifiable
Unless otherwise noted, summary values represent data from September 2007-August 2009
a. Per the 2008 CDPH draft groundwater recharge regulations, recycled water used for groundwater recharge must
b. Notification Levels are health-based advisory levels established by CDPH for chemicals in drinking water that lack
c. Surface water objectives (not applicable the proposed recharge project)/groundwater objectives - water used for
d. Surface water objectives - not applicable to the proposed groundwater recharge project.
e. This group contains priority pollutants and constituents of emerging concern that have no applicable limits for

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Attachment C
Secondary Effluent Water Quality Summary

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	Summary					Regulatory Requirements				Raw Data																																
										2009								2008												2007												
Pollutant	Units	Maximum	Monthly Average	No of Samples	Notes	Detection Level Range for ND Samples	MCL Requirements[a]	NLs[b]	Other Basin Plan Requirements[c]	Aug	Jul	Jun	May	Apr	Mar	Feb	Jan	Dec	Nov	Oct	Sep	Aug	Jul	Jun	May	Apr	Mar	Feb	Jan	Dec	Nov	Oct	Sep	Aug	Jul	Jun	May	Apr	Mar	Feb	Jan	Samples before Jan 2007
Inorganics																																										
Nitrate	mg/L	7.09	5.80	23	Peak Day-10, 696 samples		10			--	5.21	5.21	6.44	6.23	5.68	5.83	5.59	5.25	5.49	5.97	5.54	5.51	6.26	6.44	7.09	6.11	4.99	6.49	6.32	5.91	5.74	5.28	4.73	5.58	6.65	--	--	--	--	--	--	
Nitrite	mg/L	0.32	0.12	23	Peak Day-0.7, 696 samples		1			--	0.12	0.08	0.06	0.23	0.15	0.06	0.05	0.17	0.12	0.1	0.1	0.05	0.03	0.07	0.11	0.32	0.19	0.07	0.12	0.11	0.11	0.11	0.27	0.13	0.61	--	--	--	--	--	--	
Compounds with a MCL																																										
Iron	ug/L	80	80	1	Sample from September 2005		300			--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	Sep 05=80
Turbidity	NTU	3.5	2.3	22	Peak Day-5.8, 664 samples		5			--	--	3.1	3.3	1.5	1.4	2.3	2.7	1.7	1.4	1.4	1.4	1.7	2	2	2	2.5	2.7	2.9	3.2	3.5	3	2.4	2.9	2	2	--	--	--	--	--	--	Sep 06=0.53
Compounds with a Basin Plan																																										
Ammonia	mg/L	0.43	0.15	23	Peak Day-1.4, 696 samples				1.4[d]	--	0.2	0.18	0.01	0.23	0.2	0.22	0.11	0.22	0.19	0	0.06	0.05	0.04	0.03	0.08	0.43	0.19	0.03	0.21	0.11	0.08	0.25	0.42	0.08	0.61	--	--	--	--	--	--	
Other Compounds[e]																																										
Atenolol	ng/L	745	745	1						--	--	--	--	--	--	745	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
Atorvastalin	ng/L	90.5	90.5	1						--	--	--	--	--	--	90.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
Atrazine	ng/L	0.67	0.67	1						--	--	--	--	--	--	0.67	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
Benzophenone	ng/L	315	315	1						--	--	--	--	--	--	315	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
BHA	ng/L	61.5	61.5	1						--	--	--	--	--	--	61.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
Bisphenol A	ng/L	37	37	1						--	--	--	--	--	--	37	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
Caffeine	ng/L	5	5	1		5				--	--	--	--	--	--	5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
Carbamazepine	ng/L	140	140	1						--	--	--	--	--	--	140	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
DEET	ng/L	605	605	1						--	--	--	--	--	--	605	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
Diazepam	ng/L	3	3	1						--	--	--	--	--	--	3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
Diclofenac	ng/L	155	155	1						--	--	--	--	--	--	155	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
Dilantin	ng/L	145	145	1						--	--	--	--	--	--	145	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
Estradiol	ng/L	5	5	1		5				--	--	--	--	--	--	5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
Estrone	ng/L	3.1	3.1	1						--	--	--	--	--	--	3.1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
Ethynylestradiol	ng/L	1	1	1		1				--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
Fluoxetine	ng/L	52	52	1						--	--	--	--	--	--	52	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
Gemfibrozil	ng/L	500	500	1						--	--	--	--	--	--	500	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
Ibuprofen	ng/L	1.55	1.55	1						--	--	--	--	--	--	1.55	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
Iopromide	ng/L	645	645	1						--	--	--	--	--	--	645	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
Meprobamale	ng/L	675	675	1						--	--	--	--	--	--	675	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
Musk Ketone	ng/L	58.5	58.5	1						--	--	--	--	--	--	58.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
Naproxen	ng/L	43	43	1						--	--	--	--	--	--	43	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
Octylphenol	ng/L	34	34	1						--	--	--	--	--	--	34	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
Phosphate (Dissolved)	mg/L	0.18	0.10	12		0.1				0.18	0.14	0.06	0.01	0.05	0.1	0.1	0.1	0.1	0.1	0.1	0.1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
Phosphate (Total)	mg/L	0.36	0.24	12						0.36	0.295	0.24	0.26	0.26	0.14	0.27	0.22	0.24	0.14	0.2	0.225	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	Sep 06=0.29
Potassium	mg/L	14	14	1						--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	14	--	--	--	--	--	--	--	--	
Primidone	ng/L	180	180	1						--	--	--	--	--	--	180	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
Progesterone	ng/L	5	5	1		5				--	--	--	--	--	--	5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
Sulfamethoxazole	ng/L	2900	2900	1						--	--	--	--	--	--	2900	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
TCEP	ng/L	325	325	1						--	--	--	--	--	--	325	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
TCPP	ng/L	1200	1200	1						--	--	--	--	--	--	1200	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
Testosterone	ng/L	5	5	1		5				--	--	--	--	--	--	5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
Triclosan	ng/L	81	81	1						--	--	--	--	--	--	81	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
Trimethoprim	ng/L	715	715	1						--	--	--	--	--	--	715	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	

Footnotes

Unless otherwise noted, summary values represent data from September 2007-August 2009

a. Per the 2008 CDPH draft groundwater recharge regulations, recycled water used for groundwater recharge must meet MCLs, with the exception of the disinfection byproducts, which can be met after soil aquifer treatment; the Basin Plan also contains water quality objectives for groundwater based on MCLs and water used for recharge cannot cause or contribute to an exceedance of a groundwater quality objective.

b. Notification Levels are health-based advisory levels established by CDPH for chemicals in drinking water that lack MCLs. When chemicals are found in drinking water at concentrations greater than their NLs, certain requirements and recommendations apply. NLs are not applies as limits in IPR project permits.

c. Surface water objectives (not applicable the proposed recharge project)/groundwater objectives - water used for recharge cannot cause or contriubte to an excedance of a groundwater quality objective

d. This is the NPDES permit limit for DCT based on the Basin Plan surface water quality objectives and the Los Angeles River Nitrogen TMDL Waste Load Allocations

e. This group contains priority pollutants and constituents of emerging concern that have no applicable limits for groundwater recharge project.

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Attachment D
Tertiary Effluent Water Quality Summary

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	Summary					Regulatory Requirements				Raw Data																																
										2009								2008												2007												
Pollutant	Units	Maximum	Monthly Average	No of Samples	Notes	Detection Level Range for ND Samples	MCL Requirements[a]	NLs[b]	Other Basin Plan Requirements[c]	Aug	Jul	Jun	May	Apr	Mar	Feb	Jan	Dec	Nov	Oct	Sep	Aug	Jul	Jun	May	Apr	Mar	Feb	Jan	Dec	Nov	Oct	Sep	Aug	Jul	Jun	May	Apr	Mar	Feb	Jan	Samples before Jan 2007
Inorganics																																										
Aluminum	ug/L	165	59	5			200			--	--	--	--	--	--	26	--	--	32	--	--	39	--	--	32	--	--	165	--	--	--	--	--	--	--	--	--	--	--	--	--	
Antimony	ug/L	1.12	0.73	7			6			--	--	--	0.65	--	--	0.5	--	--	0.58	--	--	0.97	--	--	1.12	--	--	0.59	--	--	0.69	--	--	1.15	--	--	0.47	--	0.43	0.76	--	
Arsenic	ug/L	4.1	2.31	6			10			--	--	--	--	--	--	1.78	--	--	1.8	--	--	3.4	--	--	4.1	--	--	1.8	--	--	1	--	--	1.1	--	--	2.8	--	1.7	--	--	Monthly from Jan-May 05, Ave=2.8
Asbestos	MFL	0.2	0.2	5		0.2	7			--	--	--	--	--	--	0.2	--	--	0.2	--	--	0.2	--	--	0.2	--	--	0.2	--	--	--	--	--	--	--	--	--	--	--	--	--	
Barium	ug/L	23.3	20.8	6			1000			--	--	--	--	--	--	18.9	--	--	23.3	--	--	21	--	--	18	--	--	20.3	--	--	23	--	--	20	--	--	21	--	19.9	18	--	
Beryllium	ug/L	0.3	0.3	7		0.2-0.4	4			--	--	--	0.2	--	--	0.3	--	--	0.3	--	--	0.3	--	--	0.3	--	--	0.3	--	--	0.3	--	--	0.35	--	--	0.3	--	0.3	0.4	--	
Cadmium	ug/L	0.7	0.3	12		0.2-0.55	5			--	--	0.4	0.7	0.55	0.4	0.21	0.4	0.45	0.2	--	--	0.05	--	--	0.2	--	--	0.27	--	--	0.21	--	--	0.53	--	--	0.08	--	0.33	--	--	
Chromium (VI)	ug/L	0.5	0.4	2		0.5-0.21				--	--	--	--	--	--	0.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.21	--	--	0.21	--	--	0.21	--	0.21	--	--	
Chromium Total	ug/L	2.0	1.0	7			50			--	--	--	0.8	--	--	0.7	--	--	0.5	--	--	0.8	--	--	0.83	--	--	1.95	--	--	1.27	--	--	0.7	--	--	1.08	--	3.8	0.99	1.02	
Copper	ug/L	22.5	13.7	23			1300			--	11.4	15.4	9.3	11.75	10.8	11.65	18	13.95	12.3	13.7	15.3	17.1	11.7	17	15.5	15	12	12.8	14	14	22.5	11	10	13.7	17	16	15	19	30.3	--	--	
Cyanide	ug/L	6	4	23		4	150			--	4	4	6	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	
Fluoride	mg/L	1.1	0.8	23			2			--	0.7	0.9	0.8	0.8	0.7	0.6	0.6	0.8	0.7	0.9	0.7	0.9	0.8	0.7	0.9	0.8	0.7	0.7	0.8	0.87	1.09	0.74	0.69	0.83	0.25	0.25	0.59	0.89	1.14	--	--	
Lead	ug/L	2	2	23		1.1-2.0	15			--	2	2	2	2	2	1.165	2	2	0.52	2	2	0.68	2	2	1.12	1.5	1.1	0.95	1.1	1.5	1.42	1.1	1.1	1.15	1.1	1.1	0.68	1.1	0.8	2.8	1.1	
Mercury	ug/L	0.055	0.009	23		0.004-0.0055	2			--	0.004	0.004	0.004	0.0365	0.004	0.0055	0.004	0.004	0.004	0.004	0.004	0.055	0.004	0.005	0.004	0.004	0.004	0.032	0.008	0.004	0.004	0.004	0.004	0.01	0.004	0.027	0.006	1.82	0.011	0.007	0.016	
Nickel	ug/L	20	5.7	8			100			--	--	--	3.4	--	--	3.6	--	3.7	4.4	--	--	3.7	--	--	3.2	--	--	20	--	--	3.4	--	--	4.1	--	--	3.7	--	4.3	4.2	6.49	
Nitrate	mg/L	7.2	5.8	24			10			5.1	4.8	5.8	6.8	6.4	5.7	5.8	5.5	5.4	6.8	5.3	5.6	6.3	5.6	7.2	6.6	5.0	5.7	6.2	7.2	5.74	5.72	5.58	4.66	5.57	0.47	0.49	0.35	0.61	0.59	0.59	0.61	
Nitrite	mg/L	0.27	0.06	24		0.02-0.05	1			0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.27	0.05	0.05	0.05	0.05	0.05	0.27	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.68	0.05	0.87	0.05	0.07	0.06	--	
Total Nitrate/Nitrite (as N)	mg/L	12.6	9.2	23			10			--	8.6	12.6	8.7	9.1	8.5	9.2	9.4	8.50	9.30	8.30	9.30	9.20	8.70	10.10	9.70	8.00	8.60	9.30	10.50	9.7	10	8.7	7.5	7.5	21.8	19.9	22.4	19.4	27.5	26.4	28.8	
Selenium	ug/L	1.8	0.70	23			50			--	0.48	0.59	0.42	0.785	0.82	1.075	0.45	0.65	0.6	0.6	0.6	0.6	0.6	0.8	0.5	1	1.2	1.8	0.7	0.4	0.3	0.8	0.3	0.3	0.4	0.2	0.4	0.4	0.1	0.6	0.4	
Thallium	ug/L	0.07	0.03	7		0.01	6.3	2		--	--	--	0.01	--	--	0.06	--	--	0.04	--	--	0.01	--	--	0.02	--	--	0.02	--	--	0.07	--	--	0.85	--	--	0.04	--	0.05	0.02	--	
Radionuclides																																										
Uranium	ug/L				No Sample		20			--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
Combined radium-226 & 228	pCI/L				No Sample		5			--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
Alpha Radioactivity	pCi/L	5.6	2.6	3			15			--	--	--	--	--	--	1.2	--	--	--	--	--	1.08	--	--	--	--	--	5.62	--	--	--	--	--	1.49	--	--	--	--	--	--	--	
Beta Radioactivity	pCi/L	15.8	9.5	3			4 millirem/yr			--	--	--	--	--	--	4.2	--	--	--	--	--	8.57	--	--	--	--	--	15.8	--	--	--	--	--	5.99	--	--	--	--	--	--	--	
Strontium	pCi/L				No Sample		8			--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
Tritium	pCi/L				No Sample		20000			--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
VOCs																																										
Benzene	ug/L	0.09	0.08	7		0.07-0.09	1			--	--	--	0.09	--	--	0.09	--	--	0.09	--	--	0.09	--	--	0.07	--	--	0.07	--	--	0.07	--	--	0.07	--	--	0.07	--	--	0.07	--	
Carbon Tetrachloride	ug/L	0.1	0.1	7		0.09-0.1	0.5			--	--	--	0.1	--	--	0.1	--	--	0.1	--	--	0.1	--	--	0.09	--	--	0.09	--	--	0.09	--	--	0.09	--	--	0.09	--	--	0.09	--	
1,2-Dichlorobenzene	ug/L	0.17	0.09	6		0.06-0.17	600			--	--	--	--	--	--	0.17	--	--	0.07	--	--	0.07	--	--	0.07	--	--	0.07	--	--	0.06	--	--	0.06	--	--	0.06	--	--	--	--	
1,4-Dichlorobenzene	ug/L	0.17	0.11	6		0.07-0.17	5			--	--	--	--	--	--	0.17	--	--	0.11	--	--	0.11	--	--	0.11	--	--	0.11	--	--	0.07	--	--	0.07	--	--	0.07	--	--	--	--	
1,1-Dichloroethane	ug/L	0.12	0.11	7		0.11-0.12	5			--	--	--	0.11	--	--	0.11	--	--	0.11	--	--	0.11	--	--	0.11	--	--	0.12	--	--	0.12	--	--	0.12	--	--	0.12	--	--	0.12	--	
1,2-Dichloroethane	ug/L	0.1	0.09	7		0.08-0.10	0.5			--	--	--	0.08	--	--	0.08	--	--	0.08	--	--	0.08	--	--	0.1	--	--	0.1	--	--	0.1	--	--	0.1	--	--	0.1	--	--	0.1	--	
1,1-Dichloroethylene	ug/L	0.19	0.16	7		0.12	6			--	--	--	0.19	--	--	0.19	--	--	0.19	--	--	0.19	--	--	0.12	--	--	0.12	--	--	0.12	--	--	0.12	--	--	0.12	--	--	0.12	--	
Cis-1,2-Dichloroethene	ug/L	0.08	0.08	4		0.08	6			--	--	--	--	--	--	--	--	--	0.08	--	--	0.08	--	--	0.08	--	--	0.08	--	--	--	--	--	--	--	--	--	--	--	--	--	
Trans-1,2-Dichloroethene	ug/L	0.15	0.12	7		0.07-0.15	10			--	--	--	0.15	--	--	0.15	--	--	0.15	--	--	0.15	--	--	0.07	--	--	0.07	--	--	0.07	--	--	0.07	--	--	0.07	--	--	0.07	--	
Dichloromethane	ug/L	0.15	0.11	7		0.09-0.12	5			--	--	--	0.09	--	--	0.09	--	--	0.09	--	--	0.15	--	--	0.12	--	--	0.12	--	--	0.12	--	--	0.12	--	--	0.91	--	--	0.12	--	
1,3-Dichloropropylene	ug/L	0	0	1						--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0	--	--	0	--	--	0	--	--	0	--	
1,2-Dichloropropane	ug/L	0.12	0.11	7		0.10-0.12	5			--	--	--	0.12	--	--	0.12	--	--	0.12	--	--	0.12	--	--	0.1	--	--	0.1	--	--	0.1	--	--	0.1	--	--	0.1	--	--	0.1	--	
Ethylbenzene	ug/L	0.17	0.13	7		0.08-0.17	300			--	--	--	0.17	--	--	0.17	--	--	0.17	--	--	0.17	--	--	0.08	--	--	0.08	--	--	0.08	--	--	0.08	--	--	0.08	--	--	0.08	--	
MTBE	ug/L	1.1	0.27	5		0.06-1.10	5			--	--	--	--	--	--	1.1	--	--	0.06	--	--	0.06	--	--	0.06	--	--	0.06	--	--	--	--	--	0.08	--	--	--	--	--	0.08	--	
Monochlorobenzene	ug/L	0.12	0.09	7		0.60-0.12	70			--	--	--	0.12	--	--	0.12	--	--	0.12	--	--	0.12	--	--	0.06	--	--	0.06	--	--	0.06	--	--	0.06	--	--	0.06	--	--	0.06	--	
Styrene	ug/L	0.16	0.16	5		0.16	100			--	--	--	--	--	--	0.16	--	--	0.16	--	--	0.16	--	--	0.16	--	--	0.16	--	--	--	--	--	--	--	--	--	--	--	--	--	
1,1,2,2-Tetrachloroethane	ug/L	0.12	0.12	7		0.11-0.12	1			--	--	--	0.12	--	--	0.12	--	--	0.12	--	--	0.12	--	--	0.11	--	--	0.11	--	--	0.11	--	--	0.11	--	--	0.11	--	--	0.11	--	
Tetrachloroethylene	ug/L	0.1	0.1	4		0.1	5	same		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	--	
Tetrachloroethene	ug/L	1.92	0.24	23		0.10-0.31	5	same		--	0.31	0.22	1.92	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	--	
Toluene	ug/L	0.14	0.11	7		0.06-0.14	150			--	--	--	0.14	--	--	0.14	--	--	0.14	--	--	0.14	--	--	0.06	--	--	0.06	--	--	0.06	--	--	0.06	--	--	0.06	--	--	0.11	--	
1,2,4-Trichlorobenzene	ug/L	0.19	0.12	6		0.08-0.19	5			--	--	--	--	--	--	0.19	--	--	0.11	--	--	0.11	--	--	0.11	--	--	0.11	--	--	0.08	--	--	0.08	--	--	0.08	--	--	--	--	
1,1,1-Trichloroethane	ug/L	0.23	0.18	7		0.05-0.23	200			--	--	--	0.23	--	--	0.23	--	--	0.23	--	--	0.23	--	--	0.23	--	--	0.05	--	--	0.05	--	--	0.05	--	--	0.05	--	--	0.05	--	
1,1,2-Trichloroethane	ug/L	0.1	0.1	7		0.05-0.10	5			--	--	--	0.1	--	--	0.1	--	--	0.1	--	--	0.1	--	--	0.05	--	--	0.05	--	--	0.05	--	--	0.05	--	--	0.05	--	--	0.05	--	
Trichloroethene	ug/L	0.17	0.13	7		0.08-0.17	5	same		--	--	--	0.17	--	--	0.17	--	--	0.17	--	--	0.17	--	--	0.08	--	--	0.08	--	--	0.08	--	--	0.08	--	--	0.08	--	--	0.08	--	
Trichloroethylene	ug/L	0.08	0.08	1		0.08	5	same		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.08	--	--	0.08	--	--	0.08	--	--	0.08	--	
Trichlorofluoromethane	ug/L	0.2	0.1	5		0.1-0.2	150			--	--	--	--	--	--	0.2	--	--	0.1	--	--	0.1	--	--	0.1	--	--	0.1	--	--	--	--	--	--	--	--	--	--	--	--	--	
1,1,2-Trichloro-1,2,2-Trifluoroethane	ug/L	1.6	0.39	5		0.09-1.60	1200			--	--	--	--	--	--	1.6	--	--	0.09	--	--	0.09	--	--	0.09	--	--	0.09	--	--	--	--	--	--	--	--	--	--	--	--	--	
Vinyl Chloride	ug/L	0.22	0.16	7		0.07-0.22	0.5			--	--	--	0.22	--	--	0.22	--	--	0.22	--	--	0.22	--	--	0.07	--	--	0.07	--	--	0.07	--	--	0.07	--	--	0.07	--	--	0.07	--	
Xylene	ug/L	0.37	0.31	5		0.29-0.37	1750			--	--	--	--	--	--	0.37	--	--	0.29	--	--	0.29	--	--	0.29	--	--	0.29	--	--	--	--	--	--	--	--	--	--	--	--	--	
SOCs																																										
Alachlor	ug/L	0.07	0.07	5		0.07	2			--	--	--	--	--	--	0.07	--	--	0.07	--	--	0.07	--	--	0.07	--	--	0.07	--	--	--	--	--	--	--	--	--	--	--	--	--	
Atrazine (EDC and PPCP)	ng/L	0.31	0.31	1			1000			--	--	--	--	--	--	0.31	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
Atrazine (WDR)	ug/L	0.047	0.047	5		0.047	1			--	--	--	--	--	--	0.047	--	--	0.047	--	--	0.047	--	--	0.047	--	--	0.047	--	--	--	--	--	--	--	--	--	--	--	--	--	
Bentazon	ug/L	0.23	0.23	5		0.23	18			--	--	--	--	--	--	0.23	--	--	0.23	--	--	0.23	--	--	0.23	--	--	0.23	--	--	--	--	--	--	--	--	--	--	--	--	--	
Benzo(a)pyrene	ug/L	0.13	0.083	6		0.057-0.130	0.2			--	--	--	--	--	--	0.073	--	--	0.073	--	--	0.073	--	--	0.073	--	--	0.073	--	--	0.13	--	--	0.13	--	--	0.0057	--	--	--	--	
Carbofuran	ug/L	0.63	0.63	5		0.63	18			--	--	--	--	--	--	0.63	--	--	0.63	--	--	0.63	--	--	0.63	--	--	0.63	--	--	--	--	--	--	--	--	--	--	--	--	--	
Chlordane	ug/L	0.045	0.04	6		0.020-0.045	0.1			--	--	--	--	--	--	0.045	--	--	0.045	--	--	0.045	--	--	0.045	--	--	0.045	--	--	0.02	--	--	0.02	--	--	0.04	--	--	--	--	
Dalapon	ug/L	0.45	0.12	5		0.04	200			--	--	--	--	--	--	0.04	--	--	0.04	--	--	0.04	--	--	0.04	--	--	0.45	--	--	--	--	--	--	--	--	--	--	--	--	--	
Dibromochloropropane	ug/L	0.003	0.003	5		0.003	0.2			--	--	--	--	--	--	0.003	--	--	0.003	--	--	0.003	--	--	0.003	--	--	0.003	--	--	--	--	--	--	--	--	--	--	--	--	--	
Di-(2-ethylhexyl)adipate	ug/L	0.28	0.24	5		0.023	400			--	--	--	--	--	--	0.23	--	--	0.23	--	--	0.23	--	--	0.23	--	--	0.28	--	--	--	--	--	--	--	--	--	--	--	--	--	
Di-(2-Ethylhexyl)phthalate	ug/L	2.3	1.0	9		0.51-1.1	4			--	--	--	--	--	--	1.1	--	--	0.51	--	0.71	--	--	--	2.3	--	--	0.51	--	1	1	1	1	1	1	1	1	1	1	1	--	
2,4-D	ug/L	0.05	0.05	5		0.05-0.80	70			--	--	--	--	--	--	0.05	--	--	0.05	--	--	0.05	--	--	0.05	--	--	0.05	--	--	--	--	--	0.8	--	--	--	--	--	--	--	
Dinoseb	ug/L	0.05	0.05	5		0.05	7			--	--	--	--	--	--	0.05	--	--	0.05	--	--	0.05	--	--	0.05	--	--	0.05	--	--	--	--	--	--	--	--	--	--	--	--	--	
Diquat	ug/L	0.9	0.6	5		0.90-0.21	20			--	--	--	--	--	--	0.9	--	--	0.9	--	--	0.9	--	--	0.21	--	--	0.21	--	--	--	--	--	--	--	--	--	--	--	--	--	
Endothall	ug/L	5.6	4.3	5		3.5-5.6	100			--	--	--	--	--	--	3.5	--	--	3.5	--	--	3.5	--	--	5.6	--	--	5.6	--	--	--	--	--	--	--	--	--	--	--	--	--	
Endrin	ug/L	0.005	0.005	6		0.005	2			--	--	--	--	--	--	0.005	--	--	0.005	--	--	0.005	--	--	0.005	--	--	0.005	--	--	0.005	--	--	0.005	--	--	0.005	--	--	--	--	
Ethylene Dibromide	ug/L	0.007	0.006	5		0.0049-0.0070	0.5			--	--	--	--	--	--	0.0049	--	--	0.0049	--	--	0.007	--	--	0.007	--	--	0.007	--	--	--	--	--	--	--	--	--	--	--	--	--	
Glyphosate	ug/L	1.8	1.8	5		1.8	700			--	--	--	--	--	--	1.8	--	--	1.8	--	--	1.8	--	--	1.8	--	--	1.8	--	--	--	--	--	--	--	--	--	--	--	--	--	
Heptachlor	ug/L	0.0052	0.0048	6		0.0010-0.0052	0.1			--	--	--	--	--	--	0.0052	--	--	0.0052	--	--	0.0052	--	--	0.0052	--	--	0.0052	--	--	0.003	--	--	0.003	--	--	0.001	--	--	--	--	
Heptachlor Epoxide	ug/L	0.0058	0.0053	6		0.0010-0.0058	0.1			--	--	--	--	--	--	0.0058	--	--	0.0058	--	--	0.0058	--	--	0.0058	--	--	0.0058	--	--	0.003	--	--	0.003	--	--	0.001	--	--	--	--	
Hexachlorobenzene	ug/L	0.07	0.015	6		0.002-0.070	1			--	--	--	--	--	--	0.002	--	--	0.002	--	--	0.005	--	--	0.005	--	--	0.005	--	--	0.07	--	--	0.07	--	--	0.07	--	--	--	--	
Hexachlorocyclopentadiene	ug/L	2.9	0.50	6		0.016-2.900	50			--	--	--	--	--	--	0.016	--	--	0.016	--	--	0.019	--	--	0.019	--	--	0.019	--	--	2.9	--	--	2.9	--	--	2.9	--	--	--	--	
Lindane	ug/L	0.005	0.004	9		0.002-0.005	0.2			--	--	--	--	--	--	0.005	--	--	0.005	--	--	0.005	--	--	0.005	--	--	0.005	--	0.003	0.003	0.003	0.003	0.003	0.002	0.003	0.002	0.002	0.003	--	--	
Methoxychlor	ug/L	0.0064	0.0064	5		0.0030-0.0064	30			--	--	--	--	--	--	0.0064	--	--	0.0064	--	--	0.0064	--	--	0.0064	--	--	0.0064	--	--	--	--	--	0.003	--	--	--	--	--	--	--	
Molinate	ug/L	0.051	0.051	5		0.051	20			--	--	--	--	--	--	0.051	--	--	0.051	--	--	0.051	--	--	0.051	--	--	0.051	--	--	--	--	--	--	--	--	--	--	--	--	--	
Oxamyl	ug/L	1.8	0.82	5		0.57	50			--	--	--	--	--	--	0.57	--	--	1.8	--	--	0.57	--	--	0.57	--	--	0.57	--	--	--	--	--	--	--	--	--	--	--	--	--	
Pentachlorophenol	ug/L	0.4	0.08	6		0.2-0.4	1			--	--	--	--	--	--	0.02	--	--	0.02	--	--	0.02	--	--	0.02	--	--	0.02	--	--	0.4	--	--	0.4	--	--	0.4	--	--	--	--	
Picloram	ug/L	0.34	0.34	5		0.34	500			--	--	--	--	--	--	0.34	--	--	0.34	--	--	0.34	--	--	0.34	--	--	0.34	--	--	--	--	--	--	--	--	--	--	--	--	--	
Polychlorinated Biphenyls	ug/L	0	0.00	1			0.5			--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0	--	--	0	--	--	0	--	--	--	--	
Simazine	ug/L	0.083	0.083	5		0.083	4			--	--	--	--	--	--	0.083	--	--	0.083	--	--	0.083	--	--	0.083	--	--	0.083	--	--	--	--	--	--	--	--	--	--	--	--	--	
Thiobencarb	ug/L	0.11	0.11	5		0.11	1			--	--	--	--	--	--	0.11	--	--	0.11	--	--	0.11	--	--	0.11	--	--	0.11	--	--	--	--	--	--	--	--	--	--	--	--	--	

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Pollutant	Units	Maximum	Monthly Average	No of Samples	Notes	Detection Level Range for ND Samples	MCL Requirements[a]	NLs[b]	Other Basin Plan Requiremets[c]	Samples before Jan 2007
Toxaphene	ug/L	0.031	0.03	6		0.031-0.100	3			
2,3,7,8-TCDD (Dioxin)	pg/L	0	0	5			30			
2,4,5-TP (Silvex)	ug/L	0.02	0.02	5		0.02-0.34	50			
Disinfection Byproducts										
Total Trihalomethanes (TTHM)	ug/L	32.6	19.5	5			80			
Total Haloacetic Acids (HAA5)	ug/L	23.2	20.6	5			60			
Bromate	ug/L				No Sample		10			
Chlorite	ug/L				No Sample		1,000			
Drinking Water Standard - Treatment Technique										
Acrylamide					No Sample					
Epichlorohydrin					No Sample					
Compounds with a MCL										
Chloride	mg/L	156	134	23			250-600		190/50-150	
Iron	ug/L	247	84	6			300			
Manganese	ug/L	37.2	23.3	6			50	500		
MBAS	mg/L	12.2	0.8	17			0.5			
Odor	T.O.N.	400	164	4			3			
Perchlorate	ug/L	0.82	0.57	3		0.30-0.82	6			
Silver	ug/L	0.2	0.11	8		0.08	100			
Sulfate	mg/L	162	118	23			250-600		300/50-300	Monthly from Jan 05, Ave=134
TDS	mg/L	734	583	23			500-1,500		900/400-900	
Trans-1,3-Dichloropropene	ug/L	0.17	0.11	6		0.06-0.17	0.5			
Turbidity	NTU	1.1	0.7	22	Peak Day-2.1, 664 samples		5			
Zinc	ug/L	135	69.8	12			1500			
Compounds with a Notification Level										
Boron	mg/L	0.8	0.5	23				1	1.5	
Carbon Disulfide	ug/L	0.23	0.15	6		0.09-0.10		160		
Chlorate	ug/L	490	303	3				800		
2-Chlorotoluene	ug/L	0.18	0.13	6		0.11-0.18		140		
4-Chlorotoluene	ug/L	0.17	0.12	6		0.10-0.17		140		
Dichlorodifluoromethane	ug/L	0.26	0.15	6				1000		
1,4-Dioxane[f]	ug/L	1.469	1.152	3				3		
Ethylene Glycol	mg/L	1	1	3		1-4		14		
Formaldehyde	ug/L	12	9.6	2		7.2		100		
Isopropylbenzene	ug/L	0.17	0.14	6		0.13-0.17		770		
Naphthalene	ug/L	0.21	0.12	6		0.07-0.21		17		
N-Butylbenzene	ug/L	0.16	0.16	6		0.15-0.16		260		
N-Nitrosodiethylamine	ug/L	1.2	0.3	4				0.1		
N-Nitrosodimethylamine (NDMA)[f]	ug/L	0.26	0.18	4				0.1		
N-Nitroso-Di-N-Propylamine	ug/L	0.41	0.36	6		0.13-0.41		0.1		
N-Propylbenzene	ug/L	0.15	0.13	6		0.12-0.15		260		
SEC-Butylbenzene	ug/L	0.15	0.15	6		0.15		260		
Tert-Butylbenze	ug/L	0.14	0.13	6		0.13-0.14		260		
1,2,3-Trichloropropane	ug/L	0.007	0.005	3		0.0015-0.230		0.005		
1,2,4-Trimethylbenzene	ug/L	0.19	0.13	6		0.10-0.19		330		
1,3,5-Trimethylbenzene	ug/L	0.15	0.13	6		0.12-0.15		330		
Vanadium	ug/L	1.56	1.15	3				50		
Compounds with Federal Technology Based Standards										
BOD5	mg/L	3	3	23	Peak Day-7, 683 samples	3			20	
TSS	mg/L	1	1	24	Peak Day-2.1, 683 samples	1				
Compounds with a Basin Plan Limit										
Ammonia	mg/L	1.4	1.2	22					1.4[d]	
Chlorine (Free)	mg/L	0.3	0.15	24	Peak Day 6.1, 689 samples				0.1[e]	
pH	(unitless)	7.4	7.3	24	Peak Day-7.7, 683 samples				6.5-8.5[e]	
Temperature	F	84	77	24	Peak Day-86, 710 samples				86[e]	
Total Coliform	Daily Max (CFU/100mL)	2	1	23		1			1.1/2.2[f]	
Other Compounds[g]										
Acenaphthene	ug/L	0.31	0.28	6		0.10-0.31				
Acenaphthylene	ug/L	0.26	0.24	6		0.086-0.260				
Acetominophen	ng/L	25	25	1	Sample from April 207	25				
Acrolein	ug/L	1.96	1.19	7		0.61-1.96				
Acrylonitrile	ug/L	0.17	0.13	7		0.08-0.17				
Aldrin	ug/L	0.0037	0.0036	6		0.0010-0.0037				
Alkalinity	mg/L	110	110	1						Jul 05=170, May 05=228
Alkalinity Bicarbonate as HCO3	mg/L	130	130	1						
Alkalinity Carbonate as CaCO3	mgL	0	0	1						
Alkalinity Hydroxide as CaCO3	mg/L	0	0	1						
Alpha-BHC	ug/L	0.0053	0.00	6		0.0010.0053				
Alpha-Endosulfan	ug/L	0.008	0.008	1		0.001-0.008				
17-alpha-ethynylestradiol	ng/L	2	2.00	1	Sample from April 2007	2				
Ammonia (as N)	mg/L	0.12	0.12	1						
Anthracene	ug/L	0.28	0.25	6		0.0029-0.28				
Aroclor 1016 (PCB)	ug/L	0.097	0.074	6		0.006-0.097				
Aroclor 1221 (PCB)	ug/L	0.084	0.073	6		0.02-0.084				
Aroclor 1232 (PCB)	ug/L	0.064	0.063	6		0.06-0.10				
Aroclor 1242 (PCB)	ug/L	0.07	0.07	6		0.04-0.20				
Aroclor 1248 (PCB)	ug/L	0.070	0.053	6		0.049-0.070				
Aroclor 1254 (PCB)	ug/L	0.068	0.063	6		0.02-0.068				
Aroclor 1260 (PCB)	ug/L	0.069	0.063	6		0.03-0.07				
Atenolol	ng/L	550	550	1						
Atorvastalin	ng/L	5	5	1		5				
Azobenzene (1,2-Diphenylhydrazine)	ug/L	0.3	0.3	6		0.06-0.30				
Benzidine	ug/L	5	3.5	6		3.2-5				
Benzo(a)anthracene	ug/L	0.19	0.18	6		0.0048-0.1900				
Benzo(b)fluoranthene	ug/L	0.24	0.17	6		0.0049-0.1600				

Raw Data

Pollutant	2009 Aug	2009 Jul	2009 Jun	2009 May	2009 Apr	2009 Mar	2009 Feb	2009 Jan	2008 Dec	2008 Nov	2008 Oct	2008 Sep	2008 Aug	2008 Jul	2008 Jun	2008 May	2008 Apr	2008 Mar	2008 Feb	2008 Jan	2007 Dec	2007 Nov	2007 Oct	2007 Sep	2007 Aug	2007 Jul	2007 Jun	2007 May	2007 Apr	2007 Mar	2007 Feb	2007 Jan
Toxaphene	--	--	--	--	--	--	0.031	--	--	0.031	--	--	0.031	--	--	0.031	--	--	0.031	--	--	0.02	--	--	0.02	--	--	0.1	--	--	--	--
2,3,7,8-TCDD (Dioxin)	--	--	--	--	--	--	--	--	--	0	--	--	0	--	--	0	--	--	0	--	--	0	--	--	0	--	--	--	--	--	--	--
2,4,5-TP (Silvex)	--	--	--	--	--	--	0.02	--	--	0.02	--	--	0.02	--	--	0.02	--	--	0.02	--	--	--	--	--	0.34	--	--	--	--	--	--	--
Disinfection Byproducts																																
Total Trihalomethanes (TTHM)	--	--	--	--	--	--	32.6	--	--	19.98	--	--	18.7	--	--	13.1	--	--	13	--	--	--	--	--	--	--	--	--	--	--	--	--
Total Haloacetic Acids (HAA5)	--	--	--	--	--	--	23.2	--	--	20	--	--	20.3	--	--	19.9	--	--	19.7	--	--	--	--	--	--	--	--	--	--	--	--	--
Bromate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chlorite	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Drinking Water Standard - Treatment Technique																																
Acrylamide	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Epichlorohydrin	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Compounds with a MCL																																
Chloride	--	147	123	156	150.5	117.5	111	144	138	148	138	136	125	133	131	118	140	145	132	127	133	136	135	120	129	123	150	123	112	136	--	--
Iron	--	--	--	--	--	--	41	--	--	47	--	--	60	--	--	50	--	--	247	--	--	59	--	--	114	--	--	53	--	50	57	59
Manganese	--	--	--	--	--	--	14.6	--	--	13.9	--	--	35.2	--	--	18.6	--	--	37.2	--	--	20.4	--	--	29.6	--	--	27.7	--	21.0	--	--
MBAS	--	--	--	--	--	--	12.2	--	0.03	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.11	0.15	0.07	0.12	0.14	0.17	0.1	0.06	0.11	0.13	0.18	0.15	0.16	0.15	--	--
Odor	--	--	--	--	--	--	--	--	--	40	--	--	400	--	--	200	--	--	17	--	--	--	--	--	--	--	--	--	--	--	--	--
Perchlorate	--	--	--	--	--	--	0.82	--	--	--	--	--	0.45	--	--	--	--	--	0.45	--	--	--	--	--	0.3	--	--	--	--	0.3	--	--
Silver	--	--	--	0.08	--	--	0.12	--	--	0.08	--	--	0.08	--	--	0.08	--	0.08	0.2	--	--	0.14	--	--	0.2	--	--	0.2	--	0.36	0.58	0.57
Sulfate	--	111	117	130	127	116	122	116	113	117	110	109	112	112	140	115	134	154	162	108	102	96	99	99	103	108	133	115	113	118	102	90.1
TDS	--	584	546	612	592	601	522	554	578	570	590	588	544	556	610	550	630	583	734	590	543	574	598	566	614	566	626	618	524	544	--	--
Trans-1,3-Dichloropropene	--	--	--	--	--	--	0.17	--	--	0.1	--	--	0.1	--	--	0.1	--	--	0.1	--	--	0.06	--	--	0.06	--	--	0.06	--	--	0.06	--
Turbidity	--	--	0.6	0.7	0.7	0.6	0.8	1.1	0.6	0.5	0.5	0.5	0.6	0.7	0.6	0.7	0.6	0.6	0.6	0.7	1	1.1	0.7	0.8	0.7	0.8	--	--	--	--	--	--
Zinc	--	--	63	60.5	66.5	64	60.65	135	66	55.6	--	--	58.5	--	--	69.7	--	--	70.2	--	--	67.7	--	--	80	--	--	67	--	57.1	57	51
Compounds with a Notification Level																																
Boron	--	0.5	0.6	0.4	0.4	0.6	0.4	0.7	0.5	0.1	0.4	0.4	0.5	0.5	0.5	0.8	0.5	0.6	0.7	0.5	0.5	0.5	0.6	0.4	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.9
Carbon Disulfide	--	--	--	--	--	--	0.21	--	--	0.12	--	--	0.12	--	--	0.12	--	--	0.12	--	--	0.23	--	--	0.12	--	--	0.12	--	0.12	--	--
Chlorate	--	--	--	--	--	--	210	--	--	--	--	--	490	--	--	--	--	--	210	--	--	--	--	--	820	--	--	--	--	230	--	--
2-Chlorotoluene	--	--	--	--	--	--	0.18	--	--	0.11	--	--	0.11	--	--	0.11	--	--	0.11	--	--	0.18	--	--	0.11	--	--	0.11	--	0.11	--	--
4-Chlorotoluene	--	--	--	--	--	--	0.17	--	--	0.1	--	--	0.1	--	--	0.1	--	--	0.1	--	--	0.17	--	--	0.1	--	--	0.1	--	0.1	--	--
Dichlorodifluoromethane	--	--	--	--	--	--	0.26	--	--	0.09	--	--	0.09	--	--	0.09	--	--	0.09	--	--	0.26	--	--	0.09	--	--	0.09	--	0.09	--	--
1,4-Dioxane[f]	--	--	--	--	--	--	1.469	--	--	--	--	--	1.111	--	--	--	--	--	0.875	--	--	--	--	--	1.4	--	--	--	--	1.7	--	--
Ethylene Glycol	--	--	--	--	--	--	1	--	--	--	--	--	1	--	--	--	--	--	1	--	--	--	--	--	4	--	--	--	--	48	--	--
Formaldehyde	--	--	--	--	--	--	7.2	--	--	--	--	--	--	--	--	--	--	--	12	--	--	--	--	--	7.2	--	--	--	--	7.2	--	--
Isopropylbenzene	--	--	--	--	--	--	0.17	--	--	0.13	--	--	0.13	--	--	0.13	--	--	0.13	--	--	0.17	--	--	0.13	--	--	0.13	--	0.13	--	--
Naphthalene	--	--	--	--	--	--	0.21	--	--	0.07	--	--	0.07	--	--	0.07	--	--	0.07	--	--	0.21	--	--	0.07	--	--	0.07	--	0.07	--	--
N-Butylbenzene	--	--	--	--	--	--	0.15	--	--	0.16	--	--	0.16	--	--	0.16	--	--	0.16	--	--	0.15	--	--	0.16	--	--	0.16	--	0.16	--	--
N-Nitrosodiethylamine	--	--	--	--	--	--	1.2	--	--	--	--	--	0	--	--	0.0029	0.0008	--	--	--	--	--	--	--	0	--	--	--	--	0	--	--
N-Nitrosodimethylamine (NDMA)[f]	--	--	--	--	--	--	0.14	--	--	--	--	--	0.26	--	--	0.17	0.16	--	--	--	--	AE	--	--	0.3	--	--	AE	--	0.19	--	--
N-Nitroso-Di-N-Propylamine	--	--	--	--	--	--	0.41	--	--	0.41	--	--	0.41	--	--	0.41	--	--	0.41	--	--	0.13	--	--	0.13	--	--	0.13	--	--	--	--
N-Propylbenzene	--	--	--	--	--	--	0.15	--	--	0.12	--	--	0.12	--	--	0.12	--	--	0.12	--	--	0.15	--	--	0.12	--	--	0.12	--	0.12	--	--
SEC-Butylbenzene	--	--	--	--	--	--	0.15	--	--	0.15	--	--	0.15	--	--	0.15	--	--	0.15	--	--	0.15	--	--	0.15	--	--	0.15	--	0.15	--	--
Tert-Butylbenze	--	--	--	--	--	--	0.14	--	--	0	--	--	0	--	--	0	--	--	0	--	--	0.14	--	--	0.13	--	--	0.13	--	0.13	--	--
1,2,3-Trichloropropane	--	--	--	--	--	--	0.0057	--	--	--	--	--	0.007	--	--	--	--	--	0.003	--	--	--	--	--	0.03	--	--	--	--	0.0015	0.23	--
1,2,4-Trimethylbenzene	--	--	--	--	--	--	0.16	--	--	0.1	--	--	0.1	--	--	0.1	--	--	0.1	--	--	0.19	--	--	0.1	--	--	0.1	--	0.1	--	--
1,3,5-Trimethylbenzene	--	--	--	--	--	--	0.15	--	--	0.12	--	--	0.12	--	--	0.12	--	--	0.12	--	--	0.15	--	--	0.12	--	--	0.12	--	0.12	--	--
Vanadium	--	--	--	--	--	--	0.92	--	--	--	--	--	0.96	--	--	--	--	--	1.56	--	--	--	--	--	0.56	--	--	--	--	0.02	--	--
Compounds with Federal Technology Based Standards																																
BOD5	--	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4	5	6	6	6	--
TSS	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	--
Compounds with a Basin Plan Limit																																
Ammonia	--	1.2	1.3	--	0.9	1.2	1.1	1.1	1.4	1.3	1.4	1.3	1.3	1.4	1.4	1.2	1.4	1.1	1.1	1.4	1.1	1.1	1.1	1.4	DNQ	19.8	17.1	20.2	14.9	19.4	24.4	26.7
Chlorine (Free)	0.1	0.1	0.1	0.2	0.1	0.1	0.3	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.1	0.2	0.2	0.2	0.1	0.2	1.4	3.7	0.3	0.3	0.2	0.3	0.1	0.2
pH	7.3	7.3	7.3	7.4	7.3	7.3	7.3	7.2	7.1	7.1	7.2	7.3	7.3	7.2	7.2	7.3	7.2	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.4	7.3	7.3	7.2	7.3	7.2	7.2	--
Temperature	83	82	79	77	74	73	72	73	75	78	81	83	83	82	79	77	75	73	71	72	74	78	81	84	83	82	78	76	74	73	71	--
Total Coliform	--	1	1	1	1	1	1	2	2	2	1	1	2	1	2	1	1	1	1	1	2	2	2	1	1	6	2	2	1	1	1	1
Other Compounds[g]																																
Acenaphthene	--	--	--	--	--	--	0.31	--	--	0.31	--	--	0.31	--	--	0.31	--	--	0.31	--	--	0.13	--	--	0.13	--	--	0.1	--	--	--	--
Acenaphthylene	--	--	--	--	--	--	0.26	--	--	0.26	--	--	0.26	--	--	0.26	--	--	0.26	--	--	0.13	--	--	0.13	--	--	0.086	--	--	--	--
Acetominophen	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	25	--	--	--
Acrolein	--	--	--	0.61	--	--	0.61	--	--	0.61	--	--	0.61	--	--	1.96	--	--	1.96	--	--	1.96	--	--	1.96	--	--	1.96	--	--	1.96	--
Acrylonitrile	--	--	--	0.17	--	--	0.17	--	--	0.17	--	--	0.17	--	--	0.08	--	--	0.08	--	--	0.08	--	--	0.08	--	--	0.08	--	--	0.08	--
Aldrin	--	--	--	--	--	--	0.0037	--	--	0.0037	--	--	0.0037	--	--	0.0037	--	--	0.0037	--	--	0.003	--	--	0.003	--	--	0.001	--	--	--	--
Alkalinity	110	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity Bicarbonate as HCO3	130	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity Carbonate as CaCO3	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity Hydroxide as CaCO3	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alpha-BHC	--	--	--	--	--	--	0.0053	--	--	0.0053	--	--	0.0053	--	--	0.0053	--	--	0.0053	--	--	0.003	--	--	0.003	--	--	0.001	--	--	--	--
Alpha-Endosulfan	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.008	--	--	0.008	--	--	0.001	--	--	--	--
17-alpha-ethynylestradiol	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2	--	--	--
Ammonia (as N)	0.12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Anthracene	--	--	--	--	--	--	0.28	--	--	0.28	--	--	0.28	--	--	0.28	--	--	0.28	--	--	0.11	--	--	0.11	--	--	0.0029	--	--	--	--
Aroclor 1016 (PCB)	--	--	--	--	--	--	0.097	--	--	0.097	--	--	0.083	--	--	0.083	--	--	0.083	--	--	0.003	--	--	0.003	--	--	0.006	--	--	--	--
Aroclor 1221 (PCB)	--	--	--	--	--	--	0.084	--	--	0.084	--	--	0.084	--	--	0.084	--	--	0.084	--	--	0.02	--	--	0.02	--	--	0.49	--	--	--	--
Aroclor 1232 (PCB)	--	--	--	--	--	--	0.064	--	--	0.064	--	--	0.064	--	--	0.064	--	--	0.064	--	--	0.06	--	--	0.06	--	--	0.1	--	--	--	--
Aroclor 1242 (PCB)	--	--	--	--	--	--	0.07	--	--	0.07	--	--	0.07	--	--	0.07	--	--	0.07	--	--	0.04	--	--	0.04	--	--	0.2	--	--	--	--
Aroclor 1248 (PCB)	--	--	--	--	--	--	0.049	--	--	0.049	--	--	0.049	--	--	0.049	--	--	0.049	--	--	0.07	--	--	0.07	--	--	0.1	--	--	--	--
Aroclor 1254 (PCB)	--	--	--	--	--	--	0.068	--	--	0.068	--	--	0.068	--	--	0.068	--	--	0.068	--	--	0.04	--	--	0.04	--	--	0.02	--	--	--	--
Aroclor 1260 (PCB)	--	--	--	--	--	--	0.069	--	--	0.069	--	--	0.069	--	--	0.069	--	--	0.069	--	--	0.03	--	--	0.03	--	--	0.07	--	--	--	--
Atenolol	--	--	--	--	--	--	550	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Atorvastalin	--	--	--	--	--	--	5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Azobenzene (1,2-Diphenylhydrazine)	--	--	--	--	--	--	0.3	--	--	0.3	--	--	0.3	--	--	0.3	--	--	0.3	--	--	0.06	--	--	0.06	--	--	0.06	--	--	--	--
Benzidine	--	--	--	--	--	--	3.2	--	--	3.2	--	--	3.2	--	--	3.2	--	--	3.2	--	--	5	--	--	5	--	--	5	--	--	--	--
Benzo(a)anthracene	--	--	--	--	--	--	0.19	--	--	0.19	--	--	0.19	--	--	0.19	--	--	0.19	--	--	0.14	--	--	0.14	--	--	0.0048	--	--	--	--
Benzo(b)fluoranthene	--	--	--	--	--	--	0.16	--	--	0.16	--	--	0.24	--	--	0.16	--	--	0.16	--	--	0.14	--	--	0.14	--	--	0.0049	--	--	--	--

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Pollutant	Summary					Regulatory Requirements				Raw Data: 2009								2008												2007												Samples before Jan 2007
	Units	Maximum	Monthly Average	No of Samples	Notes	Detection Level Range for ND Samples	MCL Requirements[a]	NLs[b]	Other Basin Plan Requiremets[c]	Aug	Jul	Jun	May	Apr	Mar	Feb	Jan	Dec	Nov	Oct	Sep	Aug	Jul	Jun	May	Apr	Mar	Feb	Jan	Dec	Nov	Oct	Sep	Aug	Jul	Jun	May	Apr	Mar	Feb	Jan	
Benzo(g,h,i)perylene	ug/L	0.31	0.26	6		0.0071-0.31				--	--	--	--	--	--	0.31	--	--	0.31	--	--	0.31	--	--	0.31	--	--	0.31	--	--	0.03	--	--	0.03	--	--	0.0071	--	--	--	--	
Benzo(k)fluoranthene	ug/L	0.23	0.21	6		0.0003-0.2300				--	--	--	--	--	--	0.23	--	--	0.23	--	--	0.23	--	--	0.23	--	--	0.23	--	--	0.11	--	--	0.11	--	--	0.0003	--	--	--	--	
Benzophenone	ng/L	240	240	1						--	--	--	--	--	--	240	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
Beta-BHC	ug/L	0.0053	0.0049	6		0.0020-0.0053				--	--	--	--	--	--	0.0053	--	--	0.0053	--	--	0.0053	--	--	0.0053	--	--	0.0053	--	--	0.003	--	--	0.003	--	--	0.002	--	--	--	--	
Beta-Endosulfan	ug/L	0.007	0.007	1		0.002-0.007				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.007	--	--	0.007	--	--	0.002	--	--	--	--	
Beta-extradiol	ng/L	2	2	1	Sample from April 2007	2				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2	--	--	--	
BHA	ng/L	1	1	1		1				--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
Bis-(2-chloroethoxy)methane	ug/L	0.4	0.3	6		0.05-0.4				--	--	--	--	--	--	0.4	--	--	0.4	--	--	0.4	--	--	0.4	--	--	0.4	--	--	0.05	--	--	0.05	--	--	0.05	--	--	--	--	
Bis-(2-Chloroethyl)ether	ug/L	0.46	0.40	6		0.09-0.46				--	--	--	--	--	--	0.46	--	--	0.46	--	--	0.46	--	--	0.46	--	--	0.46	--	--	0.09	--	--	0.09	--	--	0.09	--	--	--	--	
Bis-(2-Chloroisopropyl)ether	ug/L	0.48	0.40	6		0.05-0.48				--	--	--	--	--	--	0.48	--	--	0.46	--	--	0.46	--	--	0.46	--	--	0.46	--	--	0.05	--	--	0.05	--	--	0.05	--	--	--	--	
Bisphenol A	ng/L	42	42	1						--	--	--	--	--	--	42	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	43	--	--	--	--	
Bromodichloromethane	ug/L	45	10.9	7						--	--	--	45	--	--	7.2	--	--	6	--	--	5.6	--	--	4.7	--	--	3.1	--	--	4.36	--	--	37.8	--	--	0.54	--	--	0.66	--	
Bromoform	ug/L	3.37	0.94	7		0.07				--	--	--	3.37	--	--	1.38	--	--	0.75	--	--	0.38	--	--	0.07	--	--	0.58	--	--	0.07	--	--	0.07	--	--	0.07	--	--	0.07	--	
Bromomethane	ug/L	1.27	0.39	7		0.21-0.26				--	--	--	0.26	--	--	0.26	--	--	0.26	--	--	0.26	--	--	1.27	--	--	0.21	--	--	0.21	--	--	0.21	--	--	0.21	--	--	0.21	--	
4-Bromophenyl phenyl ether	ug/L	0.23	0.20	6		0.07-0.23				--	--	--	--	--	--	0.23	--	--	0.23	--	--	0.23	--	--	0.23	--	--	0.23	--	--	0.07	--	--	0.07	--	--	0.07	--	--	--	--	
Busk Ketone	ng/L	55	55	1						--	--	--	--	--	--	55	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
Butylbenzyl Phthalate	ug/L	1	0.67	6		0.04-0.98				--	--	--	--	--	--	0.98	--	--	0.98	--	--	0.72	--	--	1	--	--	0.29	--	--	0.04	--	--	0.04	--	--	0.04	--	--	--	--	
Caffeine	ng/L	5	5	1		5				--	--	--	--	--	--	5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	22	--	--	--	
Calcium	mg/L	44	44	1						44	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	Jul 06=45
Carbamazepine	ng/L	90	90	1						--	--	--	--	--	--	90	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	200	--	--	--	
Chlorine (Total)	mg/L	7.6	6.1	24						4.7	4.7	4.8	4.5	5.4	5.7	6.2	5.8	6	6.2	6	5.8	6	6.8	7.1	6.8	7.2	7.2	7	7.6	7.4	7.1	5.7	5.5	6.3	7.7	11.5	9.3	6.7	6.7	6.7	6.4	
Chloroethane	ug/L	0.21	0.12	7		0.04-0.17				--	--	--	0.17	--	--	0.17	--	--	0.17	--	--	0.21	--	--	0.04	--	--	0.04	--	--	0.04	--	--	0.04	--	--	0.04	--	--	0.04	--	
2-Chloroethylvinylether	ug/L	0.48	0.39	7		0.27-0.48				--	--	--	0.48	--	--	0.48	--	--	0.48	--	--	0.48	--	--	0.27	--	--	0.27	--	--	0.27	--	--	0.27	--	--	0.27	--	--	0.27	--	
Chloroform	ug/L	56.1	18.1	7						--	--	--	56.1	--	--	12.8	--	--	11.1	--	--	14.5	--	--	11.3	--	--	10.4	--	--	10.4	--	--	60.9	--	--	1.67	--	--	2.78	--	
Chloromethane	ug/L	0.16	0.16	7		0.16				--	--	--	0.16	--	--	0.16	--	--	0.16	--	--	0.16	--	--	0.16	--	--	0.16	--	--	0.16	--	--	0.16	--	--	0.16	--	--	0.16	--	
4-Chloro-3-Methylphenol	ug/L	0.4	0.4	6		0.18-0.40				--	--	--	--	--	--	0.4	--	--	0.4	--	--	0.4	--	--	0.4	--	--	0.4	--	--	0.18	--	--	0.18	--	--	0.18	--	--	--	--	
2-Chloronaphthalene	ug/L	0.26	0.23	6		0.07-0.26				--	--	--	--	--	--	0.26	--	--	0.26	--	--	0.26	--	--	0.26	--	--	0.26	--	--	0.07	--	--	0.07	--	--	0.07	--	--	--	--	
2-Chlorophenol	ug/L	0.71	0.61	6		0.09-0.71				--	--	--	--	--	--	0.71	--	--	0.71	--	--	0.71	--	--	0.71	--	--	0.71	--	--	0.09	--	--	0.09	--	--	0.09	--	--	--	--	
4-Chlorophenyl phenyl ether	ug/L	0.24	0.21	6		0.04-0.24				--	--	--	--	--	--	0.24	--	--	0.24	--	--	0.24	--	--	0.24	--	--	0.24	--	--	0.04	--	--	0.04	--	--	0.04	--	--	--	--	
Chrysene	ug/L	0.25	0.23	6		0.004-0.250				--	--	--	--	--	--	0.25	--	--	0.25	--	--	0.25	--	--	0.25	--	--	0.25	--	--	0.12	--	--	0.12	--	--	0.004	--	--	--	--	
Cis-1,3-Dichloropropene	ug/L	0.15	0.12	7		0.09-0.15				--	--	--	0.15	--	--	0.15	--	--	0.15	--	--	0.15	--	--	0.09	--	--	0.09	--	--	0.09	--	--	0.09	--	--	0.09	--	--	0.09	--	
Corrosivity	20C	0.381	0.100	5						--	--	--	--	--	--	-0.512	--	--	0.381	--	--	0.291	--	--	0.138	--	--	0.201	--	--	--	--	--	--	--	--	--	--	--	--	--	
Corrosivity	60C	0.712	0.408	5						--	--	--	--	--	--	0.321	--	--	0.133	--	--	0.224	--	--	0.65	--	--	0.712	--	--	--	--	--	--	--	--	--	--	--	--	--	
CTAS	mg/L	0.7	0.1	14		0.1				--	--	--	--	--	--	--	--	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.67	0.1	0.1	DNQ	DNQ	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	--	--	
DEET	ng/L	130	130	1						--	--	--	--	--	--	130	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
Delta-BHC	ug/L	0.0046	0.0043	6		0.0010-0.0046				--	--	--	--	--	--	0.0046	--	--	0.0046	--	--	0.0046	--	--	0.0046	--	--	0.0046	--	--	0.003	--	--	0.003	--	--	0.001	--	--	--	--	
Demeton-O	ug/L	0.09	0.09	1	Sample from August 2007	0.09				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.09	--	--	--	--	--	--	--	
Demeton-S	ug/L	0.11	0.11	1	Sample from August 2007	0.11				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.11	--	--	--	--	--	--	--	
Diazepam	ng/L	3.5	3.5	1						--	--	--	--	--	--	3.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
Diazinon	ug/L	0.051	0.051	6		0.51				--	--	--	--	--	--	0.051	--	--	0.051	--	--	0.051	--	--	0.051	--	--	0.051	--	--	0.051	--	--	0.051	--	--	0.051	--	0.051	--	--	
Dibenzo(a,h)anthracene	ug/L	0.32	0.27	6		0.02-0.32				--	--	--	--	--	--	0.32	--	--	0.32	--	--	0.32	--	--	0.32	--	--	0.32	--	--	0.02	--	--	0.02	--	--	0.0082	--	--	--	--	
Dibromoacetic Acid	ug/L	1.8	1.0	5		0.26				--	--	--	--	--	--	1.2	--	--	0.42	--	--	1.4	--	--	1.8	--	--	0.26	--	--	--	--	--	--	--	--	--	--	--	--	--	
Dibromochloromethane	ug/L	21.8	4.89	7						--	--	--	21.8	--	--	3.64	--	--	2.25	--	--	1.65	--	--	0.62	--	--	2.51	--	--	1.74	--	--	17.9	--	--	1.3	--	--	0.66	--	
Dichloroacetic Acid	ug/L	12	10.1	5						--	--	--	--	--	--	11	--	--	10	--	--	9.5	--	--	12	--	--	8.1	--	--	--	--	--	--	--	--	--	--	--	--	--	
1,3-Dichlorobenzene	ug/L	0.1	0.1	5		0.05-0.10				--	--	--	--	--	--	--	--	--	0.1	--	--	0.1	--	--	0.1	--	--	0.1	--	--	0.05	--	--	0.05	--	--	0.05	--	--	--	--	
3,3-Dichlorobenzidine	ug/L	1.5	1.3	6		0.11-1.5				--	--	--	--	--	--	1.5	--	--	1.5	--	--	1.5	--	--	1.5	--	--	1.5	--	--	0.11	--	--	0.11	--	--	0.11	--	--	--	--	
1,1-Dichloropropene	ug/L	0.1	0.1	1	Sample from Feb 2007	0.1				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.1	--	
2,4-Dichlorophenol	ug/L	0.77	0.66	6		0.09-0.77				--	--	--	--	--	--	0.77	--	--	0.77	--	--	0.77	--	--	0.77	--	--	0.77	--	--	0.09	--	--	0.09	--	--	0.09	--	--	--	--	
Diclofenac	ng/L	5	5.00	1		5				--	--	--	--	--	--	5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
Dieldrin	ug/L	0.005	0.005	6		0.001-0.005				--	--	--	--	--	--	0.0044	--	--	0.0044	--	--	0.0044	--	--	0.0044	--	--	0.0044	--	--	0.005	--	--	0.005	--	--	0.001	--	--	--	--	
Diethylphthalate	ug/L	2	0.52	6		0.06-2.00				--	--	--	--	--	--	2	--	--	0.23	--	--	0.29	--	--	0.33	--	--	0.23	--	--	0.06	--	--	0.06	--	--	0.06	--	--	--	--	
Dilantin	ng/L	160	160	1						--	--	--	--	--	--	160	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
2,4-Dimethylphenol	ug/L	0.8	0.70	6		0.17-0.80				--	--	--	--	--	--	0.8	--	--	0.8	--	--	0.8	--	--	0.8	--	--	0.8	--	--	0.17	--	--	0.17	--	--	0.17	--	--	--	--	
Dimethylphthalate	ug/L	0.27	0.26	6		0.26-0.27				--	--	--	--	--	--	0.26	--	--	0.26	--	--	0.26	--	--	0.26	--	--	0.26	--	--	0.27	--	--	0.27	--	--	0.27	--	--	--	--	
Di-N-butylphthalate	ug/L	0.61	0.46	6		0.05-0.53				--	--	--	--	--	--	0.53	--	--	0.53	--	--	0.61	--	--	0.53	--	--	0.53	--	--	0.05	--	--	0.05	--	--	0.05	--	--	--	--	
4,6-Dinitro-2-methylphenol	ug/L	0.4	0.18	6		0.14-0.40				--	--	--	--	--	--	0.14	--	--	0.14	--	--	0.14	--	--	0.14	--	--	0.14	--	--	0.4	--	--	0.4	--	--	0.4	--	--	--	--	
2,4-Dinitrophenol	ug/L	1	0.6	5		0.21-1.00				--	--	--	--	--	--	--	--	--	1	--	--	1	--	--	0.51	--	--	0.51	--	--	0.21	--	--	0.21	--	--	0.21	--	--	--	--	
2,4-Dinitrotoluene	ug/L	0.4	0.3	6		0.08-0.4				--	--	--	--	--	--	0.4	--	--	0.4	--	--	0.4	--	--	0.4	--	--	0.4	--	--	0.08	--	--	0.08	--	--	0.08	--	--	--	--	
2,6-Dinitrotoluene	ug/L	0.46	0.24	6		0.022-0.24				--	--	--	--	--	--	0.24	--	--	0.24	--	--	0.24	--	--	0.46	--	--	0.24	--	--	0.022	--	--	0.022	--	--	0.022	--	--	--	--	
Di-N-octylphthalate	ug/L	0.5	0.27	6		0.028-0.5				--	--	--	--	--	--	0.028	--	--	0.28	--	--	0.28	--	--	0.28	--	--	0.28	--	--	0.5	--	--	0.5	--	--	0.5	--	--	--	--	
Endosulfan I	ug/L	0.0047	0.0047	5		0.0047				--	--	--	--	--	--	0.0047	--	--	0.0047	--	--	0.0047	--	--	0.0047	--	--	0.0047	--	--	--	--	--	--	--	--	--	--	--	--	--	
Endosulfan II	ug/L	0.0047	0.0047	5		0.0047				--	--	--	--	--	--	0.0047	--	--	0.0047	--	--	0.0047	--	--	0.0047	--	--	0.0047	--	--	--	--	--	--	--	--	--	--	--	--	--	
Endosulfan II Sulfate	ug/L	0.0046	0.0042	6		0.002-0.0046				--	--	--	--	--	--	0.0046	--	--	0.0046	--	--	0.0046	--	--	0.0046	--	--	0.0046	--	--	0.002	--	--	0.002	--	--	0.003	--	--	--	--	
Endrin Aldehyde	ug/L	0.0056	0.0050	6		0.002-0.0056				--	--	--	--	--	--	0.0056	--	--	0.0056	--	--	0.0056	--	--	0.0056	--	--	0.0056	--	--	0.002	--	--	0.002	--	--	0.002	--	--	--	--	
Estradiol	ng/L	5	5	1						--	--	--	--	--	--	5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
Estrone	ng/L	2	2	1		2				--	--	--	--	--	--	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
Ethyl Parathion	ug/L	0.12	0.12	1	Sample from August 2007	0.12				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.12	--	--	--	--	--	--	--	
Ethynylestradiol	ng/L	1	1	1		1				--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
Extrone	ng/L	15	15	1	Sample from April 2007					--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	15	--	--	--	
Fecal Coliform	--	1	1	24		1				1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Fluoranthene	ug/L	0.16	0.16	5		0.16				--	--	--	--	--	--	0.16	--	--	0.16	--	--	0.16	--	--	0.16	--	--	0.16	--	--	--	--	--	--	--	--	--	--	--	--	--	
Fluorene	ug/L	0.28	0.24	6						--	--	--	--	--	--	0.28	--	--	0.28	--	--	0.28	--	--	0.28	--	--	0.28	--	--	0.02	--	--	0.02	--	--	0.0045	--	--	--	--	
Fluoxetine	ng/L	44	44	1						--	--	--	--	--	--	44	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
Gemfibrozil	ng/L	380	380	1						--	--	--	--	--	--	380	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2500	--	--	--	
Guthion	ug/L	0.17	0.17	1	Sample from August 2007	0.17				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.17	--	--	--	--	--	--	--	
Hexachlorobutadiene	ug/L	0.28	0.20	6		0.027-0.07				--	--	--	--	--	--	0.028	--	--	0.28	--	--	0.27	--	--	0.27	--	--	0.28	--	--	0.07	--	--	0.07	--	--	0.07	--	--	--	--	
Hexachloroethane	ug/L	0.36	0.31	6		0.017-0.36				--	--	--	--	--	--	0.36	--	--	0.36	--	--	0.36	--	--	0.36	--	--	0.36	--	--	0.07	--	--	0.07	--	--	0.07	--	--	--	--	
Ibuprofen	ng/L	1.8	1.8	1						--	--	--	--	--	--	1.8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	78	--	--	--	
Indeno(1,2,3-CD)pyrene	ug/L	0.32	0.27	6		0.02-0.32				--	--	--	--	--	--	0.32	--	--	0.32	--	--	0.32	--	--	0.32	--	--	0.32	--	--	0.02	--	--	0.02	--	--	0.004	--	--	--	--	
Iopromide	ng/L	720	720	1						--	--	--	--	--	--	720	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	16	--	--	--	
Isophorone	ug/L	0.33	0.29	6		0.07-0.33				--	--	--	--	--	--	0.33	--	--	0.33	--	--	0.33	--	--	0.33	--	--	0.33	--	--	0.07	--	--	0.07	--	--	0.07	--	--	--	--	
Lipitor	ng/L	0.5	0.50	1	Sample from April 2007	0.5				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.5	--	--	--	
Magnesium	ug/L	13	13	1						13	--	--	--	--	--	--	--	--	--	--	--	--	14	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
Malathion	ug/L	0.11	0.11	1	Sample from August 2007	0.11				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.11	--	--	--	--	--	--	--	
Meprobamale	ng/L	610	610	1						--	--	--	--	--	--	610	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
Methadone	ng/L	28	28	1	Sample from April 2007					--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	28	--	--	--	
4-Methyl-2-Pentanone	ug/L	1.5	0.58	6		0.12-1.50				--	--	--	--	--	--	1.5	--	--	0.12	--	--	0.12	--	--	0.12	--	--	0.12	--	--	1.5	--	--	0.12	--	--	0.12	--	0.12	--	--	
Mirex	ug/L	0.004	0.004	1	Sample from August 2007	0.004				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.004	--	--	--	--	--	--	--	
Monobromoacetic Acid	ug/L	0.78	0.32	5		0.21-0.78				--	--	--	--	--	--	0.21	--	--	0.21	--	--	0.21	--	--	0.21	--	--	0.78	--	--	--	--	--	--	--	--	--	--	--	--	--	
Monochloroacetic Acid	ug/L	5.3	1.43	5		0.32				--	--	--	--	--	--	0.32	--	--	0.32	--	--	0.91	--	--	0.32	--	--	5.3	--	--	--	--	--	--	--	--	--	--	--	--	--	

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Pollutant	Units	Summary				Regulatory Requirements				Raw Data 2009								2008												2007												Samples before Jan 2007
		Maximum	Monthly Average	No of Samples	Notes	Detection Level Range for ND Samples	MCL Requirements[a]	NLs[b]	Other Basin Plan Requiremets[c]	Aug	Jul	Jun	May	Apr	Mar	Feb	Jan	Dec	Nov	Oct	Sep	Aug	Jul	Jun	May	Apr	Mar	Feb	Jan	Dec	Nov	Oct	Sep	Aug	Jul	Jun	May	Apr	Mar	Feb	Jan	
Morphine	ug/L	2	2	1	Sample from April 2007	2				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2	--	--	--	
Musk Ketone	ng/L	55	55	1						--	--	--	--	--	--	55	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
Naproxen	ng/L	11	11	1						--	--	--	--	--	--	11	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
Nitrobenzene	ug/L	0.37	0.32	6		0.05-0.37				--	--	--	--	--	--	0.37	--	--	0.37	--	--	0.37	--	--	0.37	--	--	0.37	--	--	0.05	--	--	0.05	--	--	0.05	--	--	--	--	
2-Nitrophenol	ug/L	0.71	0.61	6		0.09-0.71				--	--	--	--	--	--	0.71	--	--	0.71	--	--	0.71	--	--	0.71	--	--	0.71	--	--	0.09	--	--	0.09	--	--	0.09	--	--	--	--	
4-Nitrophenol	ug/L	1	0.84	6		0.06-0.12				--	--	--	--	--	--	1	--	--	1	--	--	1	--	--	1	--	--	1	--	--	0.06	--	--	0.06	--	--	0.06	--	--	--	--	
N-Nitrosodiphenylamine	ug/L	0.09	0.09	7		0.09				--	--	--	0.09	--	--	0.09	--	--	0.09	--	--	0.09	--	--	0.09	--	--	0.09	--	--	0.09	--	--	0.09	--	--	0.09	--	--	--	--	
Nonylphenol Diethoxylate, Total	ug/L	2.2	2.2	1	Sample from April 2007	2.2				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2.2	--	--	--	--	
Nonylphenol Monoethoxylate, Total	ug/L	4.3	4.3	1	Sample from April 2007	4.3				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	4.3	--	--	--	--	
Nonylphenol, Total	ug/L	8.5	8.5	1	Sample from April 2007	8.5				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	8.5	--	--	--	--	
Octylphenol	ng/L	25	25	1		25				--	--	--	--	--	--	25	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
P,P-DDD	ug/L	0.0056	0.0053	6		0.001-0.0056				--	--	--	--	--	--	0.0056	--	--	0.0056	--	--	0.0056	--	--	0.0056	--	--	0.0056	--	--	0.004	--	--	0.004	--	--	0.001	--	--	--	--	
P,P-DDE	ug/L	0.0048	0.0046	6		0.002-0.0048				--	--	--	--	--	--	0.0046	--	--	0.0048	--	--	0.0048	--	--	0.0048	--	--	0.0048	--	--	0.004	--	--	0.004	--	--	0.002	--	--	--	--	
P,P-DDT	ug/L	0.0048	0.0045	6		0.002-0.0048				--	--	--	--	--	--	0.0046	--	--	0.0048	--	--	0.0048	--	--	0.0048	--	--	0.0048	--	--	0.003	--	--	0.003	--	--	0.002	--	--	--	--	
PBDE 100	ng/L	1.1	1.1	1	Sample from April 2007					--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.1	--	--	--	
PBDE 128	ng/L	1.1	1.1	1	Sample from April 2007	1.1				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.1	--	--	--	
PBDE 138	ng/L	1.1	1.1	1	Sample from April 2007	1.1				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.1	--	--	--	
PBDE 153	ng/L	1.1	1.1	1	Sample from April 2007	1.1				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.1	--	--	--	
PBDE 154	ng/L	1.1	1.1	1	Sample from April 2007	1.1				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.1	--	--	--	
PBDE 17	ng/L	1.1	1.1	1	Sample from April 2007	1.1				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.1	--	--	--	
PBDE 183	ng/L	1.1	1.1	1	Sample from April 2007	1.1				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.1	--	--	--	
PBDE 190	ng/L	1.1	1.1	1	Sample from April 2007	1.1				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.1	--	--	--	
PBDE 203	ng/L	1.1	1.1	1	Sample from April 2007	1.1				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.1	--	--	--	
PBDE 206	ng/L	110	110	1	Sample from April 2007	110				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	110	--	--	--	
PBDE 209	ng/L	110	110	1	Sample from April 2007	110				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	110	--	--	--	
PBDE 28	ng/L	1.1	1.1	1	Sample from April 2007					--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.1	--	--	--	
PBDE 47	ng/L	3.8	3.8	1	Sample from April 2007					--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3.8	--	--	--	
PBDE 66	ng/L	1.1	1.1	1	Sample from April 2007	1.1				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.1	--	--	--	
PBDE 71	ng/L	1.1	1.1	1	Sample from April 2007	1.1				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.1	--	--	--	
PBDE 85	ng/L	1.1	1.1	1	Sample from April 2007	1.1				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.1	--	--	--	
PBDE 99	ng/L	2.9	2.9	1	Sample from April 2007					--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2.9	--	--	--	
Phenanthrene	ug/L	0.01	0.01	7		0.0029-0.08				--	--	--	0.01	--	--	0.01	--	--	0.01	--	--	0.01	--	--	0.01	--	--	0.01	--	0.01	--	--	--	0.01	--	--	0.0029	--	--	0.08	--	
Phenol	ug/L	0.3	0.30	6		0.3				--	--	--	--	--	--	0.3	--	--	0.3	--	--	0.3	--	--	0.3	--	--	0.3	--	--	0.3	--	--	0.3	--	--	0.3	--	--	--	--	
Phosphate (Dissolved)	mg/L	0.2	0.12	8		0.1				0.2	0.15	0.13	0.06	.0.10	.0.10	.0.10	.0.10	0.1	0.1	0.11	0.1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.38	0.43	Monthly from Jan 05, Ave=1.07
Phosphate (Total)	mg/L	1.4	0.30	12						0.87	0.26	0.208	0.205	0.162	0.17	0.18	0.185	0.25	0.18	0.19	0.18	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.75	0.67	Monthly from Jan 05, Ave=1.16
Potassium	mg/L	14	14	1						14	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
Primidone	ng/L	160	160	1						--	--	--	--	--	--	160	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
Progesterone	ng/L	5	5	1		5				--	--	--	--	--	--	5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
Pyrene	ug/L	0.02	0.02	7		0.0062-0.07				--	--	--	0.02	--	--	0.02	--	--	0.02	--	--	0.02	--	--	0.02	--	--	0.02	--	0.02	--	--	--	0.02	--	--	0.0062	--	--	0.07	--	
Salicylic acid	ng/L	140	140	1	Sample from April 2007					--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	140	--	--	--	
Silicon	mg/L	8.6	8.6	1						8.6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
Sodium	mg/L	110	110	1						110	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	Jul 06=93
Sulfamethoxazole	ng/L	54	54	1						--	--	--	--	--	--	54	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
Sulfide	mg/L	0.1	0.1	1						0.1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
TCEP	ng/L	370	370	1						--	--	--	--	--	--	370	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
TCPP	ng/L	2000	2000	1		2000				--	--	--	--	--	--	2000	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
Tert-butyl Alcohol	ug/L	2.3	0.92	6		0.40-0.78				--	--	--	--	--	--	0.4	--	--	1	--	--	1	--	--	1	--	--	0	--	--	2.3	--	--	0.78	--	--	6.3	--	3.8	--	--	
Testosterone	ng/L	5	5	1		5				--	--	--	--	--	--	5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
Total Hardness	mg/L	282	194	23						--	174	168	196	188	176	175	172	170	168	171	163	156	166	177	180	241	278	282	208	216	214	208	208	212	236	242	235	168	174	--	--	
Total Organic Carbon[h]	mg/L	5.8	5.8	1						5.8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	Aug 05=11.3
4-tert-Octylphenol	ng/L	43	43	1	Sample from May 2007	43				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	43	--	--	--	--	
Trichloroacetic Acid	ug/L	11	8.6	5						--	--	--	--	--	--	11	--	--	10	--	--	9.4	--	--	6.1	--	--	6.3	--	--	--	--	--	--	--	--	--	--	--	--	--	
2,4,6-Trichlorophenol	ug/L	0.88	0.79	6		0.09-0.88				--	--	--	--	--	--	0.88	--	--	0.88	--	--	0.88	--	--	0.88	--	--	0.88	--	--	0.31	--	--	0.09	--	--	0.09	--	--	--	--	
Triclosan	ng/L	1.6	1.6	1						--	--	--	--	--	--	1.6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	20	--	--	--	
Trimethoprim	ng/L	65	65	1						--	--	--	--	--	--	65	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	

Footnotes:

(shaded) Estimated value from a sample that was detected, but not quantifiable

Unless otherwise noted, summary values represent data from September 2007-August 2009

a. Per the 2008 CDPH draft groundwater recharge regulations, recycled water used for groundwater recharge must meet MCLs, with the exception of the disinfection byproducts, which can be met after soil aquifer treatment; the Basin Plan also contains water quality objectives for groundwater based on MCLs and water used for recharge cannot cause or contribute to an exceedance of a groundwater quality objective.

b. Notification Levels are health-based advisory levels established by CDPH for chemicals in drinking water that lack MCLs. When chemicals are found in drinking water at concentrations greater than their NLs, certain requirements and recommendations apply. NLs are not applies as limits in IPR project permits.

c. Surface water objectives (not applicable the proposed recharge project)/groundwater objectives - water used for recharge cannot cause or contriubte to an excedance of a groundwater quality objective

d. This is the NPDES permit limit for DCT based on the Basin Plan surface water quality objectives and the Los Angeles River Nitrogen TMDL Waste Load Allocations

e. Surface water objectives - not applicable to the proposed groundwater recharge project.

f. The CDPH draft groundwater recharge regulations include treatment performance requirements for this compound.

g. This group contains priority pollutnants and constituents of emerging concern that have no applicable limits for groundwater recharge project.

h. The CDPH draft groundwater recharge regulations require the TOC = 0.5/RWC.

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Appendix E

Advanced Water Treatment Technology Assessment TM

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Summary of Modifications to "Advanced Water Treatment Technology Assessment TM" since Initial Publication on September 1, 2009

The Recycled Water Master Planning (RWMP) effort has spanned three years (April 2009 to March 2012). As is the nature of a planning project, assumptions are typically modified and refined as a project is further developed. The most recent assumptions related to the Groundwater Replenishment (GWR) master planning effort are presented in the GWR Master Planning Report. Assumptions and conclusions presented in this report supersede assumptions included in this technical memorandum (TM). The following table summarizes the modifications applicable to all RWMP TMs and those specifically applicable to this TM are described in the following sections.

Assumption	Modified	Original
Applicable to all RWMP TMs		
Recycled Water Goal	59,000 AFY by 2035 This goal reflects the 2010 LADWP Urban Water Management Plan that was adopted in early 2011, after the original RWMP goals were drafted	50,000 AFY by 2019
Name for Project and Master Planning Reports	Recycled Water Master Planning Documents GWR Master Planning Report NPR Master Planning Report	Recycled Water Master Plan GWR Master Plan NPR Master Plan
Introduction Section	This is superseded by the Introduction Sections in the NPR Master Planning Report.	This section was included in all initial TMs but the terms described have been replaced by the Introduction Section for the NPR Master Planning Report.
NPR Projects Terminology	To avoid confusion related to LADWP's water rate structure, the terms "Tier 1" and "Tier 2" are superseded with the terms "planned" and "potential," respectively. Both planned and potential projects would be considered for implementation by 2035.	"Tier 1" for NPR projects that were originally planned for design and construction by the year 2015. "Tier 2" for NPR projects that were originally being evaluated in the NPR Master Planning Report for potential future implementation after the year 2015.
Name for MF/RO/AOP treatment plant	Advanced water purification facility (AWPF)	Advanced water treatment facility (AWTF)
Name for water produced by AWPF	Purified recycled water	Advanced treated recycled water, highly purified recycled water, etc.
Treatment Plant Acronyms	DCTWRP LAGWRP	DCT LAG
GWR Project Phases	Phase 1 = 15,000 AFY annual recharge goal and 25 mgd AWPF product water capacity Phase 2 = 30,000 AFY annual recharge goal and 35 mgd AWPF product water capacity	Phase 1 = 20 mgd AWPF product water capacity Phase 2 = 40 mgd AWPF product water capacity

The following modifications are specific to this TM.

Overall TM

This TM was a preliminary analysis of advanced water purification (AWP) technologies. Further analysis and conclusions regarding the AWPF are outlined in the GWR Master Planning Report.

TM References

Throughout this TM there are references to preliminary TMs that were prepared at the onset of the RWMP effort. Relevant information from these TMs has been updated and incorporated into the four RWMP documents: GWR Master Planning Report; NPR Master Planning Report; TIWRP Barrier Supplement and NPR Concepts Report; and Long-Term Concepts Report.

Section 2.3 Regulatory Requirements

In November 2011, as the planning process was nearing completion, the California Department of Public Health (CDPH) released a new draft of its groundwater recharge regulations. Although the groundwater recharge regulations will not be final until at least the end of 2013, the revised draft appears to provide flexibility for GWR projects that may allow the City to consider other alternatives that could reduce project costs. An updated discussion of regulatory requirements is included in the GWR Master Planning Report, Section 3.1.

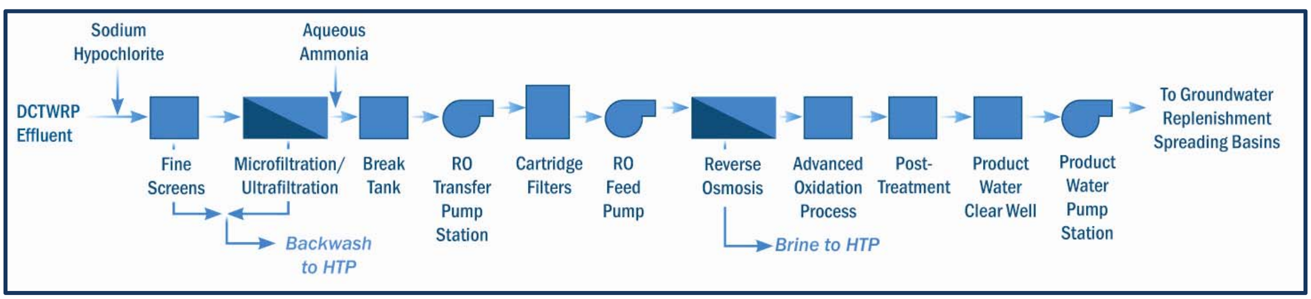
Section 2.5 Preliminary AWTP Design Capacity

The AWPF design capacity was refined as part of the development of the GWR Master Planning Report. See the GWR Master Planning Report Section 3.7 Tables 3-6, 3-7, and 3-8 for the AWPF design flows (influent and product water).

Section 3 Advanced Water Treatment Components

Figure 3-1 was updated to show that the RO brine would be conveyed to Hyperion Treatment Plant (HTP) only, not to a separate ocean outfall.

Figure 3-1: Process Flow Diagram of Proposed Treatment Train (Revised)



Section 3.7 Advanced Oxidation Process and Appendix A Alternative Advanced Oxidation Processes

Section 3.7 and Appendix A both recommended that two advanced oxidation processes (AOP), ozone with hydrogen peroxide (O_3/H_2O_2) and titanium dioxide photocatalyis treatment (TiO_2/UV), be pilot tested in addition to ultraviolet (UV) light with hydrogen peroxide (UV/H_2O_2). Based on further evaluation of these alternative AOPs, a decision was made not to conduct TiO_2/UV pilot testing as this treatment method was deemed too experimental at this time. Both UV/ H_2O_2 and O_3/H_2O_2 processes were pilot tested and the results are presented in the GWR Treatment Pilot Study Report as well as the GWR Master Planning Report.

Section 3.8 Product Water Stabilization

Product water post treatment/stabilization was evaluated as part of the GWR Master Planning Report Section 5.3.11 and Appendix A. A total of four post-treatment options were evaluated and a method using calcium chloride, caustic soda and carbon dioxide was recommended based on the following evaluation results:

- Best overall control of water quality,
- Ease of operation
- Smallest footprint,
- Lowest capital cost, and
- Lowest lifecycle cost.

The recommended alternative (calcium chloride, caustic soda, and carbon dioxide) is described in the GWR Master Planning Report, Section 5.3.11. The four alternatives are described in detail and evaluated in the GWR Master Planning Report Appendix A.

Section 4 Residuals Management

DCTWRP currently discharges residuals streams to the Additional Valley Outfall Relief Sewer (AVORS). It is assumed that the residuals generated at the AWPF, including MF backwash and RO concentrate, would be discharged to the AVORS for treatment at the HTP (Hyperion Treatment Plant).

The AWPF waste side-stream flows were updated during development of the GWR Master Planning Report. See the GWR Master Planning Report Section 5.3.14 Table 5-32 for the updated residuals estimates for both Phases 1 and 2 of the project.

The TDS impacts on HTP shown in Table 4-3 were estimated for a 40-mgd AWPF (product water capacity), which means that the predicted impacts are more conservative than for the 35-mgd AWPF presented in the GWR Master Planning Report. The TDS impacts on HTP should be reassessed during preliminary design.

The original TM follows so these modifications should be considered when reading this TM.

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Technical Memorandum

Title:	Advanced Water Treatment Technology Assessment TM
Version:	Draft
Prepared For:	John Hinds, Project Manager, LADWP Doug Walters, Project Manager, BOS Brian Tan, Task 1a Lead, LADWP Hiddo Netto, Co-Task Lead, BOS
Prepared by:	Jennifer Thompson, Task 1a Lead, CDM Evelyn You, Task 1a Project Engineer, CDM David Hokanson, Trussell Technologies Inc. Shane Trussell, Trussell Technologies Inc. Greg Wetterau, Task 3a Lead, CDM
Reviewed by:	Tom Richardson, Project Manager, RMC Heather Boyle VanMeter, Deputy Project Manager, RMC Don Bunts, RMC Bruce Chalmers, CDM Margie Nellor, Nellor Environmental Associates, Inc. Rhodes Trussell, Trussell Technologies Inc.
Date:	September 1, 2009
Reference:	Task 1a Indirect Potable Reuse Master Plan Task 1.4 Advanced Water Treatment Technology Assessment

1. Introduction

With imported water supplies becoming ever more unpredictable, the Los Angeles Department of Water and Power (LADWP) adopted the Mayor's vision of Securing LA's Water Supply in May 2008, calling for 50,000 acre-feet per year (AFY) of potable supplies to be replaced by recycled water by 2019. To meet this near-term challenge and plan for expanding reuse in the future, LADWP has partnered with the Department of Public Works to develop the Recycled Water Master Plan (RWMP). The RWMP includes 7 major tasks: 1 Indirect Potable Reuse (IPR) Master Plan, 2 Non-Potable Reuse (NPR) Master Plan, 3 Indirect Potable Reuse Pilot Study, 4 Maximum Reuse Concept Report, 5 Satellite Feasibility Concept Report, 6 Existing System Reliability Concept Report, and 7 Training. This technical memorandum (TM) is part of Task 1a, the first phase if the IPR Master Plan.

The importance of additional water supply options for Los Angeles has become increasingly apparent with continuation of drought conditions, building contention for limited available water supplies both statewide and across the Southwest, and growing awareness of the critical nexus between quality of life/economic stability and available supplies of quality water. Significant attention has focused on the importance of indirect potable reuse given the multiple associated benefits, among them: local control; drought-resistant supplies; beneficial use of a critical, limited resource; sustained availability for future generations; existing infrastructure; lower investment and less environmental impact than other supply options; and demonstrated success nearby, across the nation and throughout the world.

1.1 Task 1 Overview

The purpose of Task 1 is to develop an IPR Master Plan that includes a capital improvement program to implement an advanced water treatment plant (AWTP) and groundwater replenishment using high-quality recycled water in the San Fernando Valley in the Hansen, Pacoima, and possibly Tujunga spreading basins. The AWTP will be fed with effluent from the Donald C. Tillman Water Reclamation Plant (DCT). The IPR Master Plan will plan for in-service dates no later than June 30, 2018 to meet the minimum indirect-potable reuse goal of 15,000 acre-feet/year (AFY) by June 30, 2019.

Task 1a includes the preliminary evaluations for the IPR Master Plan, including developing a regulatory approach, completing preliminary evaluations about the DCT plant, developing preliminary groundwater replenishment strategies, completing a technology assessment for the AWTP (this TM), and selecting a site for the AWTP. Task 1b, the IRP Master Plan document, will commence when Task 1a is complete and will incorporate the work completed as part of Task 1a. Task 1a is subdivided into the following standalone tasks to complete the initial IPR studies:

- Task 1.1 – Regulatory Approach and Coordination: Provides a recommended approach for permitting the AWTP and groundwater replenishment with recycled water.
- Task 1.2 – DCT Data Summary: Provides a summary of historical DCT flow and water quality data for use on the RWMP.
- Task 1.3 – Groundwater and Surface Water Assessment: Initial groundwater and surface water studies to develop groundwater replenishment operational scenarios.
- Task 1.4 – Advanced Water Treatment Technology Assessment: Technology assessment for the treatment processes to be used in the AWTP.

- Task 1.5 – Site Assessment: Comparison of potential sites for the AWTP with a goal of selecting a preferred site to be able to move forward with the IPR Master Plan.
- Task 1.6 – DCT Maximum Flow Assessment: Evaluation of the maximum flows that could be routed to the DCT plan from the Tillman Service Area (TSA) to determine the quantity of water available for existing uses, IPR and NPR.

This TM for Task 1.4, the Advanced Water Treatment Technology Assessment TM, provides the basis for the advanced water treatment process to be employed in the AWTP. The purpose of this TM is described further in Section 1.2.

Task 1 is being completed in conjunction with Task 3, IPR Pilot Study, which includes bench scale testing and pilot testing of the proposed treatment process. Task 4 will be evaluating concepts to maximize reuse within the City, including maximizing IPR within the San Fernando Valley.

1.2 TM Purpose

The purpose of this Advanced Water Treatment Technology Assessment TM is to provide an initial technology assessment for the advanced water treatment processes and residuals management for the new AWTP. The AWTP will treat DCT effluent to produce high-quality product water for groundwater replenishment at the spreading grounds in the east San Fernando Valley.

This TM presents the proposed technologies for the AWTP including microfiltration (MF) or ultrafiltration (UF), reverse osmosis (RO), advanced oxidation using ultraviolet light (UV) with hydrogen peroxide (H_2O_2), and post-treatment for product water stabilization. The selected treatment process is based on the treatment train that is used at existing permitted AWTPs, including the Orange County Water District (OCWD) Groundwater Replenishment (GWR) System in Fountain Valley, California, and the West Basin Municipal Water District Edward C. Little Water Recycling Facility (West Basin WRF) in El Segundo, California. Because of the City's desire to implement an AWTP and groundwater replenishment within a relatively short time-frame, this treatment train was selected to meet anticipated regulatory requirements and to streamline the regulatory approval process.

Ongoing research for treatment of constituents of emerging concern has shown that alternative advanced oxidation processes (AOPs) could offer cost savings over UV/H_2O_2. Therefore, the RWMP includes an assessment of alternative AOPs that the City will consider for future upgrades and/or expansions of the AWTP based on the results of the pilot testing and future product developments. This TM includes a summary of potential AOPs and a recommendation of two AOPs for pilot testing under Task 3, IPR Pilot Study.

This TM also includes a discussion of brine management options for the brine waste stream generated by the RO process.

1.3 TM Overview

This TM is organized in the following sections:

- Section 1 – Introduction
- Section 2 – Background
- Section 3 – Advanced Water Treatment Components
- Section 4 – Residuals Management

2. Background

This section provides background information about the IPR project, including goals for the AWTP, the OCWD GWR System as the basis of design, a brief overview of the regulatory requirements for the AWTP (the Regulatory Assessment TM being developed under Subtask 1.1 will include a detailed regulatory assessment for the IPR project), a discussion on constituents of emerging concern and suggestions for indicator compounds, preliminary AWTP design capacity assumptions, and a discussion of potential AWTP feed water sources.

2.1 AWTP Goals

The City has the following goals for the IPR project:

- The AWTP shall be implemented with in-service dates no later than June 30, 2018.
- The AWTP shall achieve the minimum IPR goal of 15,000 AFY.
- The proposed advanced water treatment process employs proven technologies that have been shown to effectively remove regulated chemicals, constituents of emerging concern, and microorganisms.
- The stabilized, disinfected product water from the AWTP shall comply with requirements for groundwater recharge projects from the California Department of Public Health (CDPH), including drinking water maximum contaminant levels (MCL), nitrogen limits, and treatment performance and from the Regional Water Quality Control Board (RWQCB) to protect beneficial uses of groundwater, including the Los Angeles Basin Plan water quality objectives and the State Water Resources Control Board's (SWRCB) Recycled Water Policy.
- The proposed advanced water treatment process shall be effective in removing constituents of wastewater origin of interest to CDPH, including pharmaceuticals, personal care products, and endocrine disrupting compounds.
- The stabilized, disinfected product water shall be suitable for indirect potable reuse.

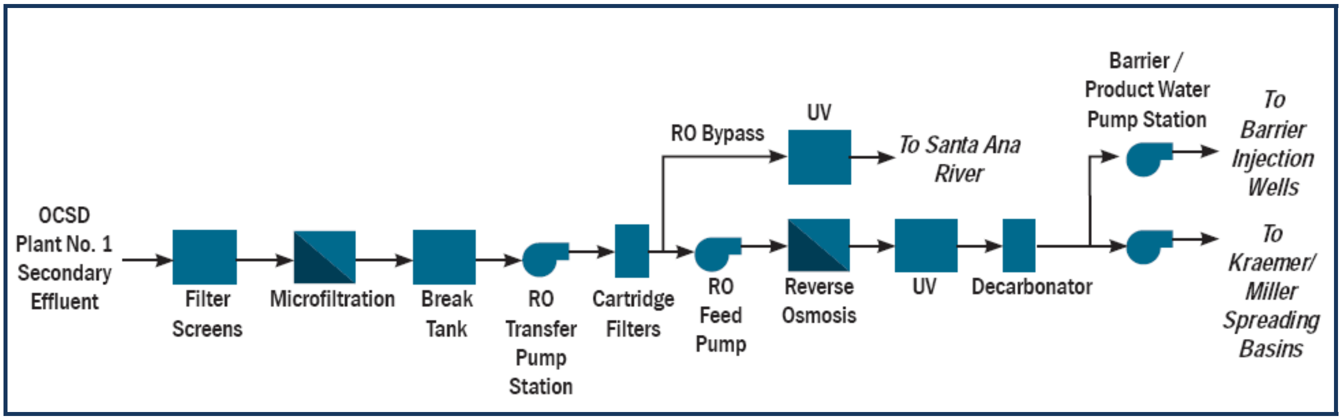
2.2 OCWD GWR System Project as Basis of Design

For the City's IPR project being developed as part of this RWMP, the OCWD GWR System process will be used as the basis of design and the basis for the pilot plant being developed under Task 3a, IPR Pilot Study. In order to implement the IPR project within the short time frame, the AWTP treatment processes will be based on the OCWD GWR System, which includes MF/UF, RO, UV/H_2O_2, and post-treatment. This decision was made because the GWR System process is proven and has been recently permitted for operation.

OCWD's GWR System supplements Orange County's existing water supplies by providing a new, reliable, high-quality source of water to recharge the groundwater basin and protect the basin from further degradation due to seawater intrusion. The GWR System treats secondary effluent from Orange County Sanitation District's (OCSD) Plant No. 1, diverting treated wastewater that would otherwise be discharged into the Pacific Ocean. By decreasing the amount of secondary effluent being discharged to the ocean, the GWR System provides peak wastewater flow disposal relief and has postponed OCSD's need for a new ocean outfall.

The GWR System's AWTP is located in Fountain Valley, California adjacent to OCSD Plant No. 1. The treatment system includes fine screening (2 millimeters), MF, RO, UV/H_2O_2, and post-treatment for product water stabilization to produce high-quality recycled water (see Figure 2-1). The plant was constructed between 2004 and 2007, began operating in November 2007, and began supplying product water for IPR in January 2008. The plant has an initial production capacity of 70 mgd and OCWD recently initiated a design project to expand the plant to 100 mgd. Based on the original master planning for the GWR System, the ultimate plant capacity is anticipated to be 130 mgd.

Figure 2-1: GWR System Process Flow Diagram



The GWR System concept is an outgrowth of the wastewater reclamation work pioneered by OCWD with implementation of Water Factory 21 (WF-21). Constructed in 1975, WF-21 produced recycled water using lime clarification and granular media filtration pretreatment, RO (a later upgrade), and UV (a later upgrade) for groundwater injection to prevent the inflow of seawater into the groundwater basin. The proven effectiveness of WF-21 led to the large-scale GWR System. Since WF-21 was nearing the end of its useful life, OCWD decided to replace WF-21 with the AWTP.

The RO process is the heart of the GWR System and removes a substantial portion of dissolved organic and inorganic components as well as viruses, producing permeate with low total dissolved solids (TDS) and total organic carbon (TOC) levels. MF is used to pretreat the secondary effluent prior to the RO process to remove suspended and colloidal solids, including bacteria and protozoa. UV/H_2O_2 is used after RO for additional bacterial and viral inactivation and oxidation of organic compounds. Finally, since the purity of the RO permeate stream results in a water that is free from stabilizing salts and moderately corrosive, the product water requires stabilization with pH adjustment and hardness addition, which is accomplished using carbon dioxide air strippers (degasifiers) and lime addition.

It is important to note that CDPH's Draft Groundwater Recharge Regulations (August 2008) require AOP to achieve a minimum 1.2-log reduction of N-nitrosodimethylamine (NDMA) and 0.5-log reduction of 1,4-dioxane, whether NDMA or 1,4-dioxane are present or not. These requirements were not in place when the permit was issued for the GWR System. While the draft regulations do not specify the treatment method that must be used, there is a general perception that UV/H_2O_2, as used by both the OCWD GWR System and the West Basin WRF, can achieve these targets.

In addition, alternative AOPs that may provide the required treatment at lower costs will be investigated as alternatives to UV/H_2O_2 and may be considered for future upgrades and/or expansions to the AWTP. The alternative AOPs are discussed in Attachment A.

2.3 Regulatory Requirements

The AWTP will be designed to meet the regulatory requirements for groundwater replenishment. As part of this master planning effort, a separate Regulatory Assessment TM is being developed under Task 1.1 which will outline the anticipated regulatory requirements associated with the AWTP water product and the groundwater recharge activities. In addition, the specific water quality goals for non-regulated compounds are being further developed as part of Task 3a, IPR Pilot Study.

Based on the assumption that recharge occurs in the Hansen, Pacoima, and possibly Tujunga spreading grounds, the permit limits (and associated treatment) would be established to:

1. Protect the groundwater beneficial uses utilizing the existing Los Angeles Basin Plan groundwater objectives and the SWRCB Recycled Water Policy provisions related to anti-degradation and any impacts of the project on existing areas of groundwater contamination or dissolution of naturally occurring chemicals, such as arsenic; and,
2. Take into consideration recommendations from the CDPH based on the agency's August 2008 draft groundwater recharge regulations.

These water quality-based requirements should easily be achieved based on the current DCT tertiary recycled water quality and/or through the application of advanced treatment. Additional studies must be undertaken to address the Recycled Water Policy requirements.

The key treatment issue for the AWTP relates to the CDPH requirements for advanced oxidation included in the draft groundwater recharge regulations. As discussed above, the draft regulations define AOP in terms of achieving at a minimum a 1.2-log NDMA reduction and 0.5 log 1,4-dioxane reduction, whether NDMA and 1,4-dixoane are present or not. Since NDMA formation and control may be plant specific, it will be important to have a good understanding of how the established form of advanced treatment (UV/H_2O_2) performs for a site-specific situation. The draft regulations note that performance criteria for RO are under discussion as well as the requirement for advanced oxidation for all projects that seek to increase their recycled water contributions (for increasing recycled water contributions (RWCs)). Since NDMA is the driver for the currently defined advanced oxidation process and will be the driver for any alternative processes, it will be critical for planning purposes to have a good understanding of the concentrations of NDMA from the feed water source, in this case DCT. Thus, information should be collected on NDMA coming into a DCT, what is removed during secondary treatment, and how NDMA can be produced in the plant (e.g., through chemical uses such as Mannich polymer that contains NDMA precursors, method of disinfection, etc.). As part of Task 1.2, the DCT Data Assessment TM (Section 4.4.1), an NDMA sampling plan is recommended to assess the NDMA concentrations at various points throughout the plant including primary effluent, secondary effluent, tertiary effluent (before and after chloramination).

Constituents of emerging concern, including NDMA and 1,4-dioxane, are discussed in the following section.

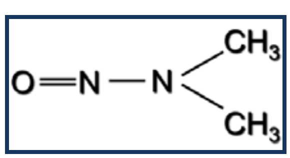
2.4 Constituents of Emerging Concern

Since the inception of the gas chromatograph/mass spectrometer in the mid-1970s, the ability to detect organic compounds in drinking water and wastewater has improved dramatically with time. During that same time, population density and economic development have reached record levels. Hence, today there are significantly more organic chemicals in the environment that can be observed, and these observations have the public's attention. Many of these compounds are probably not of great consequence, but our ability to understand their significance has not kept pace with our ability to measure their presence. As new compounds come to the public's attention, they are paid special interest if they are shown to be toxic, persistent, or to bioaccumulate. Notable among compounds that have received special attention during the past forty years are the pesticides, herbicides, disinfection by-products, solvents and their stabilizers, fuel oxygenates, fire retardants, and, more recently, pharmaceuticals and personal care products. As new compounds are identified, they are described as "constituents of emerging concern". Chloroform, trichloroethylene (TCE) and perchloroethylene (PCE) were once constituents of emerging concern. Today, the nitrosamines (NDMA), perchlorate, pharmaceuticals, DEET (N,N-diethyl-m-toluamide), bisphenol A, the perfluorooctane sulfonate (PFOS) and the perfluorooctanoic acid plus derivatives (PFOAs) might be considered as constituents of emerging concern, along with many others. This discussion addresses the principal constituents of emerging concern of interest in an indirect potable reuse project. In addition to those mentioned above, constituents of emerging concern include all the compounds on the United States Environmental Protection Agency's (USEPA) Contaminant Candidate List (CCL) and unregulated contaminant monitoring rule as well as all those compounds with a CDPH notification limit. Of special interest are those compounds directly addressed in the 2008 revision of the Draft Groundwater Recharge Reuse Regulations, namely NDMA, 1,4-dioxane, and the "Note 5 list." A brief discussion of each follows below.

2.4.1 NDMA

The USEPA considers NDMA to be a "probable human carcinogen" and, for California drinking water, the Office of Environmental Health Hazard Assessment (OEHHA) has established a public health goal (PHG) of 3 ng/L and CDPH has established a Notification Limit (NL) of 10 ng/L (USEPA, 2009; OEEHA, 2006; CDPH, 2002). Moreover, NDMA has been considered a carcinogen for some time (Magee, et al., 1976). NDMA and other members of the nitrosamine family of chemicals received considerable attention in the 1970s in connection with processed foods and beverages but they were not found in drinking water or domestic wastewater until turn of the century when analytical methods improved to the point where NDMA could be identified at sub-microgram/L levels (Taguchi et al., 1994). Subsequently, NDMA was found in groundwater down-gradient of rocket engine testing facilities, in water leaving ion exchange facilities designed to remove nitrate from drinking water and in wells influenced by Title 22 reuse projects (Najm and Trussell, 2001).

Figure 2-2: NDMA

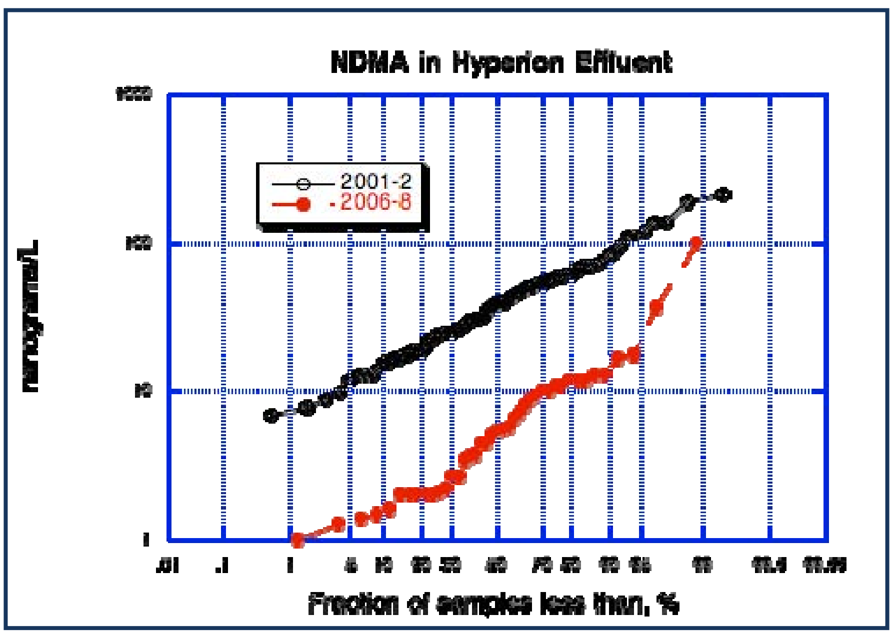


NDMA in Wastewater

In California, NDMA levels above the NL first appeared in drinking water near Aerojet Facilities in Rancho Cordova and in the San Gabriel Valley (CDPH, 2009). This led the California Department of Health Services (now CDPH) to conduct a statewide survey of NDMA in groundwater. In the survey, NDMA was also found at levels above the NL in two drinking water production wells influenced by the WF-21 project. Subsequent investigations conducted by the OCSD identified circuit board manufacturers using NDMA-contaminated dimethyldithiocarbamate as a principal source of NDMA in the WF-21 product water (OCSD, 2002). To address the NDMA, CDPH included a requirement for 1.2-log removal (i.e. 93.7 percent) of NDMA in their 2008 Draft Groundwater Recharge Reuse Regulations (CDPH, 2008).

In the meantime it has become clear that significant amounts of NDMA can also be formed during Title 22 chlorination (Najm and Trussell, 2001; Mitch and Sedlak, 2002; Brubacher et al., 2003, Sedlak et al., 2005). Thus, municipal effluents can become contaminated in two ways: 1) by the direct introduction of NDMA into the sewer system from industrial sources and 2) the formation of NDMA in the chlorination process. Now that industrial sources have been identified as a potential cause of contamination, this source of NDMA has come under the purview of industrial pretreatment programs administered by wastewater utilities and its significance has already begun to diminish, although more progress is still necessary. Figure 2-3 illustrates the improvement in NDMA levels in the Hyperion Treatment Plant (HTP) effluent as it is received at West Basin WRF.

Figure 2-3: Improvement in NDMA at HTP

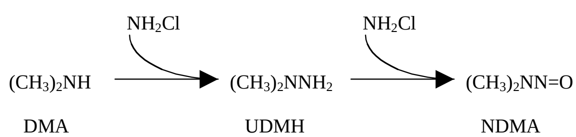


The formation of NDMA during Title 22 chlorination is a more complex process and the solution, other than avoiding chlorine altogether, is not straightforward. The following discussion provides perspective on the industry's current understanding.

NDMA Formation during Chlorination

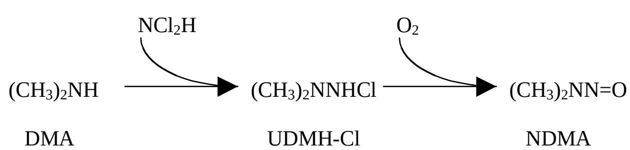
Since NDMA was first discovered to be a by-product of wastewater chlorination, a great deal has been learned about the causes and what can be done to manage the reaction, however more information is required to completely prevent its formation. Although the information below will highlight means of controlling NDMA formation in the DCT IPR project, all of the benefits offered by these reductions in NDMA formation are not likely to be realized in the first DCT IPR project phase.

The amount of NDMA formed during Title 22 chlorination is often substantial when compared to the California PHG and NL. Studies have shown that some of the precursors to NDMA formation in wastewater originate from industrial discharges (Sedlak, et al., 2005), but others originate from the use of polyelectroytes necessary for biological treatment, particularly when Mannich polymers are used for foam control in nitrification-dentrification processes (Neisses, et al., 2003). All researchers agree that the principal precursor is dimethylamine (DMA), either the nascent compound or the functional group on polymers or resins (Najm and Trussell, 2001). Originally the principal mechanism was thought to be a reaction with monochloramine to form unsymmetrical dimethylhydrazine (UDMH) (Choi and Valentine, 2002, Mitch and Sedlak, 2002):



Original UMDH Mechanism
Choi & Valentine, 2002
Mitch & Sedklak, 2002

However, subsequent research has made it clear that a reaction based on the formation of chlorinated unsymmetrical dimethylhydrazyne is much more productive (Schreiber and Mitch, 2006):



UMDH-Cl Mechanism
Schreiber & Mitch, 2006

These differences are significant because the UDMH mechanism suggested that monochloramine (NH_2Cl) was the principal reactant but the UDMH-Cl mechanism suggests that NDMA will be formed much more rapidly when dichloramine ($NHCl_2$) is present. This provides some tools to address the problem, as certain conditions, such as low pH, high chlorine to ammonia ratios, and poor mixing promote the formation of dichloramine, are known. For example, the use of pre-formed chloramines (monochloramine) has shown some success in reducing NDMA formation (Mitch et al, 2005). The UDMH-Cl mechanism also requires the presence of oxygen, but this is not deemed as significant because eliminating oxygen is not practical.

Studies undertaken by the Los Angeles County Sanitation Districts (LACSD) and others reached the following conclusions, which are applicable to this RWMP:

1) Influent NDMA concentrations in raw sewage can vary widely,

2) The biological process is capable of removing approximately 70 percent of the influent NDMA,

3) The use of Mannich-based cationic polymer for settling and foam control contributes small amounts of NDMA and substantially increases NDMA precursors,

4) Chloramination causes significant NDMA formation, but free chlorine does not,

5) The use of UV doses suitable for Title 22 disinfection results in NDMA reductions of approximately 30 to 40 percent, and

6) The provision of a free chlorine residual for a short period of time before chloramination to oxidize NDMA precursors (LACSD refers to this as "sequential chlorination"), can substantially reduce NDMA formation, even when Mannich polymers are in use (Huitric, et al., 2005, Mitch et al., 2005; Tang et al., 2006; Huitric, et al., 2007).

Based on the information presented, it would appear that, with the right provisions, the presence of NDMA in the secondary or tertiary effluent entering the AWT Facility can be minimized, but that it is less likely that the means will be found to eliminate NDMA formation during chloramination. As a result, chloraminated Title 22 effluent should be avoided as a potential source water for the AWT facility.

It is important to note that both the OCWD GWR System and the West Basin WRF treat non-nitrified wastewater with polypropylene (PP) MF units. These older membranes cannot tolerate free chlorine, however, because of the abundant ammonia concentrations in these non-nitrified wastewaters (e.g., 25 to 40 mg/L-N), chloramines are carried through these facilities to control biofouling on the PP MF and RO membranes, but this exposure to chloramines results in additional NDMA formation. As a result, these facilities require the use of intensive UV to remove the NDMA they create (approximately 1,000 mJ/cm^2 vs. the 80 mJ/cm^2 required for Title 22 disinfection of RO effluent).

This IPR project has the potential to find a lower energy solution. Modern MF and UF membranes are tolerant to free chlorine and the DCT plant produces a completely nitrified effluent. These two circumstances combine to allow the use of LACSD's "sequential chlorination" strategy to minimize NDMA formation. A free chlorine residual would be carried through the MF (oxidizing NDMA precursors in the DCT effluent while preventing biofouling of the MF membranes) and the ammonia would be added to the MF permeate to convert the free chlorine to combined chlorine, preventing excess THM formation while forming a residual suitable for preventing biofilm formation on the RO membranes (which also cannot tolerate free chlorine).

Pilot-scale testing is necessary to prove these concepts and determine to exactly what level NDMA concentrations can be maintained at DCT because there will still be a short period of chloramination that is required for biofouling control in the reverse osmosis (RO) process and some precursors may remain. Additionally, the background NDMA level in the secondary effluent is currently unknown and should be quantified throughout the pilot testing effort. The pilot-scale testing will need to consider special precautions such as careful mixing and possible pH control and/or preformed monochloramine to further minimize NDMA formation. The following principles are recommended for NDMA control in the first phase of the IPR project at DCT:

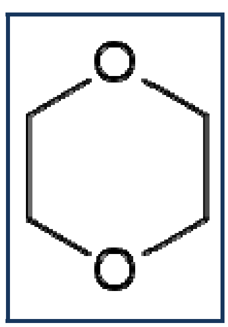
1. The influent for the AWT facility should be secondary or tertiary effluent drawn upstream of any chlorine addition point(s).
2. A strong oxidant (either ozonation or free chlorine residual) should be dosed prior to the membrane filtration pretreatment process to oxidize NDMA precursors before chloramines are used.
3. A chloramine residual should be added immediately upstream of the RO process for biofouling control and special considerations should be made for considering preformed chloramines.

2.4.2 1,4-Dioxane

Another constituent of concern identified by CDPH draft groundwater recharge regulations is 1,4-dioxane. 1,4-dioxane is a synthetic compound that is classified as a probable human carcinogen. It is primarily derived from industrial processes where it is used as an industrial solvent or solvent stabilizer. It can also be an industrial by-product in the manufacturing of polyester and various polyethoxylated compounds. 1,4-Dioxane can also be found in automotive coolant and many cosmetics, deodorants, shampoos and detergents. The draft groundwater recharge regulations require that the AWT treatment train include an AOP that is capable of achieving 0.5-log 1,4-dioxane removal (e.g., 68 percent).

In 2002, OCWD detected 1,4-dioxane at WF-21 in water produced for the seawater intrusion barrier that was above the CDPH action level of 3 ug/L. The molecular weight of 1,4-dioxane is only 88 g/mol, making this molecule small enough that effective removal by the reverse osmosis process will not occur (Drewes et al., 2006). While 1,4-dioxane is not effectively removed by the reverse osmosis process, recent work has identified that 1,4-dioxane can be biologically oxidized directly and cometabolized by monooxygenase (Mahendra et al., 2007). While source control and secondary effluent sampling are necessary to assess the concentrations at the DCT for the overall AWT Facility design, it is anticipated that 1,4-dioxane concentrations at DCT will be less than those observed at the GWR System or West Basin WRF (e.g., maximum 3.3 ug/L) because DCT provides complete nitrification. The autotrophic bacteria that biologically nitrify ammonia to nitrate utilize an ammonia monooxygenase and it is likely that this enzyme can also oxidize 1,4-dioxane (Mahendra et al., 2007).

Figure 2-4: 1,4-Dioxane



Although 1,4-dioxane removal requirements are included in the existing draft regulations, the following alternative AOP discussions will highlight that any alternative process to UV/H_2O_2 will easily achieve the required 0.5-log 1,4-dioxane removal prior to achieving the required 1.2-log NDMA removal. Additionally, the OCWD has found source control to be an effective means of addressing 1,4-dioxane and while the detection limit is currently 1 ug/L, the average RO feedwater concentration is only 1.8 ug/L. The laboratory results from the OCWD GWR System have never had a detection in the RO or UV/H_2O_2 product water with all values less than 1 ug/L. So, while 1,4-dioxane appeared to be an ideal candidate (i.e., a carcinogenic low molecular weight molecule known to pass through the RO process) for monitoring the AOP performance, AWT facilities with properly implemented source control programs are not likely to find high enough concentrations of 1,4-dioxane to quantify the required CDPH log removal through the AOP. Considering these facts, it is important to evaluate alternate constituents of emerging concern to establish a verifiable AOP unit design.

2.4.3 Potential Sentinels for Constituents of Emerging Concern

An additional goal of the AWT process train is to assure that this highly treated wastewater does not contain any contaminants that may have unknown adverse impacts to the public water supply. Thus, it is important that the AWT address any contaminants that may potentially pass through the process train and accumulate in the groundwater supply. The National Research Council (NRC) Report, *Issues in Potable Reuse,* proposes the use of sentinal parameters, which might provide early warning of process failure (NRC, 1998). It is also possible to identify certain constituents of emerging concern that might serve as sentinels of this kind. Although CDPH does not provide a specific list of constituents of emerging concern that must be monitored, CDPH does request that a monitoring program be developed for each IPR project. To assist in developing an appropriate list for the DCT project, it is important to consider the following:

1. The likely frequency of occurrence and the anticipated concentration to assure the contaminant will be measured well above the method detection limit

2. Select contaminants that are most likely to challenge the established AWT train (i.e. poorly rejected by RO or recalcitrant)

There have been quite a few lists of potential constituents of emerging concern in recent years and these lists were considered in the development of this section. In response to public hearings, CDPH first published "Note 5" in 2003, but this was never intended to be "the list" upon which projects should be based. However, the list of 27 compounds included in Endnote 5 of the August 2008 CDPH Draft Groundwater Recharge Reuse Regulations definitely provides insight into the constituents of emerging concern most of concern to CDPH at the time. Many of the contaminants on this list can be addressed by biological treatment combined with the RO process. More recently, the Independent Advisory Panel (IAP) appointed to review the West Basin WRF's performance as part of their CDPH approval process to allow groundwater recharge with 100 percent recycled water, developed the list of contaminants presented in Table 2-1. These compounds were selected to evaluate the effectiveness of the West Basin WRF AWT train and were not chosen based upon their potential health risk.

Table 2-1: West Basin's 2008 Independent Advisory Panel's Contaminant List

Constituent of Concern	Source
Atrazine	herbicide
Boron	natural occurring metalloid
Carbamazepine	anticonvulsant
N,N-Diethyl-m-toluamide (DEET)	insecticide
1,4-Dioxane	solvent and personal care products
Estrone	natural hormone
Gemfibrozil	lipid regulator
Iopromide	iodinated X
Meprobamate	Anti-anxiety
Phenytoin	antiepileptic
Sulfamethoxazole	antibiotic
Tris(2-chloroethyl) phosphate (TCEP)	fire retardant

Snyder et al. (2007) developed an occurrence list based upon samples collected from 23 source waters; some of these sources were reclaimed water. The most commonly detected compounds were: dilantin (detected in 21 of 23 waters or 21/23), meprobamate (21/23), sulfamethoxazole (21/23), atrazine (20/23), carbamazepine (19/23), gemfibrozil (18/23), atenolol (17/23), trimethoprin (17/23), estrone (17/23), naproxen (16/23), and TCEP (15/23). These commonly detected compounds are almost ubiquitous in our water supplies, making them an excellent choice for potential sentinels to evaluate the AWT train performance.

In addition to the relative occurrence of a contaminant, it is important that the compound pose a significant challenge to the AWT train so that an evaluation of its removal can serve as a measure of the facility's performance. The treatment processes that are providing a majority of the water quality improvements, or contaminant removal/oxidation, are the RO and advanced oxidation processes. The RO process is performing a large majority of the overall removal, typically removing 97 to 99 percent of the TOC. In fact, it is difficult for many of these potential sentinel contaminants to pass through the RO process. Table 2-2 presents the removal rates through the RO process for many of the constituents of emerging concern considered as possible sentinels that are available in the literature. It is important to note that much of the work presented in Table 2-2 was performed at the bench- or pilot-scale and nanofiltration (NF) membranes along with looser, "low energy" (LE) RO membranes were often employed. These "loose" RO membranes are not typically employed at full-scale AWT facilities due to accelerated membrane fouling rates associated with these products. The most meaningful information can be gleamed from Synder et al. (2007) where sampling was performed from the West Basin WRF's full-scale facility (Site 1 in Table 2-2). Based upon this data set, the following compounds are of interest because they were all present at quantifiable concentrations in the RO permeate: DEET, galaxolide, gemfibrozil, naproxen, oxybenzone, TCEP, and sulfamethoxazole.

Comparing the contaminants identified by West Basin's IAP, the ubiquitous compounds identified by Snyder et al. (2007), and the compounds identified to pass through the full-scale RO process, the potential sentinels can be narrowed down to the following three compounds: (1) gemfibrozil, (2) TCEP, and (3) sulfamethoxazole.

Table 2-2: Summary Table of Emerging Contaminant Rejections in Published Literature

Study	Snyder et al.(2007)		Drewes et al. (2006)	Amy et al. (2005)		Oppenheimer et al. (2008)			
Process	MF/RO	MF/RO	RO	RO	NF	RO 1	RO 2	RO 3	RO 4
RO or NF Membrane	Hydranautics ESPA 2	Hydranautics ESPA 2	Koch TFC-HR 8040	Dow FilmTec LE-440	Dow FilmTec NF-90	Not Specified	Not Specified	Not Specified	Not Specified
Site	Site 1	Site 2	N/A	N/A	N/A				
Chemical	**% Rejection by RO or NF Membranes**								
Acetaminophen	-	> 90.0%	-	-	-	-	-	-	-
Bromoform[a]	-	-	35%	-	32%	-	-	-	-
Caffeine	> 99.0%	99.7%	-	-	-	-	-	-	-
Carbamazepine	> 99.6%	> 99.6%	-	18%	21%	> 99.7%	> 99.7%	99.6%	> 99.7%
Chloroform[a]	-	-	20%	-	30%	-	-	-	-
Clofibric acid	-	-	-	87%	86%	-	-	-	-
DEET	99.8%	99.9%	-	-	-	> 99.4%	> 99.4%	99.3%	> 99.4%
Diclofenac	> 98.3%	> 98.0%	94.3%	91%	90%	> 98.1%	> 98.1%	> 98.1%	> 98.1%
Dilantin	> 99.4%	> 99.7%	-	-	-	> 99.5%	> 99.5%	99.5%	> 99.5%
Erythromycin-H_2O	> 99.4%	> 99.8%	-	-	-	> 99.6%	> 99.6%	> 99.6%	> 99.6%
Estradiol	> 92.9%	-	-	-	-	-	-	-	-
Estrone	> 99.4%	> 98.4%	-	-	-	-	-	-	-
Fluoxetine	-	> 95.7%	-	-	-	> 96.7%	> 96.7%	> 96.7%	> 96.7%
Galaxolide	99.0%	-	-	-	-	-	-	-	-
Gemfibrozil	99.9%	99.9%	96.2%	-	-	> 99.8%	> 99.8%	> 99.8%	> 99.8%
Hydrocodone	> 98.0%	> 99.0%	-	-	-	> 98%	> 98%	> 98%	> 98%
Ibuprofen	> 99.8%	> 99.8%	88.0%	92%	87%	> 95.7%	> 95.7%	> 95.7%	> 95.7%
Iopromide	> 99.2%	99.9%	-	-	-	99.8%	> 99.8%	> 99.8%	> 99.8%
Ketoprofen	-	-	94.4%	-	-	-	-	-	-
Mecoprop	-	-	91.4%	-	-	-	-	-	-
Meprobamate	> 99.6%	> 99.7%	-	-	-	> 99.5%	> 99.5%	> 99.5%	> 99.5%
Musk Ketone	> 85.3%	-	-	-	-	-	-	-	-
Naproxen	99.8%	99.8%	95.9%	75%	89%	> 98.8%	> 98.8%	> 98.8%	> 98.8%
Oxybenzone	92.1%	96.8%	-	-	-	-	-	-	-
Pentoxifylline	> 97.0%	> 99.1%	-	-	-	-	-	-	-
Phenacetine	-	-	82.7%	53%	38%	-	-	-	-
Primidone	-	-	-	81%	86%	-	-	-	-
Propylphenazone	-	-	91.7%	-	-	-	-	-	-
Sulfamethoxazole	99.8%	99.8%	-	-	-	> 99.8%	> 99.8%	> 99.8%	> 99.8%
TCEP	98.0%	99.6%	> 85.0%	-	-	> 95.3%	> 95.3%	> 95.3%	> 95.3%
Triclosan	> 98.4%	> 99.8%	-	-	-	-	-	-	-

Study	Snyder et al.(2007)		Drewes et al. (2006)	Amy et al. (2005)		Oppenheimer et al. (2008)			
Trimethoprim	> 99.6%	> 99.8%	-	-	-	> 99.6%	> 99.6%	> 99.6%	> 99.6%
Acetaminophen	-	> 90.0%	-	-	-	-	-	-	-
Bromoform[a]	-	-	35%	-	32%	-	-	-	-
Caffeine	> 99.0%	99.7%	-	-	-	-	-	-	-
Carbamazepine	> 99.6%	> 99.6%	-	18%	21%	> 99.7%	> 99.7%	99.6%	> 99.7%
Chloroform[a]	-	-	20%	-	30%	-	-	-	-
Clofibric acid	-	-	-	87%	86%	-	-	-	-
DEET	99.8%	99.9%	-	-	-	> 99.4%	> 99.4%	99.3%	> 99.4%
Diclofenac	> 98.3%	> 98.0%	94.3%	91%	90%	> 98.1%	> 98.1%	> 98.1%	> 98.1%
Dilantin	> 99.4%	> 99.7%	-	-	-	> 99.5%	> 99.5%	99.5%	> 99.5%
Erythromycin-H_2O	> 99.4%	> 99.8%	-	-	-	> 99.6%	> 99.6%	> 99.6%	> 99.6%
Estradiol	> 92.9%	-	-	-	-	-	-	-	-
Estrone	> 99.4%	> 98.4%	-	-	-	-	-	-	-
Fluoxetine	-	> 95.7%	-	-	-	> 96.7%	> 96.7%	> 96.7%	> 96.7%
Galaxolide	99.0%	-	-	-	-	-	-	-	-
Gemfibrozil	99.9%	99.9%	96.2%	-	-	> 99.8%	> 99.8%	> 99.8%	> 99.8%
Hydrocodone	> 98.0%	> 99.0%	-	-	-	> 98%	> 98%	> 98%	> 98%
Ibuprofen	> 99.8%	> 99.8%	88.0%	92%	87%	> 95.7%	> 95.7%	> 95.7%	> 95.7%
Iopromide	> 99.2%	99.9%	-	-	-	99.8%	> 99.8%	> 99.8%	> 99.8%
Ketoprofen	-	-	94.4%	-	-	-	-	-	-
Mecoprop	-	-	91.4%	-	-	-	-	-	-
Meprobamate	> 99.6%	> 99.7%	-	-	-	> 99.5%	> 99.5%	> 99.5%	> 99.5%
Musk Ketone	> 85.3%	-	-	-	-	-	-	-	-
Naproxen	99.8%	99.8%	95.9%	75%	89%	> 98.8%	> 98.8%	> 98.8%	> 98.8%
Oxybenzone	92.1%	96.8%	-	-	-	-	-	-	-
Pentoxifylline	> 97.0%	> 99.1%	-	-	-	-	-	-	-
Phenacetine	-	-	82.7%	53%	38%	-	-	-	-
Primidone	-	-	-	81%	86%	-	-	-	-
Propylphenazone	-	-	91.7%	-	-	-	-	-	-
Sulfamethoxazole	99.8%	99.8%	-	-	-	> 99.8%	> 99.8%	> 99.8%	> 99.8%
TCEP	98.0%	99.6%	> 85.0%	-	-	> 95.3%	> 95.3%	> 95.3%	> 95.3%
Triclosan	> 98.4%	> 99.8%	-	-	-	-	-	-	-
Trimethoprim	> 99.6%	> 99.8%	-	-	-	> 99.6%	> 99.6%	> 99.6%	> 99.6%

Footnotes:

a. Bromoform and chloroform rejection from Xu et al. (2005)

Since the compounds that are likely to be measured in the RO permeate at detectable concentrations has been determined, it is important to determine which of these compounds is the most resistant to oxidation. Table 2-3 presents the reaction rate constants (k) with ozone (O_3) and hydroxyl radical (HO•) for the majority of the contaminants of concern identified in this section. Comparing the available rate constants amongst the three potential sentinel contaminants, TCEP is the most resistant compound to oxidation by HO•. All of the compounds presented in Table 2-3 react slower with ozone because its oxidative power is significantly less than HO•.

Considering the three potential sentinel contaminants, the compounds can be placed in the following order:

(1) gemfibrozil (easiest to oxidize at 1 x10^{10} $M^{-1}s^{-1}$),

(2) sulfamethoxazole (moderate at 5.5 x 10^9 $M^{-1}s^{-1}$) and

(3) TCEP (resistant at 5.6 x 10^8 $M^{-1}s^{-1}$).

In fact, the only contaminant as resistant to oxidation by HO• is NDMA at 4.3 x 10^8 $M^{-1}s^{-1}$.

Table 2-3: Reaction Rate Constants for Constituents of Emerging Concern

Constituent	K_{O3}, $M^{-1}S^{-1}$	$K_{HO•}$, $M^{-1}S^{-1}$	Source
Atrazine	6	3 x 10^9	30
Carbamazepine	3 x 10^5	8.8 x 10^9	29
DEET	-	4.95 x 10^9	19
1,4-Dioxane	0.32	2.8 x 10^9	25,26
Estrone	9.4 x 10^5	1.6 x 10^{10}	20
Gemfibrozil	-	1 x 10^{10}	27
Iopromide	0.8	3.3 x 10^9	29
Phenytoin	-	6.28 x 10^9	21
Sulfamethoxazole	2.5 x 10^6	5.5 x 10^9	29
TCEP	-	5.6 x 10^8	28
NDMA	0.052	4.3 x 10^8	22,23
Atenolol	1700	8 x 10^9	24

Since TCEP has been a potential contaminant on prior CDPH lists, is a contaminant on the recent IAP from West Basin, has been shown to be ubiquitous, has been shown to pass through the RO process at AWT facilities, and has an oxidation rate almost equivalent to that of NDMA to OH*, it is recommended that TCEP removal be monitored as a basis of design for the AWTP.

2.5 Preliminary AWTP Design Capacity

As stated above, the City's goal for the IPR project is to reuse a minimum 15,000 AFY. The actual capacity of the AWTP will depend on multiple parameters, including the following:

- The quantity of DCT effluent that will be available for the AWTP when considering how much wastewater flow can be routed to DCT and after accounting for existing effluent uses, new Title 22 customers to be identified as part of Task 2, and the minimum flow required for the LA River. The flow available for DCT recycled water projects (both IPR and NPR) will be addressed in the DCT Maximum Flow Assessment TM (Task 1.6.).
- The quantity of recycled water that can be infiltrated into the groundwater basin for the initial operation is limited to a blend of 50/50 recycled water and surface water for infiltration and a future goal of 100 percent recycled water. This will be assessed as part of the Groundwater Replenishment Operational Scenarios TM.
- Planning for the AWTP to be out of service a portion of the time to accommodate:
    - Wet weather conditions when groundwater recharge operations with recycled water will be suspended to allow for recharge with surface water
    - Taking the plant out of service for maintenance and allowing for power interruptions, which is typical for AWTPs because they are not critical treatment processes.

Setting the actual capacity of the AWTP will be an iterative process that takes into account the above parameters. The analyses described above will be completed as part of Task 1a, so the capacity of the AWTP will be refined as part of the IPR Master Plan (Task 1b).

For the purpose of this TM and the Site Assessment (Task 1.5), the AWTP capacity is preliminarily set at 20 mgd for the initial design and 40 mgd for a potential future expansion. Assuming the plant is online approximately 90 percent of the time, the AWTP would produce approximately 20,000 AFY for the initial design. Depending on the results of the above analyses, this capacity should allow the plant to achieve the recycled water recharge goals of 15,000 AFY (13.4 mgd), while conservatively planning for space requirements in the site assessment.

Table 2-4 summarizes the preliminary AWTP design flows for the initial design and the future expansion that will be used for the site assessment. These flows will be refined once the DCT maximum flow assessment (Task 1.6) and the groundwater evaluation (Task 1.3) are completed.

Table 2-4: Preliminary AWTP Design Capacity [a]

Description	Initial Design	Future Expansion
Estimated Influent Flow (DCT Effluent) [b]	25.3 mgd	50.6 mgd
Target Effluent Flow	20 mgd	40 mgd

Footnotes:

a. Initial AWTP design capacity will be refined once the DCT maximum flow assessment (Task 1.6) and the groundwater evaluation (Task 1.3) are completed.

b. Assumes 93% MF/UF recovery and 85% RO recovery.

2.6 AWTP Feed Water Source

Generally it is advisable to use the cleanest water available as the feed water for an AWTP. Since there are chemical addition points at the tertiary filters, the quality of the DCT secondary effluent is better than a typical secondary effluent, and potential cost savings of not running all of the tertiary filters, it warrants further investigation of using secondary effluent. (Note that a description of DCT is included in the Task 1.2 TM, DCT Data Summary TM). Therefore, at DCT, there are two potential feed water sources for the AWTP:

- Secondary effluent
- Tertiary effluent before chloramination

As recommended in Section 2.3 above, tertiary effluent after chloramination should not be considered as a potential feed water for the AWTP because of the NDMA formation during chloramination.

The primary advantages and disadvantages of these two feed water sources are potential operational improvements or impacts on the MF/UF process due to lower/higher TSS concentrations (i.e., lower TSS concentration would be expected to provide MF operational improvements and vice versa). Using a higher-quality effluent (i.e., tertiary effluent) would be expected to improve MF/UF operations with potentially longer operating periods between backwashes. Because DCT produces higher-quality secondary effluent since the plant converted to nitrification denitrification (NdeN) in 2007, it is thought that the MF/UF operations may not vary substantially between the two water sources.

DCT has the ability to add Mannich polymer upstream of the filters; this could be a concern because Mannich polymer is an NDMA precursor, but the dose is limited to a "drip" and is not anticipated to cause an issue. DCT also has the ability to chlorinate the filters, which periodically create NDMA.

The advantages and disadvantages of using secondary effluent versus tertiary effluent are summarized in Table 2-5. The alternative feed water sources will be evaluated further during the pilot study. The site assessment evaluation (Task 1.5) will consider locations for the AWTP plant other than DCT, which will also require further evaluation of distributing non-chlorinated secondary or tertiary effluent to a potential remote site. If distributing non-chloraminated effluent is not feasible, then careful considerations must be made at the pilot study for treating a recycled water supply with higher NDMA concentrations than non-chlorinated effluent.

Table 2-5: Feed Water Comparison

Feed Water	Advantages	Disadvantages	Notes
Secondary Effluent	• Potential to reduce operating cost because DCT would not need to operate tertiary filters at full capacity • Upstream of tertiary filtration polymer dosing point • AWTP would not be impacted by periodic filter chlorination[a]	• Higher TSS and turbidity than tertiary effluent and possibly more frequent backwashes for MF/UF	• Connection point would be upstream of polymer dosing point
Tertiary Effluent (not chloraminated)	• Lower TSS and turbidity than secondary effluent and possibly less frequent backwashed for MF/UF	• Requires operation of full capacity of tertiary filters to provide tertiary effluent to AWTP • May have higher potential to form NDMA due to polymer dosing point upstream of filters • Periodic filter chlorination[a]	• Connection point would be upstream of ammonia and chlorine dosing points

Footnotes:

a. The future filter chlorination frequency is unknown since the filters are currently under construction. The temporary cloth filters require chlorination once every three months.

3. Advanced Water Treatment Components

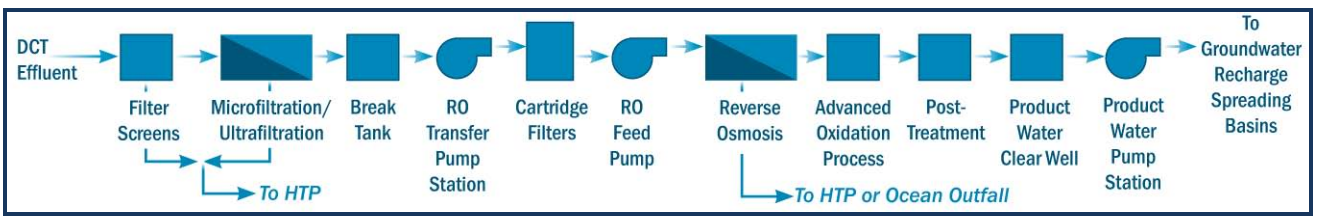
3.1 Overview

As previously discussed in Section 2, the proposed AWTP will be designed to treat secondary effluent or tertiary effluent before chloramination from DCT to produce up to 20 mgd (20,000 AFY) of high quality product water for groundwater recharge. The advance water treatment primarily consists of the following treatment processes:

- Chemical Addition
- Fine Screening
- MF or UF
- Break Tank, RO Transfer Pump Station, and Cartridge Filters
- RO
- Advanced Oxidation
- Post-Treatment/Stabilization

The proposed treatment train is presented in Figure 3-1.

Figure 3-1 Process Flow Diagram of Proposed Treatment Train



3.2 Chemical Addition

A disinfectant residual must be maintained through the RO process to prevent membrane biofouling. Because modern RO membranes are intolerant to free chlorine, sodium hypochlorite and aqueous ammonia must be added to the nitrified DCT effluent to produce chloramines prior to the RO process. As discussed in Section 2.4.1, sequential chlorination can be used to be minimize NDMA formation and can also be sued to prevent membrane fouling in the MF/RO treatment train. Chlorine (e.g., sodium hypochlorite) should be dosed prior the MF/UF process and ammonia will be dosed prior to the RO process to maintain a chloramine residual to control biofouling in the RO process.

3.3 Fine Screening

Different MF/UF membrane filtration systems have different feed water quality requirements for protecting their membranes from damage by large particles. It is recommended that all system suppliers provide pre-screening of the MF/UF feed water to remove suspended solids particles greater than 0.1 to 2 mm (100 to 2,000 micron depending on the system manufacturer).

3.4 Microfiltration/Ultrafiltration

Systems employing the RO technology in wastewater applications require pretreatment to ensure a suitable feed water that minimizes fouling by suspended solids and colloidal matter. In most installations, RO pretreatment is achieved by an MF or UF membrane system. These membrane filtration systems remove approximately 100 percent of the total suspended and colloidal solids and approximately 99.9 percent of the pathogens (e.g., *giardia lamblia* and cryptosporidium cysts, bacteria). While an enhanced coagulation system might provide similar TSS removal, an MF/UF system removes additional colloidal material and is a proven configuration upstream of the RO units that has been successfully implemented in numerous full-scale installations worldwide, including the GWR System, with stringent effluent requirements similar to those of the AWTP.

The difference between MF and UF is in the nominal pore size. MF membranes have a nominal pore size between 0.1 and 0.2 µm, whereas UF membranes have a nominal pore size between 0.01 and 0.04 µm. Due to this tighter pore size distribution, UF membranes have been shown to produce a superior RO feedwater quality than MF membranes, especially when implemented downstream of a coagulant process (Digiano et. al, 2007), however, in most cases the two technologies are used interchangeably, operating at similar pressures, removal rates, and fouling rates.

The membranes most commonly used are made from three common materials: polypropylene (PP), polyvinylidene fluoride (PVDF), and polyethersulfone (PES). PVDF materials have high free chlorine tolerance with high permeability and are the most common material used in new drinking water treatment applications. The material also has a high resistance to both biological foulants and oxidants. PES materials are slightly less tolerant to free chlorine than PVDF, which may limit cleaning opportunities with high chlorine concentrations (> 500 mg/L) but will not impact regular operation. PP membranes have a very low tolerance to free chlorine, but are the membranes most used at existing AWTPs in California.

For all MF/UF systems, the membrane geometry is a hollow fiber membrane, where several membranes are wrapped in a tubular formation with a hollow center. The feed water is generally introduced from the outside of the membranes, "outside-in" (see Figure 3-2), except for the Kruger/Norit system, where the flow is "inside-out" (see Figure 3-3).

Figure 3-2: Outside-In Filtration Process through Hollow Fiber MF/UF Membranes (Source: Siemens Memcor CP Product Guide)

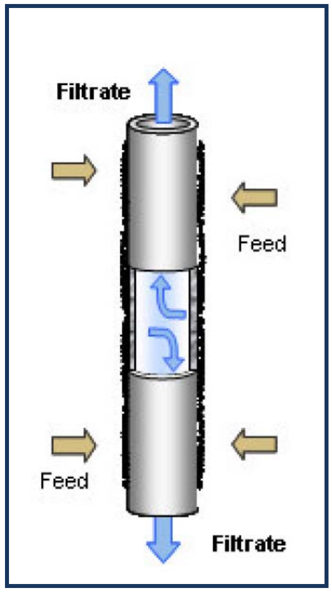
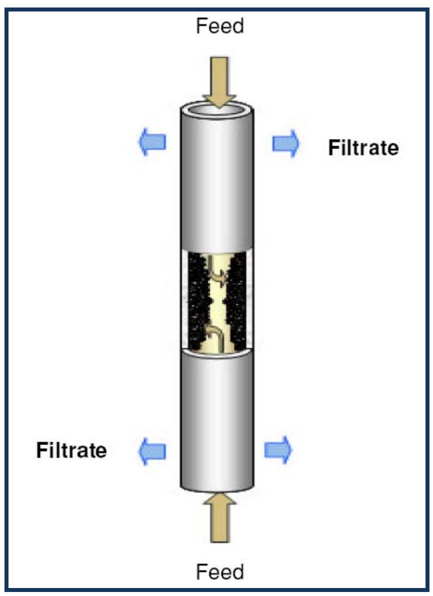


Figure 3-3: Inside-Out Filtration Process through Hollow Fiber MF/UF Membranes (Source: Siemens Memcor CP Product Guide)



The flow is pressure or vacuum driven though the fibers, and is collected in the hollow area within the vessel. All of the retained solids are concentrated in a waste stream that is discharged from the membrane system during periodic backwashes. MF/UF systems also utilize a clean-in-place (CIP) system to provide regenerative cleaning of the MF/UF membranes with chemical addition, typically consisting of acid and sodium hypochlorite cleaning (unless PP membranes are used).

MF/UF systems are available in immersed or pressurized systems. MF/UF systems use different module configurations depending on the system. Pressurized system configurations use a pump to apply a trans-membrane pressure to the feed, while the filtrate water is at roughly atmospheric pressure. In submerged system configuration, membranes are suspended in a basin and the feed water is at atmospheric pressure. In this scenario, a pump is used to provide vacuum pressure on the filtrate side of the membrane. In both instances, the pressure difference generated across the membranes drives the filtration process.

Figure 3-4 shows the MF pressure system at Terminal Island Water Reclamation Plant (TIWRP).

Figure 3-4: Siemens Memcor MF System at TIWRP

Seven MF/UF systems that could be considered for the AWTP include:

- Siemens– Memcor Submerged UF System
- Siemens – Memcor Pressure UF System
- Pall – Aria Pressurized MF System using Microza Membranes
- Kruger – Norit Pressurized UF System
- GE/Zenon – Zeeweed Submerged UF System
- Toray – Pressurized UF System
- Dow – Pressurized UF System

The comparison of these seven MF/UF systems is summarized in Table 3-1.

Table 3-1: MF/UF Membrane Systems Comparison

	Siemens Submerged	Siemens Pressure	Pall Pressure	Kruger/Norit Pressure	GE/Zenon Submerged	Toray Pressure	Dow Pressure
Company Name	Siemens Water Technologies	Siemens Water Technologies	Pall Corporation	Veolia Water Solutions & Technology Company	GE Water & Process Technologies	Toray Membrane USA, Inc.	Dow Water and Process Solution
Membrane Module							
Membrane Material	PP or PVDF	PP or PVDF	PVDF	PES	PVDF	PVDF	PVDF
Membrane Type	Hollow Fiber	Hollow Fiber	Hollow Fiber	Hollow fiber	Hollow Fiber	Hollow Fiber	Hollow Fiber
Nominal Pore Size (micrometer)	0.1 (PP) 0.04 (PVDF)	0.1 (PP) 0.04 (PVDF)	0.1	0.02	0.02	0.02	0.03
Flow pattern	Submerged, Outside-in	Pressure, Outside-in	Pressure, Outside-in	Pressure, Inside-out	Submerged, Outside-in	Pressure, Outside-in	Pressure, Outside-in
CDPH Removal Credit for Giardia/Cryptosporidium/ Viruses	4/4/0.5 for PP 4/4/1.5 for PVDF	4/4/0.5 for PP 4/4/1.5 for PVDF	4/4/0.5	4/4/4	4/4/3.5	4/4/1.5	4/4/2.5
Benefits	Proven history at GWRS and West Basin (PP); High chlorine tolerance (PVDF)	Proven history at GWRS and West Basin (PP); High chlorine tolerance (PVDF)	High chlorine tolerance; History of low fiber breakage rate	Better tolerance to coagulants than PVDF	High chlorine tolerance	High chlorine tolerance	High chlorine tolerance
Challenges	No free chlorine tolerance (PP); Coagulants may cause fouling of the elements.	No free chlorine tolerance (PP); Coagulants may cause fouling of the elements.	Coagulants may cause fouling of the elements.	Lower tolerance to hypochlorite than PVDF; Additional coagulant may be required	Coagulants may cause fouling of the elements.	No installed facilities for reuse	Limited history with reuse applications
Country of Membrane Development	Australia	Australia	Japan	Netherlands	Canada	Japan	USA
Country of Membrane Manufacturing	Australia	Australia	USA	Netherlands	Canada	China	USA
Operational Reuse Facilities							
	Orange County Water District, 86 mgd (PP membranes)	West Basin, 8.7 mgd (PP membranes)	Yucaipa VWD, Wochholz (CA), 6.7 mgd	Sulaibiya, Kuwait, 99 mgd	F. Wayne Hill Water Resources Centre, (GA), 50 mgd	No UF installation on WW	ShanXi, China, 1.4 mgd
	West Basin, 12 mgd (PP)	Yorktown, 5.7 mgd (PVDF)	Alamitos Barrier Recycled Water Project (CA), 3.5 mgd	Holland - Cerestar, 2 mgd	Alicante, (Spain), 12 mgd	> 100 mgd installed for drinking water, mostly in Japan	ShanXi, China, 13 mgd
	Pebble Beach, 1.9 mgd (PVDF)	Bundamba, Australia, 24 mgd (PVDF)	East Bay Municipal Utility District, Bay Shore (CA), 3.7 mgd	Winhoek - Namibiya, 5.5 mgd	Beijing Qinghe Tertiary Treatment, (China) 21 mgd		
		Gibson Island, Australia, 32 mgd (PVDF)	East Bay Municipal Utility District, RARE WWTP, Richmond (CA), 3.0 mgd	PetroChina Daqing, Daqing,China, 3.6 mgd	Doha West Tertiary Treatment, (Qatar) 36 mgd		
		City of Scottsdale, 14 mgd (PP), is swittching to (PVDF)	McDowell Creek WWTP, Charlotte-Mecklenburg (NC), 3.0 mgd	Tuoketuo power plant, Huhehaute, China, 5.3 mgd	Jumeirah Golf Estates, Dubai, (United Arab Emirates), 60 mgd (MBR)		
		Changi NEWater, SGP, 76 mgd (PVDF) (under construction)	Fountain Hills Irrigation District (AZ), 4 mgd	Taiyanggong thermalpower plant, Beijin, China, 1.1 mgd	Bedok NEWater Factory, Singapore, 11 mgd		

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3.5 Break Tank, RO Transfer Pump Station, and Cartridge Filters

A break tank will likely be needed to store the MF/UF filtrate prior to being pumped to the RO equipment. This tank will help limit the impact of short-term variations in flow due to MF/UF backwash cycles by providing equalization of flow (approximately 30 minutes of buffer time) between the MF/UF and RO processes.

The MF/UF filtrate water will be pumped through cartridge filters, which help protect the RO membranes from particulates that may be introduced in the break tank or chemical addition. In addition, antiscalant and possibly acid will be added to the RO feed water to reduce scaling on the RO membranes.

From the cartridge filters, the RO feed water will then be split into a series of trains, each of which will be equipped with an individual booster pump to increase the feed pressure. These pumps will be equipped with variable frequency drives (VFD) to allow operation between the minimum and maximum pressure.

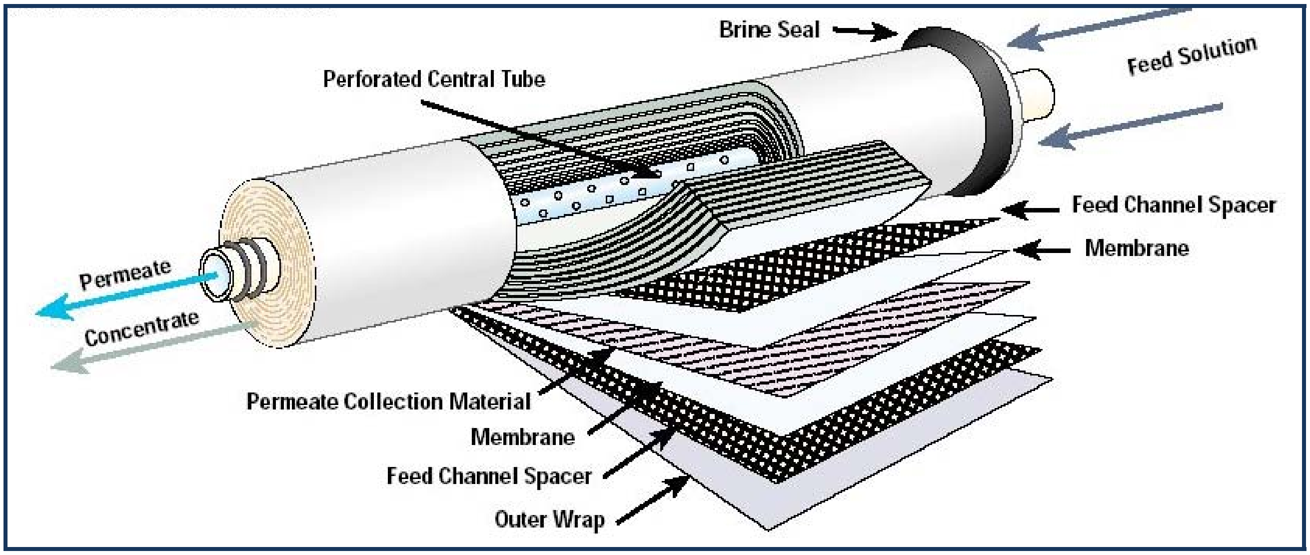
3.6 Reverse Osmosis

RO is a physical separation process that uses a membrane to separate the solvent portion of a solution from the solute portion by applying pressure. RO has an extensive history of being effectively utilized in wastewater treatment processes for removal of a wide array of dissolved constituents that are not removed through a filtration process. RO has shown that it is effective at removing the refractory dissolved organic constituents. However, it has been shown to be limited in its ability to remove some organic constituents such as NDMA, 1, 4-dioxane, and taste and odor causing compounds. Despite these limitations, RO is generally recognized as the best available technology for IPR.

The RO process involves the application of hydrostatic pressure to a liquid to allow the liquid to overcome the osmotic pressure and pass through a semi-permeable membrane. The RO membranes are composed of thin film composite (TFC) materials consisting of polysulfone support layer with polyamide membrane skin. The benefits of TFC include high porosity, high uniformity, and use over a wide pH range. The drawbacks of the TFC membranes include low free chlorine tolerance and moderate compaction over time.

RO membranes are configured in spiral wound elements. Multiple elements, typically six or seven, are used in series, within a horizontal pressure vessel. Figure 3-5 shows the spiral wound RO element configuration.

Figure 3-5: Spiral Wound RO Element



RO systems used for reuse applications typically operate at 70 to 85 percent feed water recovery, depending on the feed water quality and the number of stages utilized. For preliminary planning it is assumed that the RO system will have 85 percent recovery. The RO system for the AWTP will have two or three stages. This will be evaluated further during the development of the IPR master plan and during the pilot study. Two-stage and three-stage RO configurations are discussed in more detail below.

Two-Stage Configuration

In a two-stage RO configuration, the concentrate from the first stage is sent to a second, distinct group of pressure vessels to produce additional permeate and improve the hydraulic recovery of the plant. A booster pump or an energy recovery device, such as a turbocharger, can be used to increase the feed pressure to the second stage, improving the permeate production from this stage, and providing better flow distribution between the two stages. Using an energy recovery device will also reduce the overall energy use of the plant, reducing the required horsepower of the high pressure feed pumps and reducing the long term operating costs of the plant.

The ratio of pressure vessels in the first stage to those in the second stage is typically two to one, in order to maintain adequate crossflow velocities in both stages, preventing fouling and scaling of the membranes. Permeate from both stages is combined into one permeate line, which will combine with the other permeate lines from the other trains into a single RO product stream. The configuration of the RO vessels typically places both stages on one skid. Energy recovery turbochargers would then be placed on the concentrate from the second stage, recovering the excess energy from this stream to increase the feed pressure going onto the second stage.

Initial performance projections for the DCT tertiary effluent (using Hydranautics IMS Design Software) indicate that a hydraulic recovery up to 85 percent should be achievable with a two stage system, with 15 percent of the feed water flow wasted as concentrate. To achieve a higher recovery, it would be necessary to add a third stage of RO pressure vessels. A two stage configuration producing 20 mgd of permeate would require ten 2-mgd RO skids, each containing 36 first stage pressure vessels with eight elements per vessel, and 16 second stage pressure vessels with eight elements per vessel. While it is more common to utilize seven element vessels, adding an additional element will improve crossflow velocities for the low permeate fluxes employed at reuse facilities. Such an approach would not be necessary if operating at a lower recovery or utilizing a three stage configuration.

Three-Stage Configuration

In a three-stage RO configuration, the concentrate from the second stage is sent to an additional array of pressure vessels to achieve higher recoveries or maintain higher crossflow velocities in the latter stages. The GWR System utilizes a three-stage configuration to achieve 85 percent recovery, while other reuse facilities achieve similar recoveries with only two stages. The benefit of a three stage configuration is higher scouring velocities, which reduce fouling, however, the drawback is an increase in the feed pressure and overall energy use of the plant. If membranes become fouled, however, the energy use will increase substantially, so it is critical that the configuration chosen minimize the impacts of fouling and scaling on the membranes.

Utilizing energy recovery in a three-stage system is less efficient than a two-stage system, however, a turbocharger could be used to boost the feed to the third stage, while permeate flow through the second stage is maintained by throttling the permeate from the first stage vessels. Preliminary membrane projections (using Hydranautics IMS Design Software) indicate that a recovery of 88 percent or higher may be achievable with a three stage configuration using the DCT tertiary effluent. Such high recovery operation will reduce the waste flow from the RO facilities, but will not reduce the total load of salt discharged with the concentrate. The energy costs for this improved recovery will need to be evaluated against the benefit of a lower concentrate volume. Pilot testing should look at both two-stage and three-stage operation to determine which will provide the most benefits for the AWTP.

A three-stage configuration producing 20 mgd of permeate would require ten 2-mgd RO skids, each containing 36 first stage pressure vessels, 16 second stage pressure vessels, and eight third stage pressure vessels, all with seven elements per vessel.

RO Membrane Performance

The RO membranes will remove the majority of the dissolved organic and inorganic components, producing permeate with low TDS and TOC. The membranes will also remove any microorganisms that were not removed in previous processes. Most contaminants of emerging concern, such as pharmaceuticals and personal care products, will also be removed by the RO membranes, however, some key constituents, such as NDMA and 1,4-dioxane are not entirely removed and will require additional treatment through the advanced oxidation process.

The brine from the RO will be high in TDS, which requires special consideration for management and disposal. Brine management is discussed in Section 4 of this TM.

RO systems use a flush system to prevent biological growth and mineral fouling when membranes are non-operational, and a CIP system for membrane cleaning. The flush system uses RO permeate water to remove residual concentrate or stagnant solutions from the membrane surfaces. The CIP system uses chemicals (typically citric acid and caustic soda) to remove any inorganic and organic fouling on the membranes. Figure 3-6 shows the RO system at TIWRP.

Figure 3-6: RO (Hydranautics ESPA2) System at TIWRP

Five RO systems that could be considered for the AWTP include:

- Hydranautics
- Dow
- Toray
- Woongjin
- Koch

The comparison of these five RO systems is summarized in Table 3-2.

Table 3-2: RO Membrane Systems Comparison

	Hydranautics	Dow	Toray	Woonjin	Koch
Company Name	Nitto Denko Corporation	Dow Water and Process Solution	Toray Membrane USA, Inc.	Woongjin Chemical Company, Ltd	Koch Membrane Systems, Inc.
Membrane Module					
Membrane Model	ESPA2	XLE	TMG/TML	FE/FEn	TFC-HR
Chloride Rejection	99.5%	99%	99.5-99.7%	99.5-99.7%	
TOC Rejection [a]	98.6%	98.9%	96.7%		
NDMA Rejection [a]	35%		75%		
Phenacetine Rejection (MW 179) [a]	85%	70%	70%		
Country of Membrane Development	USA	USA	Japan	Korea	USA
Country of Membrane Manufacturing	USA	USA	USA	Korea	USA
Operational Reuse Facilities					
	Orange County WD, 70 mgd	ShanXi, China, 13 mgd	Sulaibiya, Kuwait, 99 mgd	West Basin, CA, 3 mgd	West Basin, CA
	Gibson Island, Australia, 26.4 mgd	Seoul, Korea, 7 mgd	Changi, Singapore, 60 mgd	Carson, CA, 2 mgd	
	Kranji, Singapore, 10.5 mgd	Beijing, China 11.4 mgd	Ningxia, China, 20 mgd		
	Bedok, Singapore, 8.5 mgd	BeiXiaoHe, China, 2.6 mgd	Luggage Point, Australia, 17 mgd		
	Terminal Island, 4 mgd		Sydney, Australia, 15 mgd		
	Alamitos Barrier, 2 mgd		Seletar, Singapore, 6.3 mgd		
	West Basin, CA, 6 mgd		Gippsland, Australia, 2 mgd		

Footnotes:

a. Based on 2008 study at Colorado School of Mines (AWWA, 100:9)

3.7 Advanced Oxidation Processes

Although MF/RO removes particulates, microorganisms and the vast majority of organic constituents, there are a few organic compounds that RO does not efficiently remove, notably NDMA and 1-4 Dioxane. Advanced oxidation processes (AOP) are considered the best available technology to address the destruction of emerging pollutants of concern that are not fully removed by the RO membranes.

Unlike other technologies that separate the constituents before removal, advanced oxidation destroys them. The most common advanced oxidation alternatives include various combinations of ozonation, UV exposure, and H_2O_2 application. These systems create a highly reactive hydroxyl radical (through a reaction with H_2O_2) that oxidizes target compounds. A hydroxyl radical (HO•) consists of a cluster of atoms that include an unpaired electron. This electron makes the hydroxyl radical an extremely potent oxidant. At the same time it is very non-specific and chemically unstable; it reacts with almost any compound with which it comes in contact. Therefore, a successful advanced oxidation system has to generate hydroxyl radicals in a concentration high enough so that there are plenty of radicals to react with the desired constituents.

As discussed in the Regulatory Assessment TM (Subtask 1.1) and in Section 2.4, the CDPH draft groundwater recharge requirements specify the log-removal required for NDMA and 1,4-dioxane and also provide an approach for the consideration of emerging contaminants like endocrine disruptors, pharmaceuticals, and personal care products1 (EDCs/PhPCPs). NDMA and 1,4-dioxane were identified as a concern in the implementation of the OCWD GWR System because they are low molecular weight compounds not well suited for removal by the RO process. Because of the possibility that these compounds and others like them may pass through the RO process, an advanced oxidation process (AOP) is employed to ensure removal of these challenging compounds and to provide an additional treatment barrier. The baseline AOP in the draft CDPH groundwater recharge requirements is UV/H_2O_2 and this AOP is the established process for water reuse. This AOP approach was recently permitted by CDPH for groundwater recharge and spreading applications at the GWR System.

However, given that UV/H2O2 is energy intensive, an analysis of alternative AOP technologies may be attractive to achieve the reduction of NDMA, 1,4-dioxane, and other emerging contaminants that may be required longer term. The UV dose required to achieve 1-log removal of NDMA is approximately 1000 mJ/cm^2 (Mitch et al., 2003) and for 2-log reduction is ~ 1400 to 1700 mJ/cm^2 (Sharpless and Linden, 2003) compared to a UV Dose less than ~ 100 mJ/cm^2 for UV disinfection. Alternative AOPs were considered for this task and the complete analysis can be found in the Attachment A for the following technologies:

1. Ozone alone as an AOP (preozonation and ozonation of RO permeate)
2. Ozone/H_2O_2 treatment of RO permeate
3. Titanium dioxide photocatalysis treatment of RO permeate
4. Fenton's reagent treatment of RO permeate.

1 See Endnote 5 of the CDPH Draft Groundwater Recharge Requirements, August 5, 2008

A list of AOPs in current practice is provided in Table 3-3. Only two of the advanced oxidation processes listed in Table 3-3 have been operated at full-scale drinking water treatment facilities in California: O_3/H_2O_2 and UV/H_2O_2. Conventional preozonation processes without hydrogen peroxide have been provided as a prefiltration step at full-scale for disinfection in California, such as the application at the Los Angeles Aqueduct Filtration Plant (LAAFP). Conventional O_3/H_2O_2 processes are in widespread use at full-scale facilities in California for the removal of taste and odor compounds, such as MIB and geosmin. As discussed above and in the Regulatory Assessment, UV/H_2O_2 processes are in place at the full scale in California in reuse applications for removal of NDMA and 1,4-dioxane. Research over the last 20 years has resulted in increasing interest in developing AOPs like titanium dioxide photocatalysis and Fenton's reactions with iron and as a result, these technologies were also considered in the alternative AOP analysis (see Attachment A).

Table 3-3: List of AOPs in Current Practice

Technologies	Vendors	Application
H_2O_2 / UV	RayoxTM, Calgon Carbon; UVPhox™, Trojan	Water reuse, water/wastewater, Remediation
O_3/H_2O_2	HiPOxTM, Applied Process Technology Conventional methods using O3/H2O2 are also available in the public NOMain	water/wastewater, remediation Conventional O3/H2O2 processes are extensively used in drinking water treatment for taste and odor removal
O_3/UV	WETCO, Zimpro (US Filter)	Drinking water
O_3/High pH	N/A	
O_3/H_2O_2/UV	UltroxTM, US Filter	Industry wastewater
H_2O_2 / Fe^{2+},Fe^{3+}/UV (Fenton/Photo-Fenton)	N/A	Soil, high concentration waste water
H_2O_2 / catalyst / UV	N/A	Soil, high concentration waste water
TiO_2 / H_2O_2 / UV	PhotoCatTM, Purifics Inc.	Remediation, industry wastewater

The recommendation from an analysis of alternative AOP technologies (see Attachment A) is that O_3/H_2O_2 and TiO_2/UV be investigated at the pilot-scale to develop design criteria to allow a present worth cost comparison of these technologies to the baseline AOP (UV/ H_2O_2). The pilot testing is also required for these alternate AOP technologies to develop the necessary information to support discussion with CDPH for their implementation. These alternate AOP technologies are recommended for additional investigation because HO• has been shown to oxidize NDMA, 1,4-dioxane and TCEP (indicator compound recommended in Section 2.4). In fact, if the RO permeate is adjusted to a pH of 8 following decarbonation, the O_3/H_2O_2 process will remove 1.2-log of NDMA and more than 0.5-log of 1,4-dioxane in less than 2 minutes of contact time, requiring only 1 mg/L of H_2O_2 and 1 mg/L of O_3 (see Table A-2). The advantage of the TiO_2/UV is that potentially there may be no residual of H_2O_2 to be addressed.

Relevant to the AOP discussion, it is important to understand that the removal requirements for NDMA and 1,4-dioxane detailed in the draft CDPH Groundwater Recharge regulations were the log reductions achieved at the GWR System for a given set of data and its site-specific conditions (Regulatory Assessment TM – Subtask 1.1). Through source control methods described in Section 2.4, it may be possible to effectively control the level of NDMA in the secondary effluent to lower levels than experienced in other recharge projects and this should reduce the cost of all AOP alternatives, including the baseline UV/ H_2O_2 process.

3.7.1 UV/H_2O_2

UV/H_2O_2 is the most common advanced oxidation technology for groundwater recharge systems, and it has been used extensively for the removal of trace constituents found in treated water. In fact, only UV/H_2O_2 has been installed full-scale in wastewater plants the size of the proposed AWTP. The UV/H_2O_2 process is being used successfully for advanced oxidation for the GWR System and the West Basin WRF. Since UV/H_2O_2 has been successfully permitted at these facilities, it will be used for the AWTP. Alternative AOPs, which may be considered for future facility upgrades and/or expansion, are discussed in Attachment A.

The UV/H_2O_2 system involves both the application of H_2O_2 and the use of UV irradiation (200 to 280 nm) disinfection. The H_2O_2 is added to the RO permeate upstream of the UV process. The following reaction can be used to describe the photolysis of H_2O_2 (Metcalf & Eddy, 2003):

$$H_2O_2 + UV \rightarrow HO\bullet + HO\bullet$$

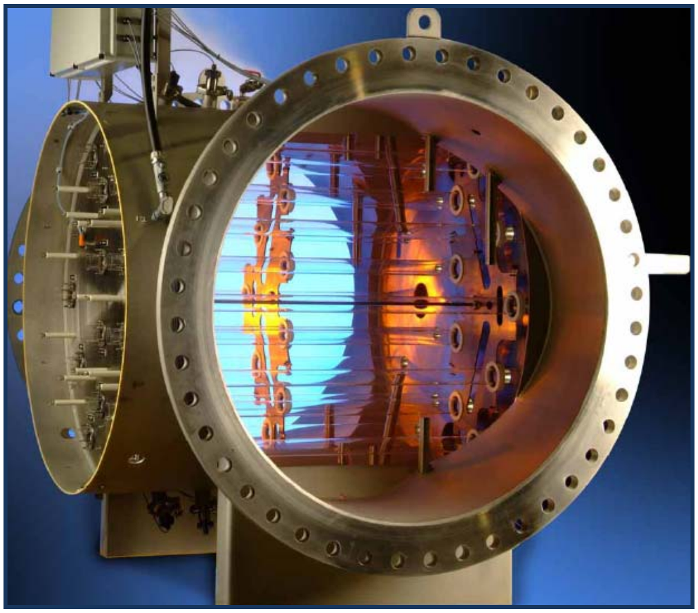
Two manufacturers of UV/H_2O_2 systems are considered in this TM:

- Calgon Carbon Corporation, UV Technologies Division (Calgon)
- Trojan Technologies, Inc. (Trojan)

Both manufacturers have experience providing UV/H_2O_2 equipment for at least one operating facility rated at 5 mgd or larger, and for a total combined capacity of at least 20 mgd.

All available full scale UV/H_2O_2 equipment is of the closed vessel type. No open-channel UV/H_2O_2 equipment is marketed for UV/H_2O_2 applications. Calgon and Trojan both use closed vessel UV/H_2O_2 systems, where the UV lamps are installed in quartz sleeves inside a stainless steel vessel or chamber. Calgon's lamps are oriented perpendicular to the direction of flow (see Figure 3-7), and Trojan's lamps are nominally parallel to the direction of flow. Electrical connections for the lamps are located outside the lamp chamber. Each chamber includes flanged connections for feed piping and discharge piping. Isolation valves are required upstream and downstream of each chamber to allow draining individual chambers for maintenance or replacement.

Figure 3-7: Sentinel Chevron in-line UV disinfection system by Calgon Carbon



The comparison of the two candidate UV/H_2O_2 systems, Sentinel system by Calgon and the UVPhox system by Trojan, is summarized in Table 3-4.

Table 3-4: UV/H_2O_2 System Comparison

Parameter	Calgon	Trojan
Model proposed	Sentinel	UVPhox
Type	Medium Pressure	Low Pressure
Maximum operating pressure	50 psi	65 psi duty, 130 psi surge
Lamp input power	20 kW each	0.25 kW each
Lamp Orientation	Horizontal, Perpendicular to direction of flow	Perpendicular
Lamp cleaning	Automated, SST wire brush	Automated cleaning available (not normally needed for LPHO lamps on RO permeate)
Ballast type	Electromagnetic, variable power	Electronic, variable power
Warm-Up Time	2-5 minutes	3 minutes
Cool-Down Time	2-3 minutes with flow 6 minutes without flow	3 minutes

3.8 Product Water Stabilization

3.8.1 Water Quality

The product water from the AWTP system will be pumped to the groundwater recharge spreading grounds in the East San Fernando Valley. Key design criteria for the product water quality must address the following requirements:

- Compatibility with the aquifer water at the percolation basins without causing scaling, corrosion, or solubilization.
- No significant corrosion to the conveyance piping from the AWTP to the recharge facilities.
- No corrosion of the product water pumping equipment.

Reverse Osmosis Permeate Quality

RO permeate water quality is primarily a function of using high rejection membranes driven to reduce salinity and dissolved organics. The resulting RO permeate will have a very low level of TDS in the range of 20-30 mg/L and corresponding low levels of calcium, magnesium, alkalinity and pH. The dissolved carbon dioxide (CO2) present in the feed water passes through the RO membranes and typically causes the permeate to have a pH less than pH 6.0. These characteristics cause the RO permeate to be corrosive requiring further treatment. Corrosion resistant pipeline materials and equipment lining may also be considered, however, these would not address leaching concerns in the percolation basins or regulatory requirements that the product water be non-aggressive.

Balanced or "Ideal" Product Water Quality

There are several indices that can be applied to evaluate if the product water has a corrosive or scaling tendency. The Langelier Saturation Index (LSI), also named Saturation Index (SI), is commonly used. These indices can apply to a wide variety of piping materials used in water distribution systems. The following four indices normally are used to assess the corrosivity of water to metallic surfaces and have all been applied in this evaluation:

- Langelier Saturation Index (LSI)
- Ryznar Index (RI)
- Aggressiveness Index (AI)
- Calcium Carbonate Precipitation Potential (CCPP)

Also included in this evaluation are three indices that specifically apply to water in contact with concrete surfaces such as cement mortar lined pipes.

- Leaching Corrosion Index (LCI)
- Spalling Corrosion Index (SCI)
- Overall Corrosion Index (OCI)

With the exception of the CCPP, all these indices are expressed in unitless numbers as they are derived from computations based on pH. Table 3-5 summarizes the ranges which are considered optimal for a balanced water. These ranges are applied to the AWTP product water to determine whether the water is considered sufficiently stable to be used with only typical internal corrosion control measures (cement mortar lining, etc.) in the ancillary facilities.

Table 3-5: Typical Indices Ranges

Index	Symbol	Range
Langelier Saturation Index	LSI	0.0 – 0.2 (slightly positive)
Ryznar Index	RI	6.8 – 7.5
Aggressiveness Index	AI	11.8 – 12.3
Calcium Carbonate Precipitation Potential	CCPP	5 – 10 (ppm as $CaCO_3$)
Leaching Corrosion Index	LCI	<500
Spalling Corrosion Index	SCI	<250
Overall Corrosion Index (= LCI + SCI)	OCI	<750

A negative LSI generally indicates that the water has the potential to be corrosive.

Alkalinity and calcium hardness have recommended minimum levels for a balanced water. For alkalinity, the lowest recommended level is 40–60 ppm as $CaCO_3$ and for calcium hardness, the recommended level is 40–50 ppm as $CaCO_3$. In addition, the pH value should stay within the range of 6.5–8.5.

3.8.2 Typical Product Water Stabilization

A major goal of the AWTP post-treatment is to achieve a positive LSI in the product water. The increased pH resulting from the degasification and chemical additional impacts the LSI. A positive LSI is typically equated with a non-aggressive water. Since high rejection membranes remove 99 percent of all ions, the typical RO permeate is nearly depleted of anions and cations. Most RO systems for potable water take advantage of this very low overall dissolved minerals concentration in RO permeate and blend it with other water sources of higher mineral concentrations, especially alkalinity and hardness to stabilize the water. Blending in this manner is not typically allowed for RO treatment of wastewater; since the physical barrier afforded by the RO system is necessary to meet regulatory requirements. Therefore, additional post-treatment other than blending and pH adjustment is required for the AWTP.

Stabilization of the product water will include increasing the pH and adding hardness. To increase the pH, the dissolved CO_2 could be removed in degasifiers by stripping the water with a counter current flow of air, or by the addition of chemicals, such as sodium hydroxide (caustic soda; NaOH), calcium carbonate (limestone; $CaCO_3$), calcium oxide (quicklime; CaO), or calcium hydroxide (hydrated lime; $Ca_2(OH)_2$). Adding a calcium based product, such as limestone, quicklime, or hydrated lime, will also add the necessary hardness to the water, however, calcium chloride could be added in conjunction with caustic soda to provide this hardness.

Degasification

Degasification, or decarbonation, is the most inexpensive and simplest to operate method to increase the pH. However, degasification alone will be insufficient for product water stabilization, as it does not provide the necessary hardness to the water and it is incapable of achieving a product water pH higher than 7.5 to 8.0 standard units, depending on the pH of the pre-degasification water.

Degasification reduces the CO_2 to levels in the 2-10 mg/L range, while at the same time increasing the pH value by 0.6-1.2 units. Because degasification in itself cannot complete the pH adjustment, further increase of the pH is accomplished by adding calcium compounds (quicklime or hydrated lime) or caustic soda. Caustic soda provides the most simplified chemical feed system, but does not address the need for hardness addition, which lime provides.

Another limitation of degasification is that by reducing the carbon dioxide content of the water, the total carbonate species, which are needed for a stable product water, are also being reduced. An RO permeate that has been stripped of carbon dioxide through degasification will not have enough remaining carbonate to produce the desired alkalinity range of 40-60 ppm as $CaCO_3$. To address this limitation, a portion of the RO permeate should be bypassed around the degasifiers, ensuring that the blended product water has a total carbonate content in the 25-35 ppm range (corresponding to an alkalinity of 40-60 ppm as $CaCO_3$).

3.8.3 Product Water Stabilization Alternatives

Five alternatives are evaluated below for product water stabilization. Each of these could utilize degasification to reduce chemical doses, however, final product water stabilization will require one of these five alternatives:

- Alternative 1: Calcium carbonate, $CaCO_3$ (limestone)
- Alternative 2: Calcium oxide, CaO (quicklime)
- Alternative 3: Calcium hydroxide, $Ca(OH)_2$ (hydrated lime)
- Alternative 4: Sodium hydroxide, NaOH (caustic soda) with calcium chloride, $CaCl_2$
- Alternative 5: Sodium hydroxide with lime

The three calcium compounds (limestone, quicklime, and hydrated lime) have the advantage that they provide both hardness and pH adjustment, however, this can create complications if it is found that excessive hardness must be added to achieve the desired product water pH. This has been an operational challenge at the OCWD facility, where diurnal flow variations have made it challenging to maintain both stable hardness and pH using degasification and lime addition alone.

Alternative 1: Calcium Carbonate (Limestone)

The most efficient post-treatment chemical is calcium carbonate. It is not easily soluble and can practically be used only in a granular form as a consumable filter bed material. As such, it has been successfully applied for small potable water treatment systems with the advantage that no over dosages of this chemical can occur. Relatively long detention times of 10-15 minutes in contact with the filter bed are needed for complete saturation of calcium carbonate. This makes this neutralization process relatively expensive for large capacity project such as the AWTP and is therefore excluded from further consideration in this report. It should be noted, however, that limestone contactors are currently planned for the 50 mgd seawater RO facility in Carlsbad, CA, which will be the first use of limestone contactors in a multi-mgd water treatment facility in the United States.

Alternative 2: Calcium Oxide (Quicklime)

Quicklime is the least costly chemical delivered to the treatment plant site for neutralization of carbon dioxide. It requires a wetting process (slaking) with water to produce the reactive component calcium hydroxide. Lime use in water treatment plants is typically employed at the front end of the treatment process, primarily at lime softening facilities, where downstream clarification and filtration can be used to remove the turbidity produced by the lime addition. Employing lime for post-treatment requires the use of a lime saturator to stabilize lime addition and eliminate turbidity before the solution is injected into the final product water. Stable flow rate through these saturators is essential to prevent upsets with high turbidity and suspended calcium carbonate, which can cause scaling and loss of capacity at the percolation basins. In addition, the operation of lime slakers is labor intensive, requiring frequent grit removal and close attention to changes in water temperature and lime quality.

Alternative 3: Calcium Hydroxide (Hydrated Lime)

Hydrated lime can be either delivered to the site as a solid dry chemical or by tanker truck as aqueous slurry. A saturated lime solution would be prepared in a lime saturator, similar to the quicklime alternative, however, slakers would not be required to wet the lime when hydrated lime is employed. Use of hydrated lime involves the same challenges of stable operation through a lime saturator, but does not require the labor intensive operation of lime slaker facilities involved with the use of less costly quicklime.

Alternative 4: Sodium Hydroxide with Calcium Chloride

The addition of the sodium hydroxide to the RO permeate will result in a stable pH, simplified chemical injection, and sufficient alkalinity to maintain the preferred range of 40-60 ppm as $CaCO_3$, provided a sufficient portion of the RO permeate is bypassed around the degasifiers. In order to provide the necessary hardness for a stable product water, it would also be required to add some type of calcium product, such as calcium chloride. Calcium chloride, like sodium hydroxide, can be purchased in liquid form, with solution concentrations up to 38 percent, avoiding the operator intensive dry feed systems and saturators associated with lime addition. This alternative would allow operators to control hardness and pH independently, producing a stable product water that can be matched to any desired combination of pH, hardness, and alkalinity. However, the high concentrations of calcium needed in the product water would also result in the addition of considerable concentrations of chloride, which could reach 30-40 mg/L, degrading the high quality of water produced by the RO membranes. Because of this undesirable increase in TDS, post-treatment with sodium hydroxide and calcium chloride is not recommended for the DCT Facility.

Alternative 5: Sodium Hydroxide with Lime

The addition of sodium hydroxide to supplement lime (quicklime or hydrated lime) addition would allow automatic control to maintain a constant product water pH, allow for a constant flow through the lime saturators, and provide the ability to bypass flows around the degasifiers, targeting alkalinity at the desired 40-60 mg/L range. Using lime to add hardness, rather than calcium chloride, will prevent the TDS addition associated with calcium chloride and would reduce the dose of sodium hydroxide required. While this alternative would still require a lime saturator and dry chemical feed facilities for the lime, flow through the saturator could be kept constant, while diurnal flow variations are addressed using automatic control of the caustic feed system. This approach is similar to the operation of many brackish water desalination facilities, where sodium hydroxide is used for final pH adjustment to adapt to varying hardness and carbonate concentrations in blended product water.

3.8.4 Proposed Post-Treatment Process

Alternative 5, Sodium Hydroxide with Lime, is recommended for the DCT Facility to provide flexibility in operation with the minimal impact on product water TDS. It is recommended to remove a portion of the CO2 from the RO permeate, using partial degasification, bypassing between 30 to 50 percent of the flow around the degasifiers. Hydrated lime would then be added to the decarbonated flow to provide hardness and partially raise the pH, and sodium hydroxide would then be added to provide automatic control of a constant product water pH. This approach requires the addition of two chemicals but allows better process control and operation, and delivers balanced product water with the recommended levels of alkalinity and calcium cation.

A potable water grade hydrated lime is recommended. While quicklime is the least costly of the calcium chemicals, it requires more process equipment in the form of large lime slaking facilities to prepare the calcium hydroxide slurry. Hydrated lime, delivered as dry solid, does not need the slaking equipment. Lime slurry can be prepared with standard dry chemical feeders in a mixing tank, with the slurry injected into in a lime saturator, where the solution stabilizes before being fed into the product water.

This proposed post treatment of RO permeate will result in a product water quality that meets all the quality criteria presented in Table 3-5, along with the recommended minimum concentrations of alkalinity and calcium. These water quality parameters will be met without exceeding a pH value of 8.5 to minimize the water's corrosivity to steel or other metallic or concrete components.

4. Residuals Management

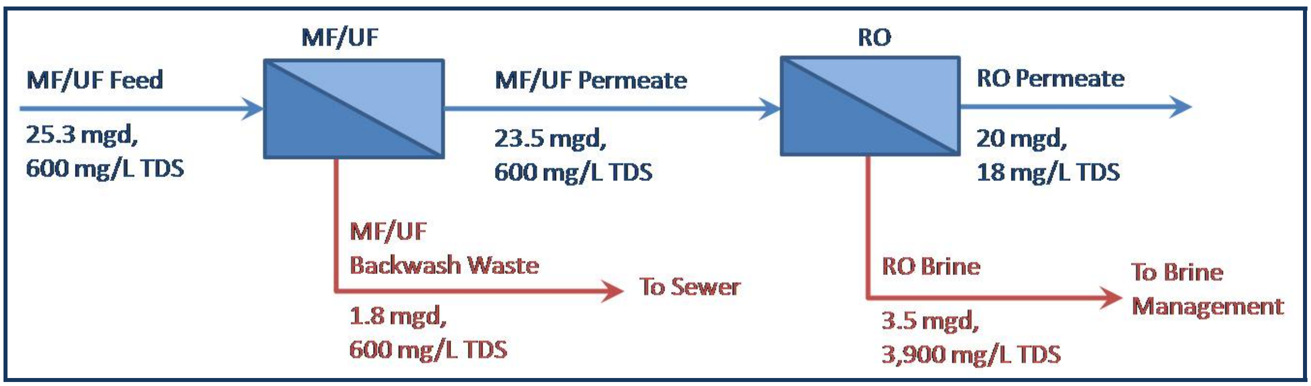
Management and disposal of residual waste streams is important when using membrane technologies, such as MF/UF and RO, because the disposal of RO brine could pose a number of unknown technical, political and regulatory questions.

4.1 Residuals Volume and Quality

Two main solids removal treatment processes in the AWTP are MF/UF and RO, and each produce a waste product that must be managed and disposed of. As discussed in Section 2.5, the AWTP has been preliminarily sized for a production capacity of 20 mgd (20,000 AFY), assuming 93 percent MF/UF recovery and 85 percent RO recovery. The RO process typically removes 95 to 98 percent of the TDS in the RO influent depending on the flux, recovery, and type of membranes used. For the brine disposal options evaluation, this TM assumes that RO achieves 97.5 percent TDS removal.

The flow and mass balance of different flow streams for the proposed AWTP are shown in Figure 4-1.

Figure 4-1: Flow and Mass Balance at Proposed 20 mgd AWTP



4.2 MF/UF Backwash Waste Disposal Methods

The backwash waste from the MF/UF is a concentrated solution of TSS removed by the membranes that can be discharged to the sewer without impacting downstream wastewater treatment processes.

4.3 RO Brine Disposal Methods

The concentrate or brine from the RO is a high TDS solution of dissolved constituents rejected by the RO membranes. The concentration of these constituents will depend on their concentration in the feed water, their rate of rejection by the membranes, and on operating characteristics of the RO system, such as flux, recovery, and temperature. It is anticipated, based on current water quality data from the DCT plant, and an assumed recovery rate of 85 percent, that the TDS in the RO concentrate will be approximately 3,900 mg/L, consisting of a mix of sodium chloride, calcium sulfate, other inorganic salts, and dissolved organic compounds. This waste stream will need to be disposed of through one of five brine disposal alternatives, including:

- Alternative 1: Sewer Discharge
- Alternative 2: Surface Water Discharge/Ocean Outfall
- Alternative 3: Deep Well Injection
- Alternative 4: Zero-Liquid Discharge
- Alternative 5: Land Application/Irrigation

4.3.1 Brine Reduction Alternatives

In addition to five disposal alternatives, a number of concentrate or brine reduction methods are available, which will decrease the volume of concentrate to be disposed of, but will not impact the total quantity of salts in the final waste stream. Brine reduction may be beneficial when the cost of disposal is driven primarily by the volume of the waste stream, however, when the total quantity of salt is the primary concern, there is little value in increased concentration of the waste stream, apart from any value realized in the clean water produced in the concentration process. All of the brine reduction alternatives are costly, and tend to be utilized only where no practical disposal alternatives are available for the higher volume of concentrate. Brine reduction methods are listed in Table 4-1, but will not be discussed further in this TM.

Table 4-1: Brine Reduction Methods

Method	Description	Waste Product
Electrodialysis/ Electrodialysis Reversal (ED/EDR)	ED/EDR desalts electrically rather than with pressure through a semi-permeable membrane, which allows charged cations or anions to pass through.	Concentrated brine
Vibratory Shear Enhanced Processing (VSEP) Membrane System	VSEP produces intense shear waves on membrane surfaces to reduce fouling and increase recovery.	Concentrated brine
Precipitative Softening/RO	RO is limited at higher recoveries due to the precipitation of sparingly soluble inorganic salts onto membrane surfaces. These salts can be removed through precipitative softening to achieve higher recovery in the RO.	Concentrated brine
High Efficiency Reverse Osmosis (HERO) Membrane System	HERO process is similar to precipitative softening/RO, except that RO is run at elevated pH to prevent silica scaling. This process was developed to deal with the precipitation of inorganic salts at higher recoveries in mining waste.	Concentrated brine
Brine Concentrators	Vapor compressor evaporator system using compressor. Vertical tube, falling film evaporators are most common type. Brine concentrators often concentrate brine to about 20% TS (USEPA, 1996), which is then processed further to a solids waste in either solar ponds or a crystallizer.	Concentrated brine
Evaporation Ponds	Relies on solar energy to evaporate water from the concentrate, leaving behind precipitated salts, which are ultimately disposed in landfills.	Dried salts
Thermal Evaporators	Relies on steam. This mechanical evaporation process is driven by heat transfer from condensing steam to the lower temperature brine across a metallic heat transfer surface (Foster, 2008).	Dried salts
Crystallizers	Crystallizers have vertical cylindrical vessels with heat input from vapor compressors or steam supply. While brine recirculates, water is evaporated and crystals form. Crystallizers can achieve up to 90% dry slurry (USEPA, 1996).	Dried salts

4.3.2 Alternative 1: Sewer Discharge

This alternative involves discharging the RO brine to the sewer, which is how DCT currently manages the other residuals streams generated at the plant. The residuals would be conveyed to HTP for treatment. If the AWTP is located at the DCT, the residuals discharge to the sewer would be done with minimal capital cost. If the AWTP is located offsite, a new sewer line may be required. It should be noted that brine reduction methods listed in Table 4-1 could be employed if the volume of flow in the location of the sewer connection is limited for any reason, however, the impact of salt loading on HTP would be the same regardless of whether or not brine reduction methods are employed.

Feasibility Analysis – General

This disposal method is generally cost-effective, although additional treatment may be required at the downstream wastewater treatment plant.

Sewer discharge is the second most common disposal method used at desalting plants, with 26 percent of the 236 desalination plants built in the United States before 2002 discharging RO brine to sewers (Mickley, 2006).

Feasibility Analysis – Impact of Brine Discharge to HTP Sewer

Since TDS at HTP is already of concern for West Basin WRF, which produces recycled water using the HTP effluent, this TM includes a preliminary evaluation of the brine impacts on the HTP influent. As this RWMP moves forward, a more detailed evaluation of the potential impacts to HTP due to the subject AWTP and other upstream satellite plants (being evaluated as part of Task 5) will be evaluated.

To determine the impact of discharging brine to the HTP sewer, the increase in TDS in the HTP influent sewer was evaluated. The expected MF/UF and RO byproducts flow from a 20 mgd AWTP is 5.3 mgd, as discussed in Section 4.1. The estimated TDS concentration impacts on the HTP influent are shown in Table 4-2. Discharging the AWTP brine into the sewer is estimated to increase the TDS in HTP influent by approximately 4 percent. When the HTP influent is at minimum daily flow (i.e., at the base of the diurnal curve), the addition of brine from the AWTP, which is assumed to operate constantly without diurnal changes, will have a more dramatic impact of 16 percent increase in TDS. The TDS in HTP influent is expected to be 760 mg/L at average flow conditions and 850 mg/L at minimum flow conditions.

Table 4-2: HTP Influent Flow and Mass Balance with Brine Discharge from 20 mgd Capacity AWTP

Parameter	Daily Average	Daily Minimum	Daily Peak
Current HTP Influent Flow	340 mgd [a]	150 mgd [b]	480 mgd [b]
HTP Influent Flow with Brine from AWTP [d]	300 mgd	120 mgd	430 mgd
Current HTP Influent TDS [c]	730 mg/L	n/a	n/a
HTP Influent TDS with Brine from AWTP	760 mg/L	850 mg/L	750 mg/L
% Increase in TDS in HTP Influent	4%	16%	3%

Footnotes:

a. Source: Average of influent flow data from July 2007 through June 2009.
b. Source: Adjusted based on the diurnal flow variation determined from a single weekend (Sunday, June 7, 2009) diurnal flow curve.
c. Source: Average of monthly TDS sampling data from January 2004 through June 2009.
d. Assumed that additional 25.3 mgd will be diverted to DCT to provide feed water to the AWTP and that 5.3 mgd of MF/UF and RO brine would be discharged from 20 mgd capacity AWTP to HTP influent sewer.

The TDS impacts for a potential future expansion of the AWTP (40 mgd) are also evaluated and the results summarized in Table 4-3. The expected MF/UF and RO byproducts flow from a 40 mgd capacity, future AWTP is 10.6 mgd. Discharging the AWTP brine into the sewer is estimated to increase the TDS in HTP by approximately 11 percent. When the HTP influent is at minimum daily flow (i.e., at the base of the diurnal curve), the addition of brine from the AWTP, which is assumed to operate constantly without diurnal changes, will have a more dramatic impact of 38 percent increase in TDS. The TDS in HTP influent is expected to be 810 mg/L at average flows and 1,010 mg/L at minimum flows.

Table 4-3: HTP Influent Flow and Mass Balance with Brine Discharge from 40 mgd Capacity AWTP

Parameter	Daily Average	Daily Minimum	Daily Peak
Current HTP Influent Flow	340 mgd [a]	150 mgd [b]	480 mgd [b]
HTP Influent Flow with Brine from AWTP [d]	280 mgd	100 mgd	410 mgd
Current HTP Influent TDS [c]	730 mg/L	n/a	n/a
HTP Influent TDS with Brine from AWTP	810 mg/L	1,010 mg/L	790 mg/L
% Increase in TDS in HTP Influent	11%	38%	8%

Footnotes:

a. Source: Average of influent flow data from July 2007 through June 2009.
b. Source: Adjusted based on the diurnal flow variation determined from a single weekend (Sunday, June 7, 2009) diurnal flow curve.
c. Source: Average of monthly TDS sampling data from January 2004 through June 2009.
d. Assumed that additional 50.6 mgd will be diverted to DCT to provide feed water to the AWTP and that 10.6 mgd of MF/UF and RO brine would be discharged from 40 mgd capacity AWTP to HTP influent sewer.

In general, it is necessary to have the TDS in Title 22 recycled water below 1,000 mg/L, however, significantly lower TDS (less than 500 mg/L) is often desired by recycled water users, with chloride concentrations greater than 250 mg/L a particular concern for many users. The estimated TDS concentration with a 40 mgd AWTP is higher than these limits. Additional treatment may therefore need to be investigated for recycled water produced from HTP effluent, or other brine disposal alternatives at DCT, such as discharge to an ocean outfall (Alternative 2), should be explored.

Consideration of the cost of the sewer discharge alternative should include the cost of any additional treatment at HTP that may be needed to achieve the desired Title 22 water quality and the additional energy cost for existing and future desalination facilities utilizing HTP effluent with an increased salinity.

4.3.3 Alternative 2: Surface Water Discharge/Ocean Outfall

Surface water discharge describes the releasing of RO brine to any surface water, including seawater bodies. While discharges to saline water bodies, such as ocean outfalls, are less stringently regulated than discharge to freshwater bodies used as potential drinking water supplies, consideration must be given to ecological impacts in any receiving water body. Surface water discharges are the most common disposal method among desalting plants, and were employed by 45 percent of all desalination facilities built in the United States before 2001 (Mickley, 2006).

Feasibility Analysis – General

Costs associated with surface water discharge are typically low and are primarily based on the length of the pipeline from the treatment plant to the discharge site, with a significantly lower cost for the discharge structure and any required diffusion mechanisms. Surface water discharge is used most commonly where brackish water or ocean outfall locations are easily accessible.

Feasibility Analysis – Ocean Outfall

The surface water discharge relevant to the AWTP is ocean outfall, possibly utilizing the existing ocean outfall for HTP. For this option, the City would construct a separate brine line from the new AWTP to HTP for disposal via the existing five-mile ocean outfall, or construct a new ocean outfall independent of HTP. The primary cost of the alternative would be construction of the pipeline, however, unlike Alternative 1, there would be no incidental costs to downstream processes or users.

4.3.4 Alternative 3: Deep Well Injection

Deep well injection refers to disposal within a deep geological formation. Some plants make use of existing wells associated with petroleum mining, while others drill dedicated wells into isolated aquifers. The key to deep well injection is to separate the brine from any potential impact to drinking water aquifers that are generally closer to the surface. This method is subject to multiple regulations, including NPDES (CWA), SDWA (Underground Injection Control (UIC)), state regulations, and local regulations. These regulations are concerned with ensuring the separation of drinking water and brine, based on data about transmissivity, TDS, and separating structures.

Deep well injection is commonly practiced in south Florida, where a high capacity, high salinity aquifer, is readily available and is often considered at inland facilities where ocean outfalls are not feasible. While construction costs for the wells are high, operating costs are relatively low. A recent brackish water desalination plant in El Paso, TX reported that well injection and associated pipelines accounted for 26 percent of total capital costs of the desalination project, while the operating costs were about 4 percent of the total annual operating costs.

Feasibility Analysis – General

Existing, known, groundwater-producing aquifers cannot be used for deep well injection. Deep well injection is only feasible if there are suitable, deep, injectable aquifers separate from the groundwater-producing aquifers in the Los Angeles area in close proximity to the AWTP. Deep well injection is not a promising alternative, because of the lack of information on a readily available deep aquifer in the area, and due to permitting concerns for deep well injection of RO concentrate.

4.3.5 Alternative 4: Zero Liquid Discharge

Zero liquid discharge (ZLD) reduces brine to solids, while near-zero liquid discharge (NZLD) reduces brine to slurry. The products resulting from ZLD or NZLD require a secondary use or landfill disposal.

Unlike other disposal methods, ZLD has both high capital and operating costs. In most cases, the ZLD technology will cost considerably more than the actual desalting plant. The only operational ZLD facility in California is in the central valley, where a 1 mgd RO facility, which cost $2 million to build, employed a brine concentration facility producing zero liquid discharge for a cost of $22 million. In addition, the power consumption for the 1 mgd RO facility was 2.2 kWh/1,000 gallon, while the power consumption for the brine concentration facilities was 90 kWh/1,000 gallon (Wiesner, 2009).

ZLD technology is typically considered for inland plants where other brine management alternatives are not available. Also, this technology might be considered as a way to minimize environmental impact and thus, avoid some of the permitting process. Finally, this technology might be considered to reduce the in-plant water consumption by 10 to 90 percent by reusing the water recovered from the brine.

ZLD processes may include various combinations of the brine reduction methods listed previously in Table 4-1. Several examples of ZLD processes are listed below:

- ZLD Option 1: RO + Brine Concentrator + Crystallizer + Landfill
- ZLD Option 2: RO + Brine Concentrator + Evaporation Pond + Landfill
- ZLD Option 3: RO + EDR + Brine Concentrator + Evaporation Pond + Landfill
- ZLD Option 4: Precipitative Softening + RO + Brine Concentrator + Crystallizer + Landfill

Feasibility Analysis – General

ZLD processes are not feasible due to high capital and operating costs, discussed above.

4.3.6 Alternative 5: Land Application/Irrigation

Land application encompasses several disposal methods. Some examples are percolation ponds, spray irrigation, and leach fields. In all land application methods, the soil serves as a filter for the brine, protecting the groundwater supplies, to the extent possible, from salt contamination. Smaller flows of lower salinity are required to avoid overburden of the natural filtering capacity of the soil. Additional dilution water may also be required. Seasonality affects the efficacy of land application, so back-up disposal methods are usually required during certain parts of the year.

Land application is subject to both state and local regulations. These are based on the percolation rates, demand for irrigation, vegetation tolerance of salts, and negative effects on groundwater. Land application is also limited by the availability and cost of land.

Feasibility Analysis – General

Land application/irrigation is not feasible for the AWTP due to the impact on groundwater aquifers. Groundwater recharge with desalinated product water is the focus of the AWTP, and risking the contamination of fresh water aquifers with land application of brine would work against this goal.

4.4 Summary

The advantages and disadvantages for all five brine management alternatives are summarized in Table 4-4.

Table 4-4: Summary of Brine Management Alternatives Evaluation

	Alternative	Advantages	Disadvantages
1	Sewer Discharge	Lowest capital cost [a]	Effect on HTP water quality will result in indirect costs.
2	Ocean Outfall	Lowest operating cost. Moderate capital cost [b]	Potential environmental impact must be determined.
3	Deep Well Injection	Low operating cost. Moderate capital cost.	Suitable aquifer not readily available. Potential impact to freshwater aquifers. High permitting complexity.
4	Zero-Liquid Discharge	Benefit from additional water produced by AWTP. No NPDES permitting requirements.	High capital cost and O&M cost. Highly energy intensive/high carbon footprint. Large structures may impact public perception.
5	Land Application/ Irrigation	Low capital cost.	Requires large land areas. High potential impact to freshwater aquifers. High permitting complexity.

Footnotes:

a. Cost for sewer discharge needs to include potential additional treatment at HTP for Title 22 irrigators, as well as added energy cost for increasing feed pressure at West Basin WRF when HTP TDS increases.

b. Cost for ocean outfall is typically economical for coastal areas.

Attachment A. Alternative Advanced Oxidation Processes

A.1 Overview

As discussed in the Regulatory Assessment TM (being prepared under Subtask 1.1) and in Section 2.4, the CDPH draft groundwater recharge requirements specify the log-removal required for NDMA and 1,4-dioxane and also provide an approach for the consideration of emerging contaminants like endocrine disruptors, pharmaceuticals, and personal care products (EDCs/PhPCPs) (CDPH, 2008). As discussed in Section 2.4, NDMA and 1,4-dioxane are low molecular weight compounds not well-suited for removal by RO. UV/H_2O_2 represents the baseline advanced AOP to meet the 1.2-log removal of NDMA and 0.5-log removal of 1,4-dioxane in the draft CDPH groundwater recharge requirements in the near term as UV/H_2O_2 represents the AOP recently permitted by CDPH for the water reuse application at the GWR System. These levels of removal of NDMA (1.2-log) and 1,4-dioxane (0.5-log) are required regardless of whether NDMA and/or 1,4-dioxane are present in the feed water to the advanced treatment train, as discussed in the Regulatory Assessment TM (being developed under Subtask 1.1). For the reasons discussed in Section 2.4, TCEP was selected as a suitable surrogate representing the EDCs/PhPCPs that may be present in the secondary effluent feed to the advanced treatment train.

As discussed in the Regulatory Assessment TM (being developed under Subtask 1.1), the removal requirement for NDMA in the draft CDPH Groundwater Recharge Requirements was the log reduction achieved at the GWR System for its site-specific conditions. Through source control methods discussed in Section 2.4, it may be possible to effectively control the level of NDMA in the secondary effluent to lower levels than experienced in other recharge projects and this should reduce the cost of all AOP alternatives, including UV/H_2O_2. Given that UV/H_2O_2 is energy intensive, alternative AOP technologies may be attractive to achieve the reduction of NDMA, 1,4-dioxane, and other emerging contaminants that may be required longer term. The UV dose required to achieve 1-log removal of NDMA is ~ 1000 mJ/cm^2 (Mitch et al., 2003) and for 2-log reduction is ~ 1400 to 1700 mJ/cm^2 (Sharpless and Linden, 2003) compared to a UV Dose less than ~ 100 mJ/cm^2 for UV disinfection.

A list of AOPs in current practice is provided in Table A-1.

Table A-1: List of AOPs in Current Practice

Technologies	Vendors	Application
H_2O_2 / UV	Rayox™, Calgon Carbon; UVPhox™, Trojan	Water reuse, water/wastewater, Remediation
O_3/H_2O_2	HiPOx™, Applied Process Technology Conventional methods using O_3/H_2O_2 are also available in the public NOMain	water/wastewater, remediation Conventional O_3/H_2O_2 processes are extensively used in drinking water treatment for taste and odor removal
O_3/UV	WETCO, Zimpro (US Filter)	Drinking water
O_3/High pH	N/A	
O_3/H_2O_2/UV	Ultrox™, US Filter	Industry wastewater
H_2O_2 / Fe^{2+},Fe^{3+}/UV (Fenton/Photo-Fenton)	N/A	Soil, high concentration waste water
H_2O_2 / catalyst / UV	N/A	Soil, high concentration waste water
TiO_2 / H_2O_2 / UV	PhotoCat™, Purifics Inc.	Remediation, industry wastewater

Only two of the AOPs listed in Table A-1 have been operated at full-scale drinking water treatment facilities in California: O_3/H_2O_2 and UV/H_2O_2. Conventional preozonation processes without hydrogen peroxide have been provided as a prefiltration step at the full-scale for disinfection in California, such as the application at the Los Angeles Aqueduct Filtration Plant (LAAFP). Conventional O_3/H_2O_2 processes are in widespread use at the full-scale in California for the removal of taste and odor compounds, such as MIB and geosmin. As discussed above and in the Regulatory Assessment, UV/H_2O_2 processes are in place at the full scale in California in reuse applications for removal of NDMA and 1,4-dioxane. Research over the last 20 years has resulted in increasing interest in additional AOP applications like titanium dioxide photocatalysis and Fenton's reactions with iron.

The following alternatives will be considered during the project: (1) baseline AOP: UV/H_2O_2, (2) ozone alone as an AOP (preozonation and ozonation of RO permeate), (3) ozone/H_2O_2 treatment of RO permeate, (4) titanium dioxide photocatalysis treatment of RO permeate, and (5) Fenton's reagent treatment of RO permeate. It is anticipated that a detailed evaluation of the baseline AOP (UV/H_2O_2) and two AOP alternatives will be evaluated during the pilot-phase of the project to determine the most cost-effective AOP in terms of minimizing energy requirements.

The second order ozone, k_{O3}, and hydroxyl radical rate constants, $k_{HO\bullet}$, for the target compounds, NDMA, 1,4-dioxane, and TCEP are shown in Table A-2. It is observed that the second order hydroxyl radical rate constant for NDMA is lower than the second order hydroxyl radical rate constant for 1,4-dioxane and TCEP, suggesting that an AOP designed to meet 1.2-log removal of NDMA will also achieve a greater log reduction of 1,4-dioxane or TCEP, provided the AOP is providing the full removal of the NDMA (not the case when UV photolysis is involved).

Table A-2: Rate Constants for Target Compounds

Compound	K_{O3}	K_{HO}
NDMA [a, b]	5.2×10^{-2}	4.3×10^{8}
1,4-Dioxane [c]	3.2×10^{-1}	2.8×10^{9}
TCEP [d]		5.6×10^{8}

Footnotes:

a. Source: Lee et al., 2007
b. Source: Nakonechny et al., 2008
c. Source: Adams et al., 1994
d. Source: Watts et al., 2009

The baseline AOP approach (UV/H_2O_2) will be discussed in Section A.1.1. The AOP alternatives under consideration will be discussed in Sections A.2 to A.5. Selection of AOP alternatives in addition to the baseline approach recommended for evaluation at the pilot-scale will be provided in Section A.6.

A.1.1 Baseline AOP: UV/H_2O_2

The baseline AOP (UV/H_2O_2) approach was discussed in Section 3. During the pilot-phase of the work, the UV/H_2O_2 baseline approach will be compared to any alternative AOPs that are selected for pilot testing. In the pilot-phase, the project team will take advantage of its own recent experience with evaluation of UV/H_2O_2 technology performed on a recent project that compared removal of MtBE and tBA with an Advanced Oxidation Process Simulation Software (AdOx™) package (Li et al., 2008) for a 10 percent design case. That project compared energy requirements for several different pretreatment options including an evaluation/optimization of electrical efficiency per log order reduction (EE/O) predicted by the AdOx model for low pressure versus medium pressure UV/H_2O_2 AOP.

As appropriate, the AdOx model will be employed during the pilot phase to further the design of experiments, evaluation of results, and scale-up to a full-scale process. The capabilities of AdOx are summarized below (Li et al., 2002; Crittenden et al., 1999):

- AdOx can be used to determine optimal reactor type, optimum hydrogen peroxide dosage, and optimal electrical efficiency per log order reduction (EE/O). In this manner, AdOx™ provides insight into the impact of key design and operational variables on UV/H_2O_2 process performance
- AdOx can analyze tracer (dye) study results and determine the appropriate number of tanks-in-series (NTIS) to describe non-ideal mixing in a photochemical reactor
- AdOx can dynamically simulate parent compound destruction and hydrogen peroxide consumption in completely mixed batch reactors (CMBRs), completely mixed flow reactors (CMFRs), CMFRs in series, and plug flow reactors (PFRs)
- AdOx includes all identified and reasonably proposed photochemical and chemical reactions with regard to the degradation of parent organic compounds
- AdOx can simulate the destruction of all target compounds whose reaction mechanisms and rate constants are known

- AdOx can account for the formation of secondary by-products

A.2 Ozone (O_3)

Ozonation has been an indispensable unit process to the overall treatment train for the past twenty years at the 600-MGD LAAFP. Dedicated in 1987, this facility was the first large-scale ozonation plant in the United States. The plant incorporated a high-rate direct filtration process enhanced by ozone pretreatment, or pre-ozonation. The ozonation system had a design capacity of 7900 lbs per day at that time and now has a design capacity of 13,000 lbs per day. LAAFP is a world-class example of a large-scale ozonation system and these years of ozone experience provides a unique perspective to LADWP for considering alternative AOPs for the AWT train at DCT, particularly alternatives involving ozone.

A.2.1 Science, Chemistry and Use as a Disinfectant

Ozone for disinfection, taste and odor control, and target compound destruction has been broadly used at the water treatment plants in the Untied States. Ozone is an effective disinfectant and can be used to inactivate Giardia lamblia and Crytosporidium. In addition, the use of ozone reduces the formation of chlorinated by-products such trihalomethanes (THMs) and other disinfection by-products (DBPs) (Hodges Jr et al. 1979). Besides using O_3 as a disinfectant, ozone also has a role in oxidation.

The ozonation process is classified as an AOP because the process generates hydroxyl radicals and target compounds are oxidized both by the direct reaction with ozone and by reaction with hydroxyl radicals. Ozone begins to form hydroxyl radical (HO•) once dissolved in water (Trussell and Najm 1999). The reaction with hydroxyl radicals is important because the rate constant for the reaction of the target compound with hydroxyl radicals is typically several orders of magnitude higher than the apparent rate constant for the reaction of the target compound with ozone. For some recalcitrant compounds present in certain water qualities, it is necessary to add hydrogen peroxide to increase the production of hydroxyl radicals, which is discussed in Section A.3. Ozone reacts in two ways: (1) by direct oxidation with target compounds (as shown in Reaction A-1 and A-2) and (2) through the action of hydroxyl radicals generated during its decomposition (Reaction A-3) (MWH 2005).

$$\mathbf{O_3 + R \xrightarrow{k_1} Products} \qquad \text{A-1}$$

$$\mathbf{O_3 \rightarrow HO\cdot + R \xrightarrow{k_2} Products} \qquad \text{A-2}$$

where k1 and k2 are rate constants, L/mole·s.

In high pH (≈ 11) solution, formation of HO· radicals is directly from O3.

When O_3 reacts with certain functional groups on the surface of nature organic matter (NOM), it also produces HO• as shown in Reaction A-3 (MWH 2005).

$$\mathbf{O_3 + NOM \rightarrow HO\cdot + byproducts} \qquad \text{A-3}$$

The functional groups that participate in this reaction are called "promoters". The HO• produced from Reaction A-3 may also be scavenged by the reaction with other functional groups on the NOM to produce some by-products (Reaction A-4).

$$HO\cdot + NOM \xrightarrow{k_3} byproducts \qquad A\text{-}4$$

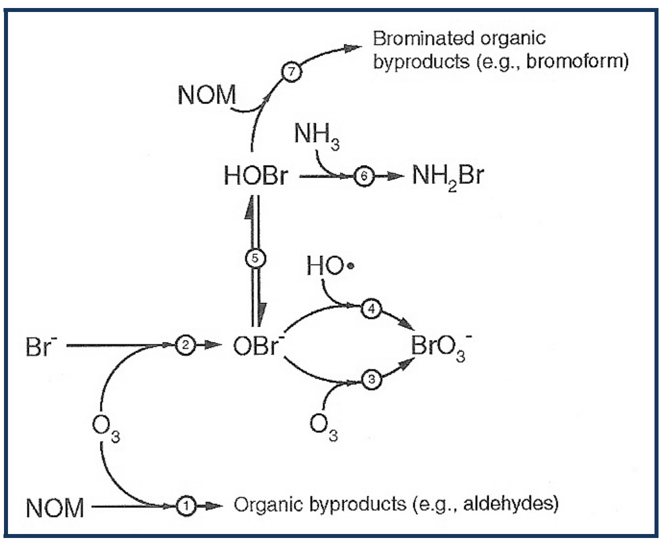
where k_3 is second-order rate constant between hydroxyl radical and NOM, L/mole·s

These functional groups are called scavengers. The net HO• produced by reactions A-3 and A-4 depends on the relative distribution of these functional groups on the NOM. The mechanism of Reaction A-3, ozone with NOM producing HO•, is the most important mechanism to destroy a target compound (MWH 2005).

A.2.2 Potential Bromate Formation

Bromate is a DBP of the ozonation of bromide-containing waters (the production of halogenated by-products). Much of the recent attention has focused on the presence of bromate ion resulting from ozonation. Bromate is classified by the USEPA as a "probable human carcinogen" and has a current drinking water maximum contaminant limit of 10 µg/L. Processes involving ozonation can produce bromate (BrO_3^-) according to the pathways shown in Figure A-1 (MWH, 2005). All the pathways between Br- and BrO_3^- require ozone (O_3) to be present.

Figure A-1: Pathways for Bromate Formation (MWH, 2005)



As shown in Figure A-1, bromate formation resulted from a complex combination of molecular ozone and free radical mechanisms initiated by the hydroxyl radical (HO•) formed through ozone decomposition. When bromide is present in a source water, it oxidizes by ozone to form hypobromous acid (HOBr). At common drinking water pH levels, HOBr is in equilibrium with the hypobromite ion, OBr^-. HOBr reacts with organic precursors to form bromoform and other brominated organic by-products, and OBr^- can be oxided by ozone to bromate (BrO_3^-).

Methods for controlling bromate formation include: (1) pH depression to shift the balance between HONr and BrO^- and (2) ammonia addition to tie up the HOBr (MWH, 2005, Gillogly et al., 2001) and, more recently 3) the chlorine-ammonia process, which seeks to tie the ammonia up as bromamine, which reacts very slowly with ozone (von Guten, 2005).

A.2.3 Pre-Ozonation

One potential application point for ozone (O_3) as an AOP at DCT is to the AWT source water, either secondary or tertiary treated effluent, prior to MF and RO treatment processes. There is evidence that the application of ozone at this point in the process may: 1) facilitate the formation of hydroxyl radicals (HO•) without the need H_2O_2 addition, 2) oxidize NDMA precursors, and 3) reduce membrane fouling of the MF pretreatment.

Early work done, first by LADWP, UCLA and James M. Montgomery Consulting Engineers (JMM) (Aieta et al. 1988) and later by MWD, JMM and UCLA (Ferguson et al. 1991; Glaze et al. 1990) demonstrated that the addition of hydrogen peroxide (H2O2) during the ozonation of San Fernando groundwater, Colorado River Water and State Project Water increased the production of HO•, making AOP more efficient. The concentration of NOM in these waters ranges from 0.5 to 4 mg/L. Later work by JMM (Trussell 1989), and more recently by the Southern Nevada Water Authority (SNWA) (Wert et al. 2009), demonstrated that the addition of H2O2 to waters with higher NOM concentrations, particularly treated wastewaters, often does little to enhance treatment performance. These observations are thought to be due to the action of "promoters" on the NOM molecules themselves (Trussell and Najm 1999).

In fact, ozone, without peroxide, has been shown to possess AOP properties that effectively oxidize many of the emerging contaminants of concern (Buffle et al. 2006; Wert et al. 2009). The reason that so many compounds can be effectively oxidized is because when ozone is added to wastewater, there is an abundance of NOM and this NOM possesses functional groups that act as the "promoters" described above, generating HO•. In fact, recent research has demonstrated that the levels of HO• ($>10^{-10}$ M) produced can actually exceed the concentrations of HO• in typical AOP applications with R_{ct} ratios ($=\int$ [HO•]dt/ $\int$[O3]dt) $>10^{-6}$. This AOP behavior oxidizes many emerging contaminants (Snyder et al. 2006) and has been shown to effectively reduce the estrogenic activity of the treated wastewater (Huber et al. 2004; Snyder et al. 2006). Researchers that have added H_2O_2 in an attempt to generate additional emerging contaminant oxidation have observed little improvement because the quantity of HO• generated by the NOM promoters was so significant (Snyder et al. 2006).

In addition to oxidizing the wastewater contaminants of concern, pre-ozonation will oxidize NDMA precursors and effectively reduce the NDMA formation potential of the water (Lee et al. 2007). Although the formation of NDMA through the AWT train cannot be avoided altogether, it can be dramatically reduced by (1) minimizing the chloramine contact time which is required for biofouling control of the RO membranes and (2) reducing the ultimate NDMA formation potential of the water. Pre-ozonation allows for an engineered treatment train that brings these goals to fruition. A potential concern with pre-ozonation is that bromate formation will be significant, but research has shown that bromate is well rejected (Gyparakis and Diamadopoulos 2007) and it is anticipated that these results would be confirmed at the pilot, if tested. If the rejection of bromate by the RO process is inadequate, considerations would need to be made to control bromate formation through the methods detailed in the previous section.

Despite the promise of pre-ozonation in AWT facilities, there are a few reasons that make this alternative AOP less attractive for application at DCT. The first reason is that the required ozone dose would be quite significant (e.g., 8 to 12 mg/L) to achieve effective emerging contaminant oxidation and this makes this particular application likely to be as costly as other AOP alternatives. Another important consideration is the fact that the wastewater at DCT is completely nitrified. This means that the effluent average pH will be closer to 7 which will slow down reaction rates and, more importantly, a nitrified effluent means that free chlorine can be dosed to the source water. The ability to carry free chlorine through the MF process will greatly enhance the sustainable membrane flux through the pretreatment process and will also have the benefit of reducing the water's NDMA formation potential by oxidizing NDMA precusors (Huitric, et al. 2007). Free chlorine is also known to effectively oxidize estrogens. The fact that a low free chlorine residual is a cost-effective means of reducing NMDA formation potential and enhancing MF performance at future AWTP makes pre-ozonation an alternative that deserves consideration only at AWT facilities that are treating a wastewater without nitrification, such as at HTP. Finally, the pre-ozonation chemistry is extremely complex and the mechanistic understanding of the reaction sequence and influence of key water quality parameters is still in its infancy (Buffle et al. 2006). In summary the following are recommended for consideration:

- For non-nitrified effluents (HTP): preozonation ahead of MF, preformed chloramines between MF and RO.
- For nitrified effluents (DCT, LAG & TIWRP): free chlorine ahead of MF, ammonia to form chloramines after MF, but before RO.

A.2.4 Post-Ozonation

The other potential application point for O_3 at the future AWTP is to the RO product water, possibly after additional post-treatment processes designed to stabilize the water quality, which might enhance performance. A simple model of a plug flow reactor (PFR) or a completely mixed batch reactor can be used to determine the required time for destruction of target compounds as shown in Equations A-5 to A-8 (MWH 2005).

$$\frac{d[O_3]}{dt} = -k[O_3] \qquad \text{A-5}$$

$$[O_3] = [O_3]_0 e^{-kt} \qquad \text{A-6}$$

$$\frac{d[R]}{dt} = -(cR + k_{O_3}[R])[O_3]_0 e^{-kt} \qquad \text{A-7}$$

$$[R] = [R]_0 e^{[([O_3]_0/k)(k_{HO\cdot} C_{[HO\cdot]/[O_3]} + k_{O_3})(e^{-kt} - 1)]} \qquad \text{A-8}$$

where k is the pseudo-first-order rate constant for ozone, s^{-1},

$[O_3]_0$ is the initial concentration of ozone, mole/L,

$[R]_0$ is the initial concentration of target compound R, mole/L

This simplified model requires that experimental tests be performed to determine *k* and $C_{[HO\bullet]/[O3]}$. Bench-scale testing is required for better model calibration for all potential O_3 application points, but extensive testing with the pre-ozone application point would be required as detailed in the previous section. In order to develop the pseudo first order rate constant, *k*, and $C_{[HO\bullet]/[O3]}$, the following steps would need to be performed using a batch-test method (MWH, 2005):

1. Add ozone to the water and measure the initial ozone concentration as well as the concentration of ozone as a function of time.
2. Calculate the k for ozone by fitting Eq. A-6 to the ozone-versus-time data.
3. Measure the concentration of target compounds as a function of time.
4. Determine the best-fit $C_{[HO\bullet]/[O3]}$ value by fitting the target compounds data using Eq. A-8. It is recommended that an objective function (OF) as shown in Equation A-9 be used to find the best fit using a spread sheet and making $C_{[HO\bullet]/[O3]}$ the target cell.

$$\mathbf{OF} = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}\left(\frac{C_{\text{data},i} - C_{\text{model},i}}{C_{\text{data},i}}\right)^2} \qquad \text{A-9}$$

where OF is the objective function, dimensionless

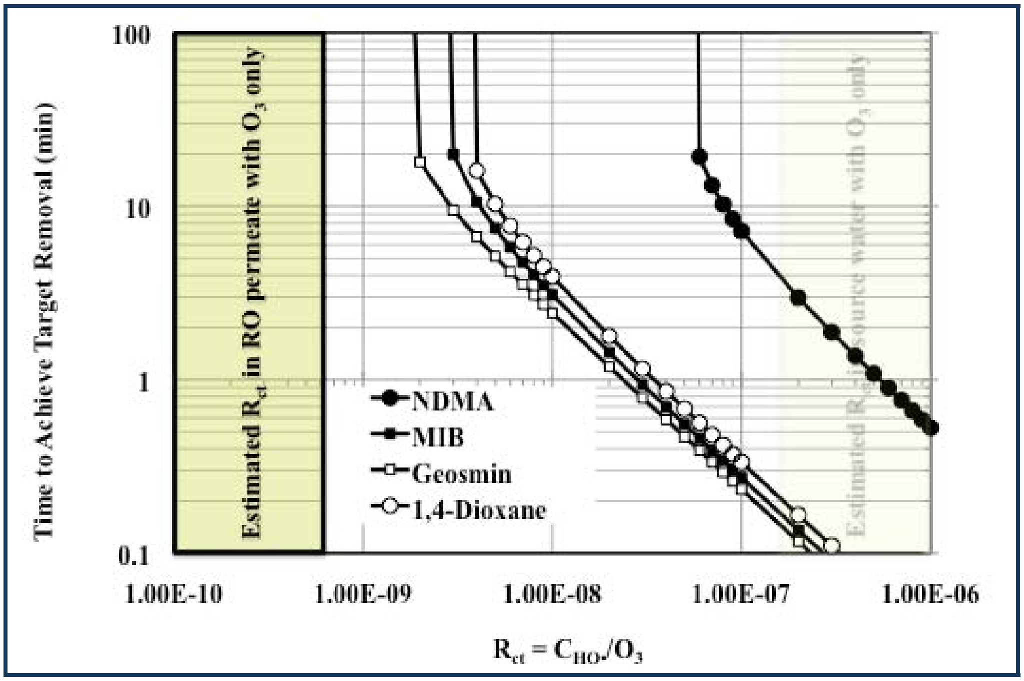
n is the number of data points, dimensionless

$C_{data,i}$ is the measured concentration of data point i, mg/L

$C_{model,i}$ is the predicted concentration of data point i, mg/L

However, even without these specific batch ozonation experiments, reasonable estimates of the required oxidation time can be generated using a typical first order rate constant of $k = 0.1\ min^{-1}$. Using this approach and contaminant specific rate constants from the literature, modeling was performed using equations A-5 to A-8 to generate Figure A-2. Figure A-2 presents the time required to oxidize 1.2-log of NDMA and 0.5-log of 1,4-dioxane as a function of R_{ct}, or the ratio of $HO\bullet/O_3$. For comparison purposes, the time required to oxidize 1.2-log of MIB and Geosmin is also presented as these are common taste and odor compounds. Because the RO permeate has a low concentration of NOM (e.g., less than 0.2 mg/L), there will be very little HO• generated and it is estimated that the R_{ct} will be close to 10^{-10} when ozone is dosed to the RO permeate. Observing Figure A-2, it is evident that O_3 alone will not suffice for application to the RO permeate. In fact, any R_{ct} less than 10^{-7} will not allow our 1.2-log NDMA removal objective to be achieved regardless of how much contact time is provided. For comparison purposes, it is important to highlight the promise of O_3 as an AOP on the source water when treating non-nitrified waters with the R_{ct} approaching 10^{-6} (as discussed in the previous section). Significantly, this figure also highlights the fact that if 1.2-log of NDMA removal is achieved with an AOP unit then the 0.5-log 1,4-dioxane removal will be easily achieved.

Figure A-2: Modeling results for the removal of NDMA, 1,4-Dioxane, Geosmin and MIB



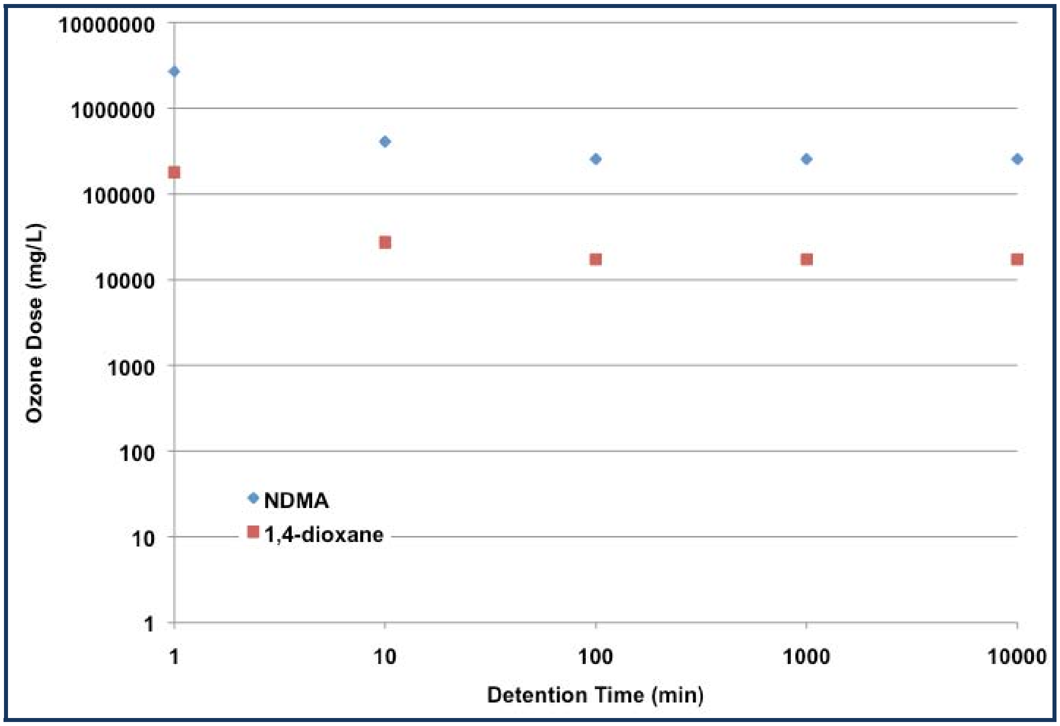
As noted in the discussion of Figure A-2, the HO• production from the reaction of O_3 with low NOM concentrations will be almost negligible. Assuming that HO• production in the RO permeate is negligible, then Eqs. A-7 and A-8 simplify to the following:

$$\frac{d[\mathrm{R}]}{dt} = -k_{O_3}[\mathrm{R}][\mathrm{O}_3]_0 e^{-kt} \qquad \text{A-10}$$

$$[R] = [R]_0 e^{[([\mathrm{O}_3]_0/k)k_{\mathrm{O}_3}(e^{-kt}-1)]} \qquad \text{A-11}$$

Using these modified equations (A-10 and A-11), Figure A-3 was constructed that presents the required ozone dose to achieve the required log removals (1.2-log NDMA and 0.5-log 1,4-dioxane) as a function of the required detention time. It is clear from the data presented in Figure A-3 that a reasonable O_3 dose cannot be achieved regardless of the detention time and there is no detention time that could be provided to make these oxidation goals feasible. Hence, with our AOP objectives in mind, the application of O_3 to the RO permeate is not an alternative that deserves any additional consideration.

Figure A-3: Required O_3 dosage to achieve the target log-removal with time



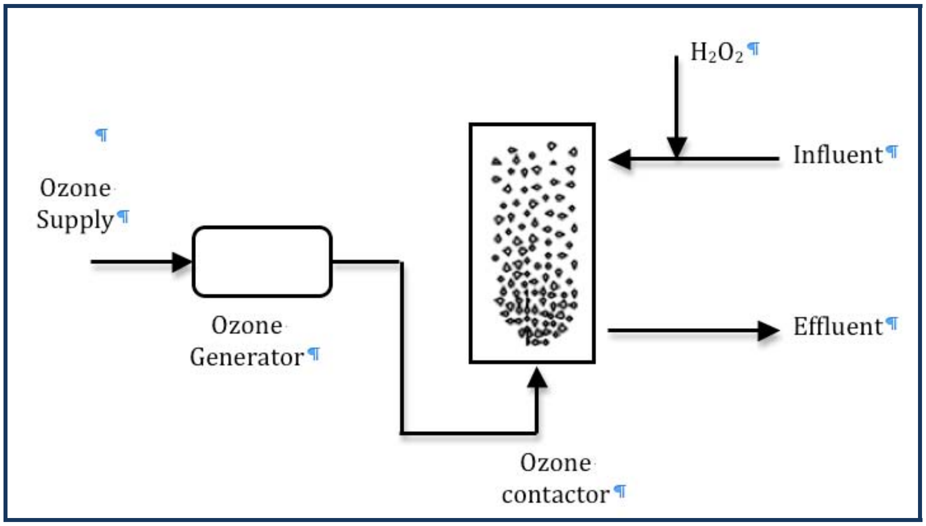
A.3 Ozone (O_3)/Peroxide (H_2O_2)

A.3.1 Science and Chemistry of HO• formation, and HO• Oxidation Power

In advanced oxidation processes, often a combination of ozone and hydrogen peroxide are applied because deprotonated hydrogen peroxide (HO_2^-) acts as initiator for the chain reactions that transform ozone into hydroxyl radicals (Gunten et al., 1994). The O_3/H_2O_2 AOP is widely and successfully used in full-scale water treatment plants to remove taste and odor compounds, as well as to treat contaminated groundwater for TCE, PCE and MtBE. In the Ozone/Hydrogen Peroxide process, ozone reacts with hydrogen peroxide to generate hydroxyl radicals. The hydroxyl radicals oxidize target organics. With hydrogen peroxide addition, the activation of NOM with ozone is ignored because it is insignificant. The O_3/H_2O_2 alternative is under consideration for treatment of the RO permeate where the extremely low TOC and alkalinity downstream of the RO make application of the O_3/H_2O_2 AOP a particularly attractive option given the lack of competition for HO• from NOM and carbonate species compared to AOP treatment of other water sources. Applying O_3/H_2O_2 AOP on the RO permeate is also attractive because bromide will be rejected by the RO eliminating the potential problem of bromate formation in ozonation processes that was discussed above.

A schematic of a typical O_3/H_2O_2 reactor is shown in Figure A-4.

Figure A-4: Schematic of O_3/H_2O_2 process



The O_3/H_2O_2 elementary reactions are (MWH, 2005):

$$HO_2^- + O_3 \xrightarrow{k_1} O_3^- + HO_2 \cdot \quad \text{A-12}$$

$$HO^- + O_3 \xrightarrow{k_2} HO_2^- \cdot + O_2 \quad \text{A-13}$$

$$O_2^- \cdot + O_3 \xrightarrow{k_3} O_3^- \cdot + O_2 \quad \text{A-14}$$

$$O_3 + H^+ \xrightarrow{k_4} HO_3 \cdot \quad \text{A-15}$$

$$HO_3 \cdot \xrightarrow{k_5} HO \cdot + O_2 \quad \text{A-16}$$

$$O_3 + R \xrightarrow{k_6} \text{Product} \quad \text{A-17}$$

$$HO \cdot + HO_2^- \xrightarrow{k_9} OH^- + HO_2 \cdot \quad \text{A-18}$$

$$HO \cdot + H_2O_2 \xrightarrow{k_{10}} H_2O + HO_2 \cdot \quad \text{A-19}$$

$$HO \cdot + HCO_3^- \xrightarrow{k_{11}} CO_3^- \cdot + H_2O \quad \text{A-20}$$

$$HO \cdot + R \xrightarrow{k_{12}} \text{Product} \quad \text{A-21}$$

$$HO \cdot + NOM \xrightarrow{k_{13}} \text{Product} \quad \text{A-22}$$

Where k_1, k_2, k_3, k_4, k_6, k_9, k_{10}, k_{11}, k_{12}, and k_{13} are the second-order rate constants, L/mole·s, and k_5 is the first-order rate constant, s^{-1} (see MWH, 2005).

The overall reaction for the formation of HO· in the O_3/H_2O_2 process is:

$$H_2O_2 + 2O_3 \rightarrow 2HO\cdot + 3O_2 \qquad \text{A-23}$$

While ozone can react directly with target organics to form products (Reaction A-1), this will not be significant compared to the reaction of HO• with target organics to form products (Equation A-21) given that the HO• rate constant for a given organic is typically several orders of magnitude higher than the apparent rate constant for the reaction of the organic with ozone.

To provide an estimate of the destruction rates of the parent compound and hydrogen peroxide in the case of when H_2O_2 is added to water containing O_3, a simplified model of the H_2O_2/O_3 process was employed (adapted from MWH, 2005). A net rate of formation of hydroxyl radicals is given by the following expression:

$$\begin{aligned} r_{HO\cdot} &= k_5[HO_3\cdot] - k_9[HO\cdot][HO_2^-] - k_{10}[HO\cdot][H_2O_2] \\ &- k_{11}[HO\cdot][HCO_3^-] - k_{12}[HO\cdot][R] - k_{13}[HO\cdot][NOM] \end{aligned} \qquad \text{A-24}$$

Equation A-24 can be rearranged to obtain the following expression for the pseudo-steady-state concentration of HO•, where radical species other than HO• can be eliminated:

$$[HO\cdot]_{ss} = \frac{2k_1[HO_2^-][O_3]}{k_{11}[HCO_3^-] + k_{12}[R] + k_{13}[NOM]} \qquad \text{A-25}$$

where $[HO\bullet]_{ss}$ is the pseudo-steady-state concentration of HO•, mole/L

According to Eq. A-25, the initial pseudo-steady-state concentration of HO• can be calculated by the following equation (MWH, 2005):

$$[HO\cdot]_{ss,0} = \frac{2k_1[H_2O_2]_0 \times 10^{(pH - pK_{H_2O_2})}[O_3]_{res}}{k_{11}[HCO_3^-]_0 + k_{12}[R]_0 + k_{13}[NOM]_0} \qquad \text{A-26}$$

Based on equation A-23, $[H_2O_2]_0 \times 10^{(pH - pK_{H_2O_2})} = [HO_2^-]_0$.

Applying a tanks-in-series (TIS) approach to determine removal:

$$\frac{C_{i,e}}{C_{i,o}} = \frac{1}{(1 + k_R \tau / n)^n} \qquad \text{A-27}$$

where τ is the hydraulic detention time of the reactor, s; n is the number of tanks; and k_R is the pseudo-first-order rate constant for target compound R, s^{-1}:

$$k_R = k_{12}[HO\cdot]_{ss,0} \qquad \text{A-28}$$

where k_{12} is the second-order rate constant between hydroxyl radical and target organic compound R, L/mole·s.

To to examine the effectiveness of H_2O_2/O_3 post-RO treatment in achieving the target log-removal of 1.2 for NDMA, the model described above was used to estimate the removal of NDMA. Several assumptions were made: 1) H_2O_2 dosed after contact time (Ct) for ozone disinfection credit achieved; 2) 4 tanks in series describes the mixing condition; 3) H_2O_2 concentration constant equal to initial concentration; 4) O_3 concentration constant equal to disinfection residual.

The following assumptions were made about feed water quality in the analysis (values in bold represent values used in analysis):

TOC = 0.15 to 0.20 mg/L (based on typical RO permeate)

Target compound concentrations:

NDMA = 30 ng/L (based on levels observed at Orange County's GWRS);

1,4-dioxane = 1.8 to 3.3 µg/L (based on levels observed at Orange County's GWRS);

TCEP = 10 ng/L (based on Snyder et al., 2007)

Two Scenarios of AOP Feed pH / alkalinity

1. Typical RO permeate water quality:
   pH = 6 to 6.5, alkalinity = 2 to 10 mg/L as $CaCO_3$
2. Water quality after post-treatment with decarbonator(s) and caustic addition
   pH =8, alkalinity = 14 mg/L as $CaCO_3$

The results for detention time required to achieve 1.2-log removal of NDMA are presented in Table A-3 for various hydrogen peroxide and ozone concentrations.

Table A-3: Detention time required for 1.2-log NDMA removal with varying AOP feed conditions

(a) Typical permeate water quality (pH 6, alkalinity = 10 mg/L as $CaCO_3$):

H_2O_2 (mg/L)	Detention Time Required for 1.2-log NDMA Removal (min) Ozone Residual (mg/L)			
	1	2	5	10
1	135	67	27	14
2	68	34	14	6.8
5	27	14	5.4	2.7
10	14	6.8	2.7	1.4

(b) After post-treatment with CO_2 stripping and caustic (pH 8, alkalinity = 14 mg/L as $CaCO_3$):

H_2O_2 (mg/L)	Detention Time Required for 1.2-log NDMA Removal (min) Ozone Residual (mg/L)			
	1	2	5	10
1	1.53	0.76	0.31	0.16
2	0.76	0.38	0.16	0.076
5	0.31	0.16	0.061	0.031
10	0.16	0.076	0.031	0.016

It is observed from Table A-3 that adjusting the AOP feed to pH 8 greatly reduces the time required to achieve 1.2-log NDMA removal. For example, at an ozone dose of 5 mg/L and a hydrogen peroxide dose of 5 mg/L, the time required decreases from 5.4 min to 0.061 min (a reduction by a factor of ~100). For the scenario of feeding RO permeate post-treated prior to AOP feed (pH 8), a greater extent of removal was achieved than for NDMA:

- 3.6 log-removal for 1,4-dioxane and
- 1.5 log-removal for TCEP.

The same trend would be expected for the pH 6 scenario.

The simplified O_3/H_2O_2 model discussed above represents a useful tool to evaluate the ability of the process to remove NDMA, 1,4-dioxane, and TCEP. As needed during the evaluation of this process at the pilot stage, the project team has available to it a dynamic O_3/H_2O_2 model recently developed by Professor John Crittenden, now at Georgia Tech (formerly of Arizona State and Michigan Tech), and his colleagues. The modeling approach for this O_3/H_2O_2 model is similar to the approach discussed above for UV/H_2O_2.

Following the example of the LAAFP's ozonation process and subsequent work done by LADWP on PCE removal from San Fernando groundwater via H_2O_2/O_3, the Metropolitan Water District of Southern California (MWD) also began to consider the application of ozonation technology to their water treatment process with combined of H_2O_2 addition for the purpose of removing trace organics that cause taste and odor in water from the Colorado Aqueduct and the California State Water Project (Glaze, et al., 1990). Using this technology, MWD also constructed a 3,500 gpm Oxidation Demonstration Plant (ODP) in Laverne. Following successful work at the ODP, MWD has nearly completed a program installing the process in all six of its water treatment plants. The process is also now widely installed in drinking water treatment plants throughout California and across the United States as a whole. Treatment plants including the technology range in size from 700 gpm to more than 600 mgd.

In summary, H_2O_2/O_3 is a proven, cost-effective AOP process and its application to the RO product water at the new AWT Plant is particularly well-suited because the water's low levels of NOM and alkalinity eliminate the major water quality components which compete for HO• activity in normal applications. Preliminary modeling suggests that both NDMA and 1,4-dioxane will be effectively removed.

A.4 Titanium Dioxide

A.4.1 Science and Commercial Process Availability

Another AOP alternative is application of titanium dioxide (TiO_2) photocatalysis. In the late 1980s and early 1990s, the American Water Works Association Research Foundation (AWWARF) invested in research on titanium dioxide photocatalysis for the destruction of DBP precursors in drinking water (Hand et al., 1993). The results were promising and showed that the effectiveness of the process depended on process variables including the properties of the TiO_2 catalyst, incident light intensity received by the catalyst, the oxygen concentration in the reactor, and contact time. At the time, a drawback of the process was the fact that the most effective removal was obtained in a slurry reactor and there was not an effective method at the time for separating the catalyst slurry from the treated water. The study demonstrated an optimum catalyst dose of 1000 mg/L and evaluated reaction times up to an hour, demonstrating increasing removal of DBP precursors with increasing reaction time (Hand et al., 1995). During the last decade, the use of TiO_2 has been the focus of additional scrutiny for photocatalytic degradation of organic compounds including emerging contaminants like endocrine disrupting compounds and pharmaceuticals and personal care products in water purification (e.g., Armon et al., 2004; Doll and Frimmel, 2004, 2005; Bahnemann et al., 2007; Benotti et al., 2009).

The mechanism of photocatalysis in the presence of TiO_2 involves the enhanced formation of hydroxyl (HO•) radicals. The following reactions describe the movement of an electron from the valance band (VB) to the conduction band (CB) produces a hole in the valence band, h^+ (MWH, 2005).

$$\mathrm{TiO_2} \xrightarrow{hv} \mathrm{h}^+ + e_{cb} \qquad \text{A-29}$$

where e_{cb} is an electron in conduction band.

h^+ is the hole in valence band.

H_2O molecules adsorbed on TiO_2 particle surface react to form HO• radicals.

$$\mathrm{h}^+ + \mathrm{H_2O} \rightarrow \mathrm{H}^+ + \mathrm{HO}\cdot \qquad \text{A-30}$$

Excess electrons in the conduction band reduce molecular oxygen to form superoxide ions.

$$e_{cb} + O_2 \rightarrow O_2^- \cdot \qquad \text{A-31}$$

which further disproportionate to form more HO• radicals (Ireland et al., 1993).

$$2O_2^- \cdot + H_2O \rightarrow 2HO \cdot + 2OH^- + O_2 \qquad \text{A-32}$$

In the presence of hydroxyl radicals, target compound destruction proceeds by the same reaction as described in the O3/H_2O_2 AOP discussed above (see Eq. A-21).

Unfortunately, the majority of the holes and conduction band electrons cleaved in the reaction shown in Equation A-29 simply recombine before they participate in any reactions on the catalyst surface and the incident light intensity is wasted:

$$h^+ + e_{cb} \rightarrow \text{photocatalyst} + \text{heat and/or light (recombination)} \qquad \text{A-33}$$

The addition of H_2O_2 has been shown to improve the rate of reaction:

$$e_{cb} + H_2O_2 \rightarrow OH^- + HO\bullet \qquad \text{A-34}$$

At the same time, UV photolysis of hydrogen peroxide generates hydroxyl radicals:

$$H_2O_2 + h\nu \rightarrow 2\,HO\bullet \qquad \text{A-35}$$

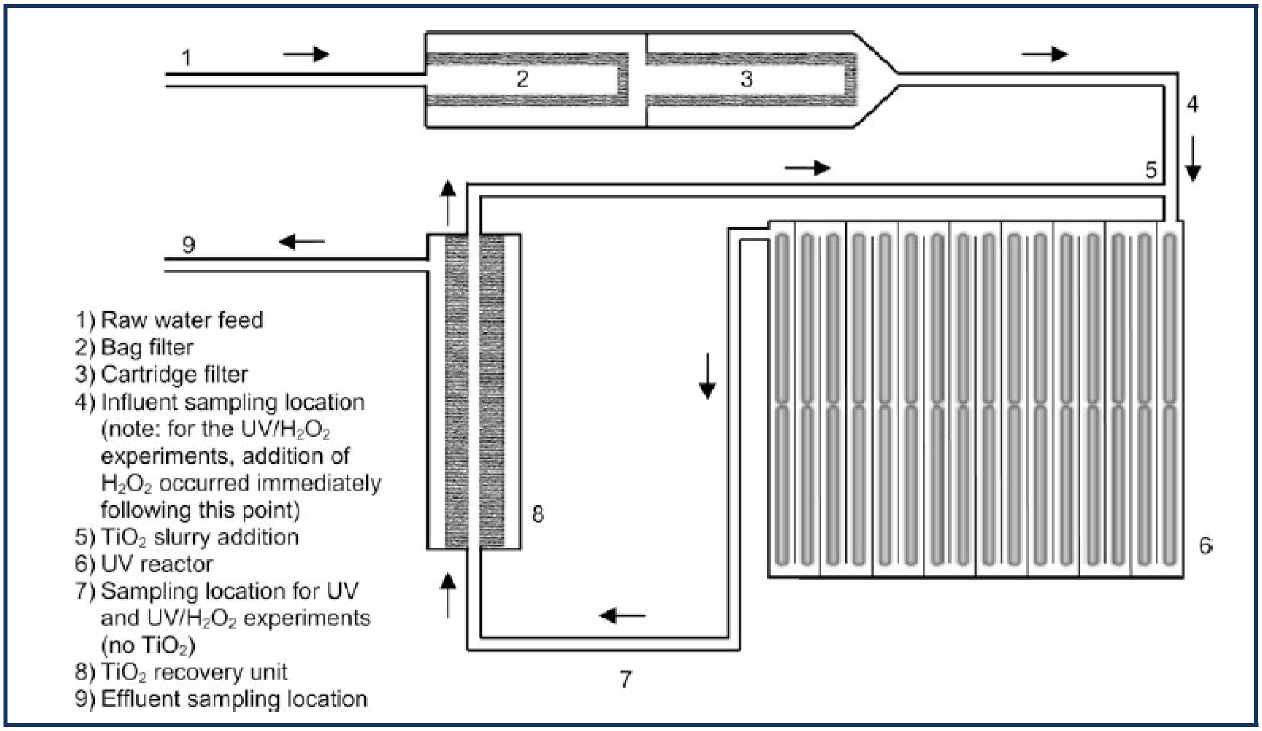
Photolysis of the target compound, such as NDMA, may also occur in UV/TiO_2 with or without H_2O_2 and photolysis of NDMA is a demonstrated approach for NDMA removal (and the same approach used in the baseline AOP approach for this reason):

$$NDMA + h\nu \rightarrow products \qquad \text{A-36}$$

In this AOP alternative, it is not desired to repeat the UV/H_2O_2 approach for removal of NDMA by photolysis but rather to assess whether a UV/TiO_2/(with or without H_2O_2) process can be optimized for NDMA destruction at lower energy and present worth costs than the UV/H_2O_2 baseline approach (i.e., at much lower incident light intensity given the presence of the TiO_2 photocatalyst in addition to the UV light). For this application, it is assumed NDMA will be removed by the mechanism shown in Eq. A-21 (noting it is uncertain how much might be removed by Eq. A-36 at the same time).

In the past decade, Purifics ES has developed a UV/TiO_2 photocatalysis process to effectively destroy organic pollutants in water, disinfect and kill biological matters, and remove metals and particles from water. This patented process (PhotoCat® Process) involves photocatalytic oxidation and reduction process that utilizes low-pressure, high output ultraviolet (UV) light including bands at 254 nm and 185 nm to activate the TiO_2 catalyst as opposed to the photons cleaving chemical bonds to create hydroxyl radicals as well as filtration and recycling of the photocatalyst by ceramic microfiltration membrane (as shown in Figure A-5). The ceramic microfiltration membrane is the method to separate the slurry from the treated water.

Figure A-5: General PhotoCat® pilot system schematic (Benotti et al., 2009).



Flow (point 1) enters the unit passing the influent chamber to a pre-filter consisting of both a bag (point 2) and cartridge filter (point 3). It is then mixed with nanoparticle TiO_2-water slurry (point 5 - rejected TiO_2 from point 8), and passed through the UV reactor (point 6). After exposing to the UV lamps, flow enters to a cross-flow ceramic membrane (Point 8) and TiO_2 is being removed from the flow stream, and the treated water exits the unit (Point 9).

Both pilot and bench-scale studies have proved that the TiO_2/UV technology or PhotoCat® technology (1) is able to remove high percentage of pharmaceuticals and endocrine disrupting compounds from contaminated water (Benotti et al., 2009, Doll et al., 2004) and has promising destruction of common emerging contaminants such as triclosan, TCEP, hexachlorobenzene, bisphenol-A, carbamazapine, and ethinyl estradiol (Hart et al., 2008); (2) can effectively inactivate pathogens such as Cryptosporidium parvum (Ryu et al., 2008), total coliform, MS2 coliphage and adenovirus (Hart et al., 2008). Hart et al. (2008) reported that even with 0.15 kW/gallon of UV strength, total coliform was removed below detection limits of 1 MPN/100mL

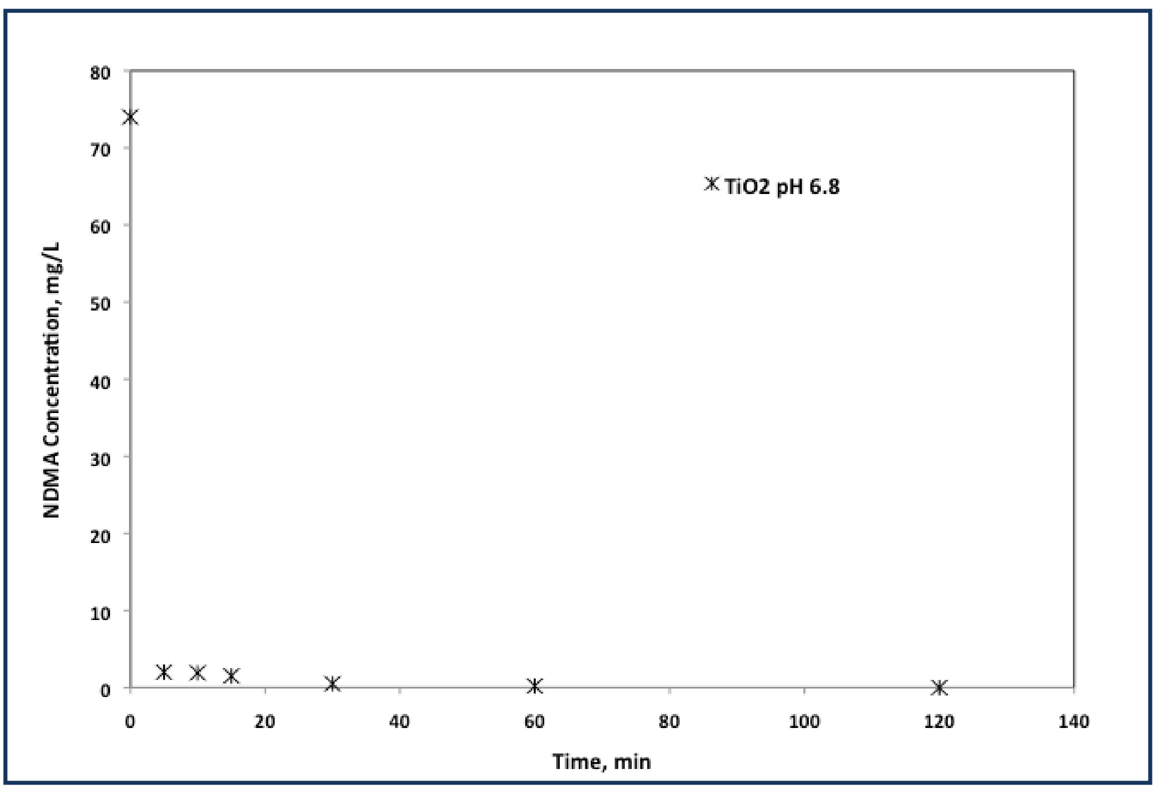
In Benotti et al. (2009)'s pilot study on spiked Colorado River Water from Lake Mead prechlorinated to control quagga mussels, it is reported that eleven of the 32 compounds were easily removed, with concentrations below or approaching MRLs with 0.53 kWh/m^3 (4 lamps) of treatment: estrone, estradiol, ethinylestradiol, bisphenol A, octylphenol, butylated hydroxyanisole (BHA), atorvastatin, triclosan, diclofenac, sulfamethoxazole, and naproxen; and 17 compounds required higher amounts of treatment (0.80–4.24 kWh/m3 or 6–32 lamps) to achieve a greater than 70 percent reduction in compound concentration; and three of them: PFOS, tris(2-chloroethyl) phosphate (TCEP), and tris(1-chloro-2-propyl) phosphate (TCPP), were less than 50 percent removed but required 4.24 kWh/m[3] (32 lamps) UV treatment. The recalcitrance of TCEP in the UV/TiO_2 process supports it is choice as a sentinel.

A conclusion of Benotti et al. (2009) was that $UV/H_2O_2/TiO_2$ may represent a preferred treatment approach in terms of electrical efficiency per log order reduction compared to UV/TiO_2 alone, but the approach was not considered in their study. The work of Benotti et al. (2009) also was limited to a catalyst dosage of 50 mg/L at the recommendation of Purifics but noted that alternative studies used much higher dosages on the order of 1000 mg/L as discussed in other works above. Another difference of the Benotti et al. (2009) study noted by the authors was their reaction time of less than a minute exposure to the UV light compared to reaction times on the order of minutes to hours to achieve destruction in other studies.

The work of Bahnemann et al. (2007) demonstrated that the effectiveness of UV/TiO_2 can be affected by pH and showed competing effects depending on the compound. Bahnemann's work also showed that the type of catalyst makes a difference, that optimum catalyst dose depends on target compound and that increasing the dose beyond a certain point may be detrimental due to increasing turbidity in the water interfering with the ability of the UV lamps to activate the photocatalyst, and that the addition of hydrogen peroxide can have a positive effect by reducing the recombination effect discussed above.

With adding TiO_2 alone as a catalyst, Jahan et al. (2008) reported that with 0.015 grams of TiO_2 added into a NDMA concentrations of 74 mg/L, the NDMA is completely removed after 2 hours of detention time as shown in Figure A-6.

Figure A-6: NDMA destruction by TiO_2 (data adapted from Jahan et al., 2008)



TiO_2 based photocatalysts such as a commercial P25, a synthesized magnetic photocatalyst and an immobilized sol-gel system can completely mineralizes 1,4-dioxane to CO_2 (Coleman et al., 2007).

Based on the discussion in this section, the TiO_2 photocatalyis process shows great promise for the destruction of the target compounds, but the process is less proven than other alternatives being considered. For this reason, the pilot study should be designed to carefully evaluate key process variables including catalyst dosage, incident light intensity, pH, dissolved oxygen concentration in the feed, and effectiveness of the process for NDMA, 1,4-dioxane, and TCEP removal with and without hydrogen peroxide.

A.5 Fenton's Reagent

Fenton's reagent is a mixture of ferrous ion and hydrogen peroxide and it has long been known as a powerful oxidant for organic contaminants. It catalyses the formation of hydroxyl radicals as shown in Reaction A-37 (MWH, 2005) which is a typical reaction scheme in the Fenton system:

$$Fe^{2+} + H_2O_2 \rightarrow Fe^{3+} + OH^- + HO\bullet \quad \text{A-37}$$

The ferric ions from the reaction can then produce $HO_2\bullet$ although the oxidation process slows down after the conversion of ferrous to ferric ion (MWH, 2005).

$$Fe^{3+} + H_2O_2 \rightarrow Fe^{2+} + HO_2\bullet + H^+ \quad \text{A-38}$$

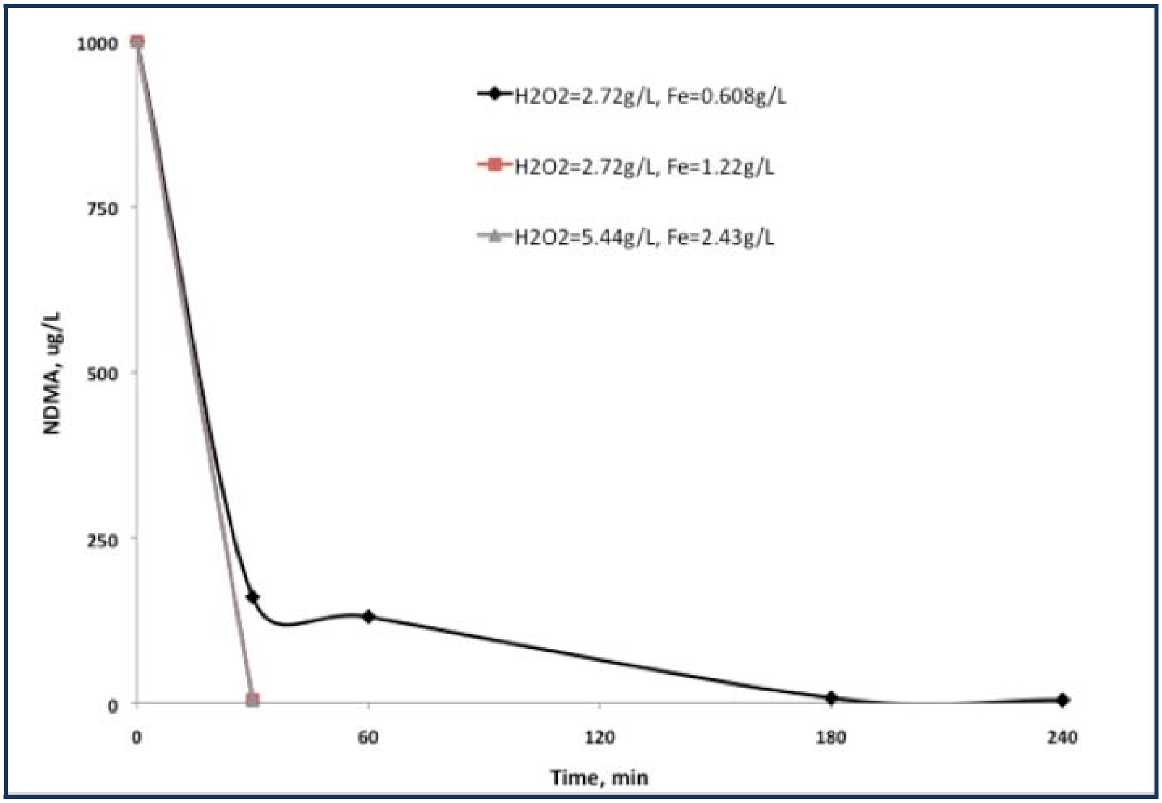
There have been many of studies into the application of Fenton or modified Fenton oxidation processes to water and wastewater treatment in the last two decades (Safarzadeh-amiri et al., 1997, Namkung et al., 2004, Liu et al., 2007, Son et al., 2009, So et al., 2009). In past years, both bench-scale and pilot studies are being carried out on treating textile industry effluent by using Fenton oxidation process (Fe^{2+}/H_2O_2) and Photo-Fenton ($Fe^{2+}/H_2O_2/UV$) (Riga et al.,2007). With Fenton alone, this method was slightly slower than the photo-Fenton's method but was suitable for compounds that are subject to direct photolysis, such as hexachlorocyclopentadiene and picloram (Haag, et al.,1992). However, the destruction efficiency of Fenton's reagents depended on hydrogen peroxide concentration. In Riga et al. 2007's dye study, three different combinations of H_2O_2 and Fe^{2+} were tested and the decolorization rates observed.

Results demonstrated that with both H_2O_2 and $FeSO_4$ at a 0.01 percent concentration and a 1/1 weight ratio, the destruction is most efficient and effective.

In Kim et al., (2006)'s study, it is reported that photo-Fenton process was able to remove a 95 percent and a 100 percent of 1,4-dioxane in two different polyester wastewater samples. The Fe(II):H_2O_2 dosages were 200:300 and 100:200 respectively. Later research found that photo-Fenton process with post-treatment could only achieve 90 percent removal of 1,4-Dixoane for polyester manufacturing wastewater (So et al., 2009). Fenton reactions, like all AOP reactions are strongly influenced by water quality, particularly pH, alkalinity, and the presence of competing organics, especially TOC, so this may be the explanation.

In terms of NDMA destruction by Fenton's reagents, Kommineni et al. 2003 has conducted a bench-scale experiment in a homogeneous system and the results are presented in Figure A-7.

Figure A-7: Rate of NDMA destruc-tion by Fenton's reagents in a homogeneous system $NDMA_0$=1000ug/L, pH=1.9 (data from Kommineni et al. 2003)



As shown from Figure A-7, Fenton-driven destruction of NDMA occurs rapidly in the homogeneous system. Kommineni et al. 2003 reported that NDMA destruction by Fenton's reagent is most efficient at low pH (near 2).

In fact, there are many process parameters that affect the efficiency of the Fenton oxidation such as pH, dosage and ratio of Fenton's reagent, concentration of hydroxyl radicals, concentration of inorganic materials forming complexes with iron species, temperature, mixing, concentration of dissolved oxygen (DO), characteristics and concentration of organic pollutants, and TOC (Namkung et al., 2004). Because of many unknown factors and its relatively high cost for practical applications (Namkung et al., 2004), substantial additional research is still required to support a more cost effective and reliable process design. Also important in the case of the Los Angeles reuse project, is the fact that Fenton reactions would be most efficient in the RO effluent and yet they would introduce significant amounts of ferric ion which must be subsequently removed. For these reasons, the Fenton reaction will not be considered further.

A.6 Recommendations for AOP Alternatives to Evaluate in Addition to the Baseline AOP Approach (UV/H_2O_2)

Based on the analysis provided in the previous sections, the following recommendations can be made for the AWT train at DCT:

1. AWT train and AOP design objectives should be developed based upon the observed concentrations of NDMA, 1,4-dioxane and TCEP in collaboration with CDPH. It is anticipated that NDMA and TCEP will control the process design and represent the most effective sentinels for AOP evaluation.
2. Influent for the AWT Plant should be taken from the DCT before chloramination in order to avoid further NDMA formation
3. Sequential chlorination, free chlorine addition prior to the MF pretreatment process followed by ammonia addition prior to the RO process, should be employed regardless of the AOP selection to minimize NDMA formation through the AWT train and enhance the sustainable MF design flux
4. Ozone alone does not merit any further evaluation for application at as an alternative AOP on the nitrified effluent at DCT or RO permeate.
5. O_3/H_2O_2 treatment applied to RO permeate should be further evaluated at the bench- and pilot-scale to refine the optimum treatment train and develop an appropriate treated cost of water comparison. Most significant, consideration must be given to the interplay between necessary post-stabilization processes and the optimal location of this AOP technology.
6. UV/TiO_2 treatment applied to RO permeate should be further evaluated at the pilot-scale to refine design criteria, optimize the required TiO_2 and UV dose, and verify manufacturer design reliability and sizing.

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Appendix F

Site Assessment TM

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Technical Memorandum

Title:	**Site Assessment**
Prepared For:	**John Hinds, Project Manager, LADWP** **Doug Walters, Project Manager, BOS** **Eloy Perez, Task 1 Lead, LADWP** **Hiddo Netto, Task 1 Co-Lead, BOS**
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Date:	**March 2012**
Reference:	**Task 1 Groundwater Replenishment Master Planning Document** **Task 1.5 Site Assessment** **Task 1.9 Site Assessment Support**

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Appendices

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Executive Summary

The Los Angeles Department of Water and Power (LADWP), in partnership with the Los Angeles Department of Public Works (LADPW) Bureau of Sanitation (BOS), and Bureau of Engineering (BOE), developed the Recycled Water Master Planning (RWMP) documents. It is a visionary plan with solutions that integrate human demands with environmental needs and costs. The plan includes an evaluation of alternatives – strategies that take into account forward-looking groundwater replenishment options as well as the more familiar form of recycling water for non-potable (purple pipe) purposes.

The Site Assessment Technical Memorandum is one element of the RWMP documents. It is a thorough examination of potential sites for a new Advanced Water Purification Facility (AWPF) in the San Fernando Valley. The site assessment includes identifying potential properties (59 sites), then narrowing those down through a pre-screening process to arrive at candidate sites for detailed evaluation (five sites). These sites were evaluated and ranked to allow the City to select a staff-preferred site for the master planning process. The actual AWPF site will be selected through the environmental documentation process.

The results of this analysis will be combined with findings and recommendations of several other technical studies being completed for the RWMP. When implemented, the RWMP will provide the 59,000 AFY of recycled water by 2035 as a sustainable source of local water.

This Site Assessment TM includes preliminary capital and operations and maintenance (O&M) cost estimates for the purpose of comparing candidate sites. The RWMP process also included an integrated alternatives analysis to help determine the split of GWR and NPR to meet the City's recycled water goals. The preliminary capital and O&M cost estimates were further refined as part of the integrated alternatives analysis effort for the alternatives, each which contained varying amounts of GWR and NPR. To provide consistency between the initial RWMP documents, the following documents were updated to include the same cost estimates:

- Site Assessment TM (this document)
- Integrated Alternatives Development and Analysis TM
- Integrated Alternatives Analysis – Preliminary Cost Summary

Note that the GWR and NPR project costs were developed in more detail as part of the GWR and NPR Master Planning Reports, respectively. The most current GWR and NPR project costs developed as part of the RWMP are included in the GWR and NPR Master Planning Reports, respectively, and would not change the outcome of this analysis.

ES.1 Introduction

The purpose of the Site Assessment Technical Memorandum is to identify and compare potential sites for the new AWPF. The TM provides two important bodies of planning information:

1. It describes the process to identify and pre-screen candidate site locations, a detailed evaluation of those sites, and a comparison achieved through the use of a decision-model process (computer analyses).

2. It also documents the advantages and disadvantages and ranking of each site based on the detailed evaluation and decision modeling.

The information that comes from this study will allow the City of Los Angeles to select a site for the future AWPF. The selected site will be developed in more detail as part of the development of the Groundwater Replenishment (GWR) Master Planning report.

The organization of the Technical Memorandum is as follows:

- Section 1 – Introduction
- Section 2 – Assumptions
- Section 3 – Site Assessment Approach
- Section 4 – Identify and Pre-Screen Potential Site Locations
- Section 5 – Candidate Site General Descriptions
- Section 6 – Detailed Site Evaluation
- Section 7 – Decision Modeling Results
- Section 8 – Key Findings and Recommendations

ES.2 Assumptions

A critical assumption for the site assessment is how the tertiary effluent from the Donald C. Tillman Water Reclamation Plant (DCTWRP) will be used. Two scenarios carried throughout the assessment study are the "Base Condition" and "Scenario 1," with the major difference between them being whether Title 22 recycled water (Base Condition) or AWPF purified recycled water (Scenario 1) is distributed to NPR customers, and if separate or combined distribution systems are necessary. The two scenarios are defined as follows:

Base Condition: Separate NPR and GWR Distribution Systems

Under this scenario, separate systems would be used to provide Title 22 water to NPR customers and AWPF purified recycled water for groundwater replenishment. An exception would occur at one of the five candidate sites (Valley Generating Station) where the existing Balboa Pump Station and 54-inch pipeline would be used to pump Title 22 water to the existing and planned[1] NPR users and the AWPF. For the Valley Generating Station (VGS), the Base Condition and Scenario 1 are identical.

Scenario 1: Combined NPR and GWR Distribution Systems

Under this scenario, tertiary effluent will be treated through the AWPF. AWPF purified recycled water will be served to NPR customers as well as used for GWR. As noted above, for the VGS site, the existing Balboa Pump Station and 54-inch pipeline would be used to pump Title 22 water to the existing and potential NPR users and the AWPF. For the VGS site, the Base Condition and Scenario 1 are identical.

[1] Planned NPR users are future customers that could be served through projects that are already in planning, design, or construction phases.

Other assumptions include the following:

- DCTWRP is designed to treat 80 million gallons per day (mgd), however, at this time, flows to the plant are lower. The RWMP planning team assumed 70 mgd of tertiary effluent would be available for all uses. (The City will implement flow diversions in the collection system and primary effluent equalization to allow the production of 70 mgd of tertiary effluent year round by 2020-2040 when plant inflows are projected to reach 80 mgd.)
  - 2 mgd is needed for DCTWRP in-plant processes
  - 27 mgd is needed to sustain nearby lakes and Los Angeles River habitat
  - 41 mgd is available for GWR and NPR
- Of the 41 mgd available, the RWMP planning team assumed that 4.0 mgd would be used to serve NPR existing and planned customers, and the remaining 37 would be allocated to GWR for the Base Condition.
- Scenario 1 would treat all of the 41 mgd available in the AWPF and provide that purified recycled water to NPR existing and planned customers and for GWR.
- Cost assumptions addressed both capital and operations & maintenance (O&M) costs based upon the size (capacity) of the AWPF. The AWPF would have a slightly smaller capacity for the Base Condition than Scenario 1.
- For the VGS AWTP Site Alternative the Base Condition and Scenario 1 are identical; the AWPF would have the smaller capacity for either scenario.
- The team assumed that the capacity of the AWPF would be expanded at a future date to produce 15,000 AFY in Phase 1 to 30,000 AFY in Phase 2. To be conservative and make sure that candidate sites have enough space for the AWPF, it was assumed for the site assessment that the AWPF production capacity would be 40 mgd and site layouts were designed accordingly.
- The following AWPF treatment processes were assumed:
  - Microfiltration (MF) and ultrafiltration (UF),
  - Reverse osmosis (RO),
  - Advanced oxidation process (AOP) using ultraviolet (UV) with hydrogen peroxide (H_2O_2), and
  - Post-treatment for purified recycled water stabilization.
- For this evaluation, it is assumed that AWPF sidestreams would be discharged into outfall sewers downstream of DCTWRP and be treated at Hyperion Treatment Plant (HTP).
- Based upon preliminary evaluations, starting in Phase I the purified recycled water is assumed to be spread at the Hansen Spreading Grounds, adjacent to the Valley Generating Station (VGS), for GWR. For Phase 2, the purified recycled water is assumed to also be spread at the Pacoima Spreading Grounds (PSG), and potentially through injection wells and Strathern Pit.

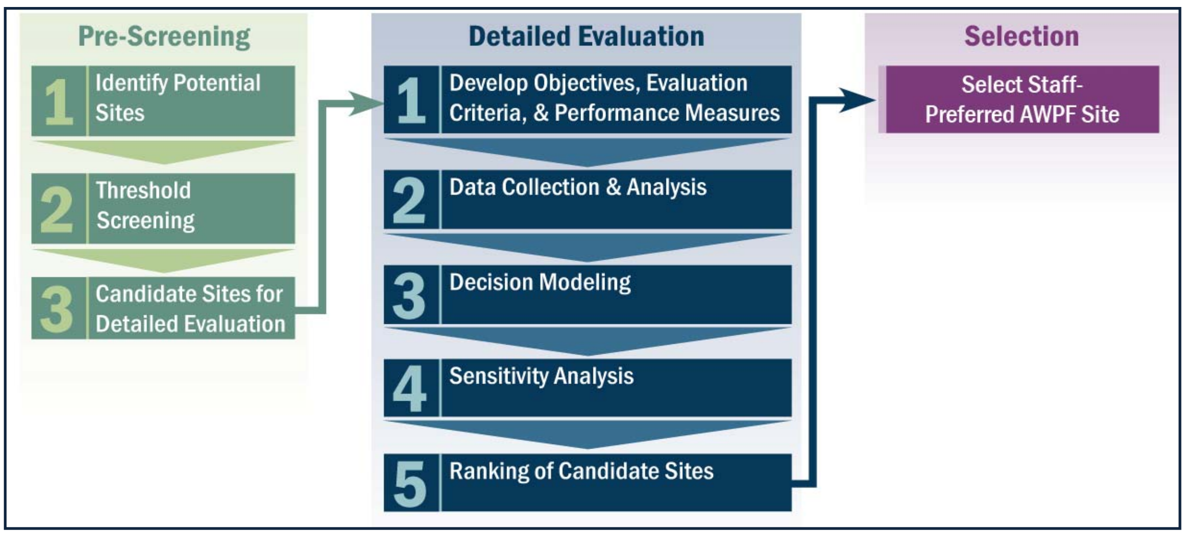
Both the Base Condition and Scenario 1 do not include pipeline costs to the PSG or injection wells, since these are common to all alternatives. These costs are included in the GWR Master Planning Report.

As an option to the Base Condition and Scenario 1, some NPR customers in the Sepulveda Basin could potentially be served tertiary treated Title 22 water. The remaining NPR customers would be served AWPF purified recycled water. This is further discussed in the GWR Master Planning Report.

ES.3 Site Assessment Approach

The site evaluation process involves site identification and pre-screening to develop a list of candidate sites for detailed evaluation. These candidate sites were evaluated in detail, including decision-modeling and sensitivity analyses, to select a staff-preferred AWPF site for master planning. Figure ES-1 presents the overall site evaluation process.

Figure ES-1: Overall Site Evaluation Process



Detailed Evaluation

The RWMP planning team recognized that the process of analyzing the candidate sites for multiple factors would be complex. So the team developed a five-step approach for the detailed evaluation, shown in Table ES-1.

Table ES-1: Detailed Evaluation Approach

Step No.	Methodology	Key Components
1	**Develop Evaluation Criteria and Performance Measures**	Establish the framework for the evaluation. Set evaluation criteria for each Recycled Water Master Planning (RWMP) objective and select appropriate performance measures. Establish weights for each objective, evaluation criterion, and performance measure depending upon its importance to the site assessment.
2	**Data Collection and Analysis**	This step includes preparing planning-level AWPF site layouts and pipeline alignments. It also includes making planning-level cost estimates. The analysis examined candidate sites for performance measures that included wastewater system benefits, habitat impacts, permitting process complexity and several others.
3	**Decision Modeling**	"Criterium DecisionPlus®" is a commercial decision model (computer software) and was used to evaluate the candidate sites for multiple RWMP objectives: Promote Cost Efficiency, Achieve Supply and Operational Goals, Protect the Environment, Maximize Implementation, Promote Economic and Social Benefits, and Maximize Adaptability and Reliability. To accomplish this evaluation, the RWMP planning team identified a number of evaluation criterion for each objective and the computer software determined a score for each site.
4	**Perform Sensitivity Analysis**	The last step of the evaluation approach was to run a series of sensitivity analyses to determine the how overall site rankings would change.
5	**Ranking of Candidate Sites**	After following this approach, the RWMP planning team was able to identify the sites that consistently ranked higher than the others. In addition, the advantages and disadvantages of each site were identified.

Framework for Detailed Evaluation: Objectives, Evaluation Criteria, and Performance Measures

The studies for each of the RWMP documents, including the *Site Assessment,* were based upon a common set of planning objectives, as follows.

Two threshold objectives were established, which any potential site had to meet:

- **Threshold Objective 1** – Meet all water quality regulations and health and safety requirements, and use proven technologies.
- **Threshold Objective 2** – Provide effective communication and education on recycled water program.

In addition to the threshold objective, six additional RWMP objectives were established. These are shown in Figure ES-2 along with their relative weights. Table ES-2 shows the evaluation criteria and performance measures developed for each of the RWMP objectives.

Figure ES-2: Recycled Water Planning Objectives with Weighting

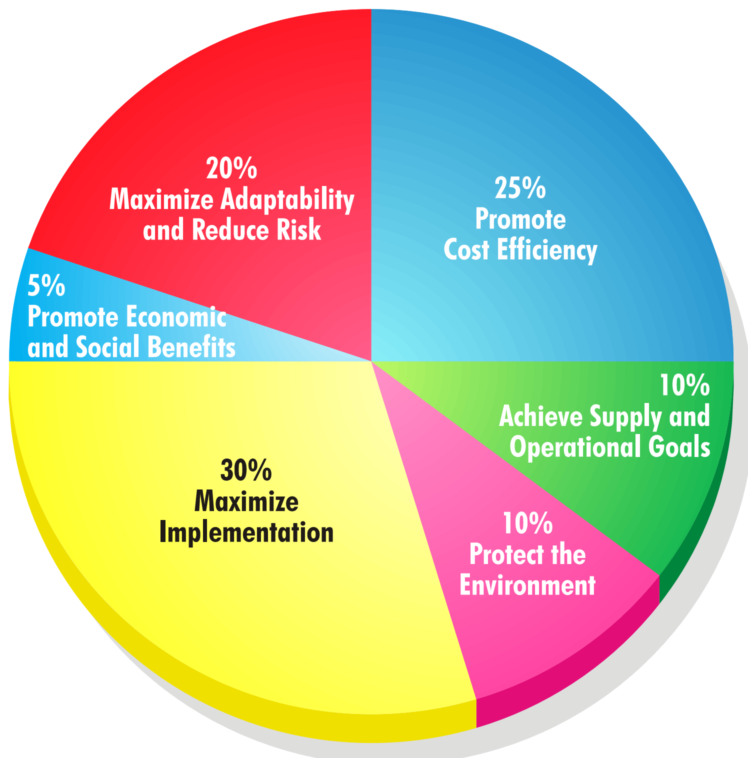


Table ES-2: Objectives, Evaluation Criteria, and Performance Measures

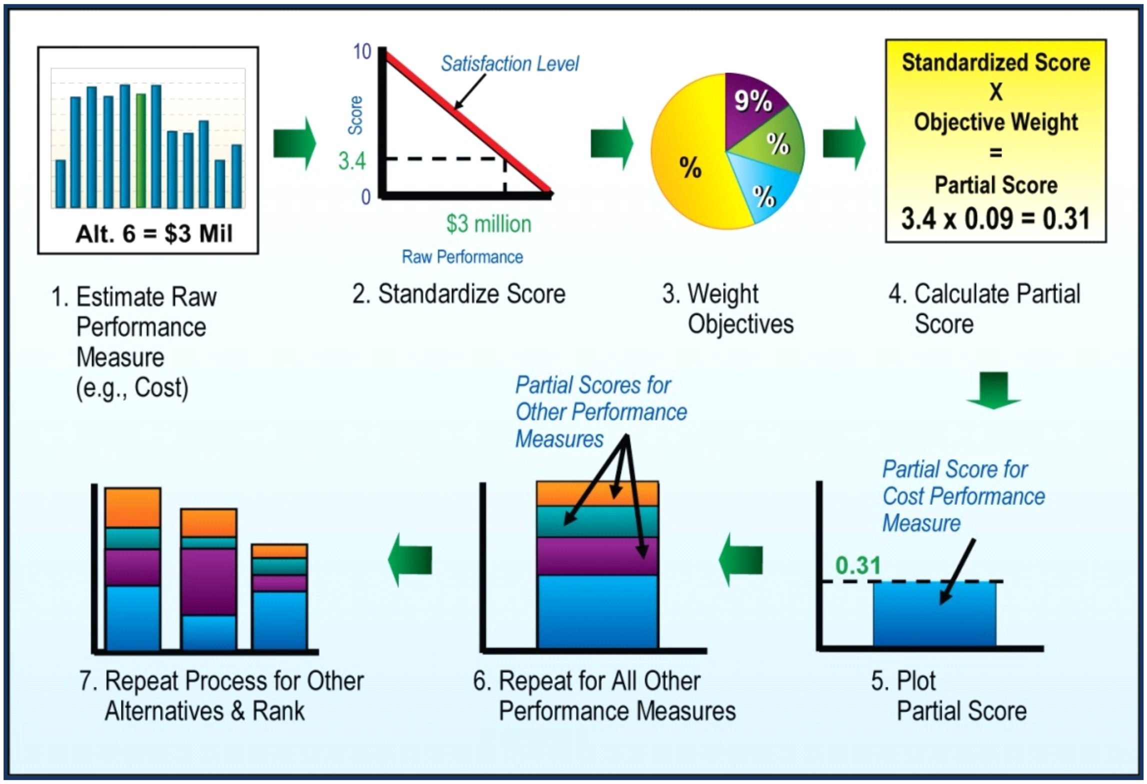
Objectives Name	Objectives Weighting	Evaluation Criteria Name	Evaluation Criteria Weighting	Performance Measures
Meet All Water Quality Regulations and Health & Safety Requirements, and Use Proven Technologies Provide Effective Communication and Education on Recycled Water Program				
1. Promote Cost Efficiency	25%	Capital Cost	50%	Capital Cost ($M)
		O&M Cost	50%	50-year O&M in Present Value ($M)
2. Achieve Supply & Operational Goals	10%	Achieve 15,000 AFY for Phase 1 and 30,000 AFY for Phase 2	0%	Non-Discriminator. All sites can accommodate 30,000 AFY AWPF.
		Wastewater System Benefits	60%	Available Space for Future DCTWRP Wastewater Expansions Score (1 to 5 score)
		Operational Flexibility	40%	Discharge Flexibility (1 to 5 score)
3. Protect Environment	10%	Habitat Impacts	50%	Habitat Impacts Score (1 to 5 score)
		Greenhouse Gas (GHG) Emissions	50%	Incremental GHG Emissions (metric tons CO_2 equivalents)
4. Maximize Implementation	30%	Public Perception	25%	Separation from Wastewater Treatment (1 to 5 score)
		Institutional Partnership	25%	Co-located with Existing BOS Facility Score (1 to 5 score)
		Permitting	25%	Permitting Score (1 to 5 score)
		Ability to Expedite Implementation	25%	Implementation Score (1 to 5 score)
5. Promote Economic & Social Benefits	5%	Economic Benefits	30%	Temporary Job Creation Score (Number of Jobs)
		Environmental Justice	35%	Environmental Justice Improvement Area (Yes or No)
		Job Creation	35%	Permanent Job Creation Score (1 to 5 score)
6. Maximize Adaptability & Reduce Risk	20%	Geotechnical	30%	Geotechnical Risk Score (1 to 5 score)
		Expansion Capability	50%	Space to Expand Beyond 30,000 AFY Score (1 to 5 score)
		Maximize Reuse	20%	Distance from Burbank Water Reclamation Plant (WRP) (miles)

Footnotes: 5 = better, 1 = worse

Decision Model Process

Figure ES-3 below illustrates the seven-step evaluation process that a computer decision model performed for each candidate site.

Figure ES-3: Multi-Attribute Rating Technique for Evaluating Candidate Sites



Planners use computer software to do the evaluation accurately and to help support the selection of a preferred site. For this evaluation, the planners used a decision model (computer software) called Criterium® DecisionPlus® (CDP).

Briefly, the seven steps can be described as follows:

1. **Estimate the raw performance measure.** The RWMP planning team determines how to measure performance, for example, tons of emissions as a quantitative measure of the objective Protect Environment; or a score of 1 to 5 for another criteria that has to be measured qualitatively. In the first step, the CDP uses the engineers' input to estimate a raw score for each site for further refinement.

2. **Standardize the score.** Because the performance measures vary significantly – dollars, tons, numeric score of 1–5, etc. – the next step is to standardize the raw performance measures into comparable numeric scores. This enables the scores to be additive (the higher the score, the better the performance).

3. **Weight the objectives.** Early in the planning process, LADWP and BOS, RWAG members, and others participated in a weighting exercise. This resulted in the weighted percentages for each planning objective shown in Figure ES-2. The CDP weights evaluation criteria in terms of their importance to the overall RWMP objectives.

4. **Calculate a partial score.** A standardized score (Step 2) is multiplied by its relative weight of importance (Step 3) to arrive at a partial score for a particular alternative.

5. **Plot the partial score.** The partial score (Step 4) is plotted on a graph to represent the results of the individual performance measure for the alternative.

6. **Repeat for all other performance measures.** Steps 1 – 5 are repeated for all of the performance measures until a total score for the candidate site can be calculated.

7. **Repeat the process for other sites and rank them.** Steps 1 – 6 are repeated for each of the candidate sites. This produces graphs showing the total score for each site. Then the total score for each site can be compared to the others and ranked. This enables the planning team can see which sites outperform others under various scenarios.

ES.4 Identify and Pre-Screen Potential Site Locations

Site Identification

The site evaluation begins with identifying potential site locations and pre-screening them to eliminate those that do not meet the threshold objective. To be selected, potential sites had to fit the following criteria:

- Located within 3 miles of the 54-inch Title 22 pipeline that conveys water from DCTWRP to a storage tank at VGS.
- Have no structures or only limited structures on-site.

The planning team searched geographic information system (GIS) maps and the City of Los Angeles Building Book for City-owned properties. These two sources yielded a total of 50 possible City-owned sites. Three additional sites were added to this list: DCTWRP, VGS, and the Sepulveda Basin Cricket Fields (located adjacent to DCTWRP).

The team for non-City owned sites, including by scanning satellite images that met the criteria above. This yielded nine additional sites.

Pre-Screening for Threshold Criteria

The potential site locations were then examined for whether or not they could meet the criteria shown in Table ES-3.

Table ES-3: Threshold Screening Criteria

Threshold Criteria	Description
Residential zoning	Sites zoned as residential were eliminated from further consideration
Adjacent to residential	Sites adjacent to residential areas on two or more sides of the site were eliminated from further consideration
Available size	Sites less than 300,000 square feet were eliminated from further consideration
Developable	Sites with an obvious feature/existing use that renders the site non-developable were eliminated from further consideration. This includes issues/uses such as airports, fire stations, buildings, golf courses, parks, former landfills, within a flood plain, and geotechnical issues.

Footnote: The typical AWPF site layout is 314,000 square feet, but an area of 300,000 square feet was used for the threshold screening assuming that the layout could be optimized for a smaller site using two-story structures.

After pre-screening for threshold criteria, three City-owned and three non-City-owned sites remained.

- City-owned: DCTWRP, VGS, and Sepulveda Basin Cricket Fields
- Non-City-owned: Open space near military recruitment center, agricultural plot near Encino Velodrome, open space near Hansen Dam Park

Sites that were not City-owned carried some concerns: two were designated prime farmland and the third was separated from the park by a major street. The three non-City-owned sites were also considered to be at risk of impacting the implementation schedule.

The DCTWRP site has three different siting opportunities: the southeast and southwest corners of the plant, the Cricket Fields, and the Contractor Lay Down Area north of the Cricket Fields. Therefore, five candidate sites survived pre-screening and were carried forward for detailed evaluation. These five sites are summarized in Table ES-4 and shown in Figures ES-4 and ES-5.

Table ES-4: Candidate Sites for Detailed Evaluation

Detailed Evaluation		
Site Name	Site No.	Abbreviated Site Name
DCTWRP Southeast	1	DCT SE
DCTWRP Southwest	2	DCT SW
Valley Generating Station	3	VGS
Sepulveda Basin Cricket Fields	4	Cricket Fields
DCTWRP (Contractor Lay Down Area)	5	Contractor Lay Down Area

Figure ES-4: DCTWRP Site Alternatives Aerial, Sites 1,2,4, and 5

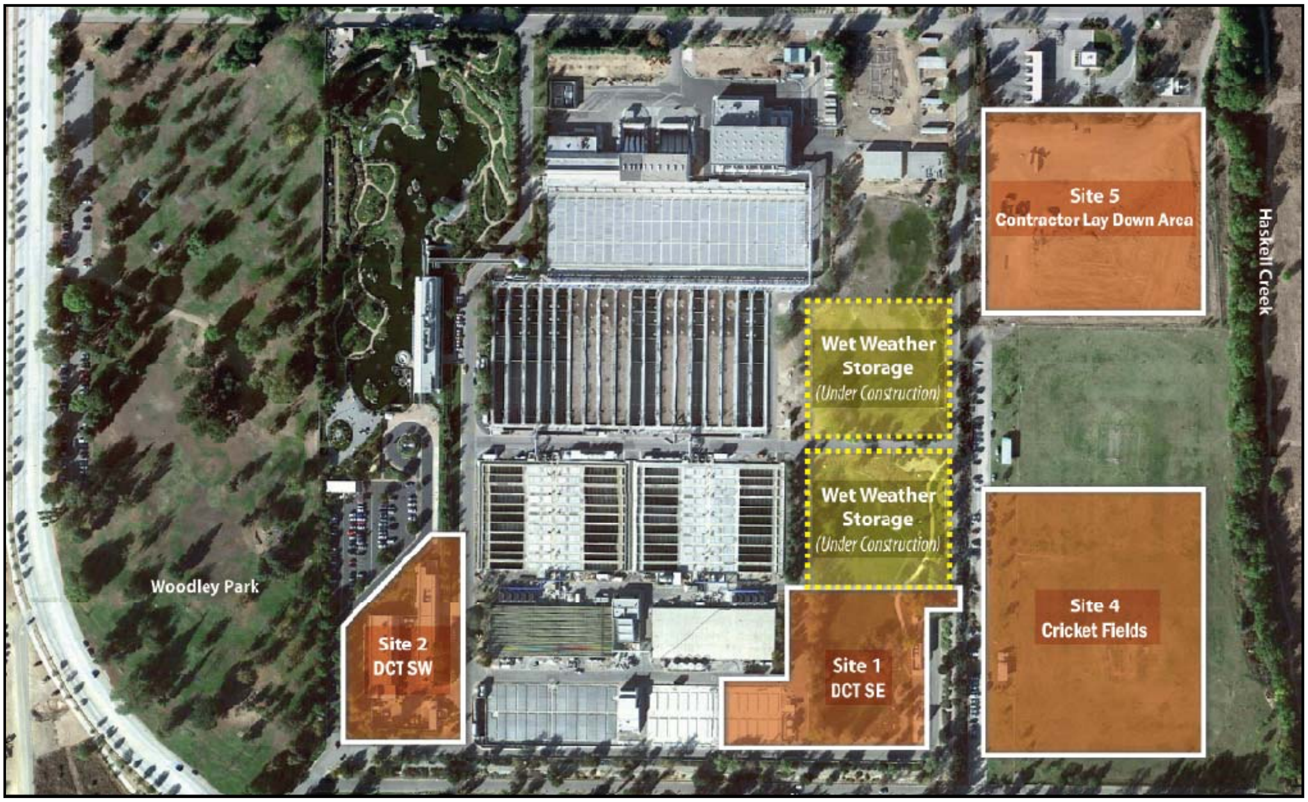


Figure ES-5: VGS Site Location, Site 3

ES.5 Candidate Site General Descriptions

For each of the five candidate sites, the planning team prepared preliminary site layouts, determined pipeline and pump station requirements, and developed a list of advantages and disadvantages. These things were analyzed for each site for both scenarios described earlier: the Base Condition and Scenario 1. The following are a series of tables (Table ES-5 through ES-14) that show unique features and advantages and disadvantages determined for the five sites. These tables represent a brief summary of the results of an extensive evaluation. For more details, see Section 5 of the Site Assessment Technical Memorandum.

Site 1: DCT SE

Figure ES-6: Location of Site 1 DCT Southeast (SE) at DCTWRP

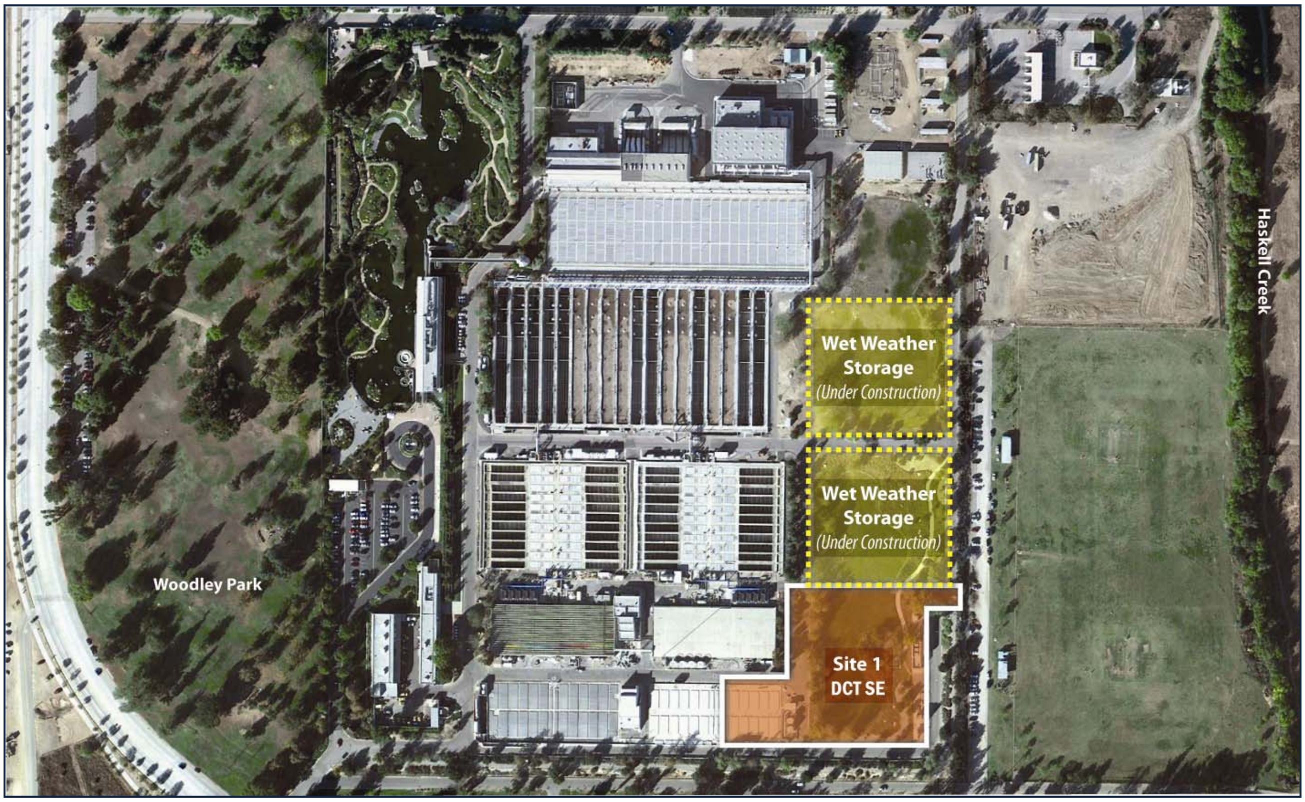


Table ES-5: Unique Features of Site 1 DCT SE for the Base Condition and Scenario 1

Features Common to Base Condition and Scenario 1	
Use southeast area of DCTWRP within property line	
Two-story MF/RO building	
Modify eastern half of Phase II CCB to use as MF/RO break tank and to build treatment processes on top	
Share existing DCTWRP facilities: security, fence, parking, administration building	
AWPF backwash and concentrate discharge to AVORS on-site	
Base Condition	**Scenario 1**
Expand existing Balboa Pump Station for AWPF purified recycled water pumping (GWR only)	Expand existing Balboa Pump Station for AWPF purified recycled water pumping (GWR & NPR)
New Title 22 Pump Station and pipeline for Title 22 recycled water pumping (NPR)	--

Table ES-6: Advantages and Disadvantages for Site 1 DCT SE

Condition	Advantages	Disadvantages
General	• Share existing facilities with DCTWRP: security, fence, parking, administration building • Discharge flexibility if the AWPF produces off-specification water • Discharge AWPF backwash and concentrate to nearby AVORS sewer • Located within flood control berm (No additional flood control measures necessary) • Ability to expedite implementation, since it does not require a new lease agreement with USACE	• Usable space is approximately half of space available at other four sites, so would need two-story MF/RO building, and would need to modify existing Phase II CCB to build treatment processes on top • Uses space that could be available for future DCTWRP wastewater expansions • Provides the least amount of adjacent space for future AWPF expansions. • It is located within the DCTWRP, near existing wastewater processes, which could affect public perception of the source of AWPF
Base Condition	• Only treat GWR water at AWPF (Lower AWPF O&M costs) • Slightly higher total reuse flow (GWR + NPR = 33 mgd)	• Requires new parallel pipeline and pump station to distribute Title 22 water to NPR users
Scenario 1	• Use existing 54-inch pipeline and Balboa Pump Station to distribute AWPF purified recycled water for GWR and NPR (New parallel Title 22 pipeline and pump station not needed)	• Treat NPR recycled water to higher quality than required (Higher AWPF O&M costs and public perception issues for other Title 22 customers within City) • Slightly lower total reuse flow (GWR + NPR = 32.5 mgd)

Site 2: DCT SW

Figure ES-7, location of Site 2 DCT Southwest (SW) at DCTWRP

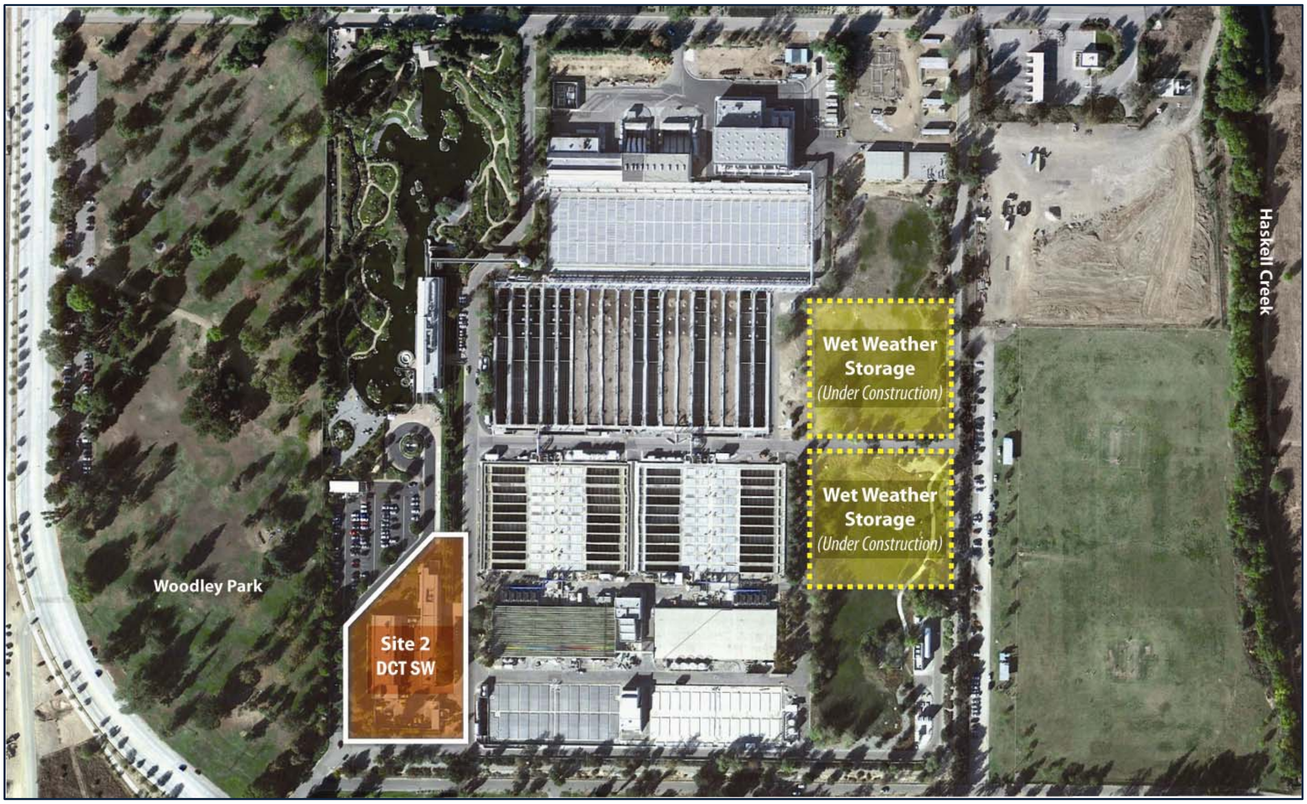


Table ES-7: Unique Features of Site 2 DCT SW for Base Condition and Scenario 1

Common to Base Condition and Scenario 1	
Use southwest area of DCTWRP partly within property line	
Two-story MF/RO building	
Demolish existing maintenance building and warehouse and reconstruct near existing blower building	
Share existing administration building with DCTWRP	
AWPF backwash and concentrate discharge to AVORS on-site	
Base Condition	**Scenario 1**
Expand existing Balboa Pump Station for AWPF purified recycled water pumping (GWR only)	Expand existing Balboa Pump Station for AWPF purified recycled water pumping (GWR & NPR)
New Title 22 Pump Station and pipeline for Title 22 recycled water pumping (NPR)	--

Table ES-8: Advantages and Disadvantages for Site 2 DCT SW

Condition	Advantages	Disadvantages
General	• Share existing administration building with DCTWRP • Discharge flexibility of AWPF procures off-specification water • Discharge AWPF backwash and concentrate to nearby AVORS sewer • Located within flood control berm (No additional flood control measures necessary) • Ability to expedite implementation, since it does not require a new lease agreement with USACE • Protects space at DCTWRP for future wastewater expansions.	• Requires demolition of existing maintenance building and warehouse and reconstruction near existing blower building
Base Condition	• Only treat GWR water at AWPF (Lower AWPF O&M costs) • Slightly higher total reuse flow (GWR + NPR = 33.5 mgd)	• Requires new parallel pipeline and pump station to distribute Title 22 water to customers
Scenario 1	• Use existing 54-inch pipeline and Balboa Pump Station to distribute AWPF purified recycled water to Title 22 customers and for GWR (New parallel Title 22 pipeline and pump station not needed)	• Treat Title 22 water to higher quality than required (higher AWPF O&M costs and public perception issues for other Title 22 customers within City) • Slightly lower total reuse flow (GWR + NPR = 32.5 mgd)

Site 3: VGS

Figure ES-8, location of Site 3 VGS at LADWP Valley Generating Station

Table ES-9: Unique Features of Site 3 VGS for the Base Condition and Scenario 1

Base Condition and Scenario 1 (same)
Larger UV system than the other four site at or near DCTWRP
Use training towers area (northwest of VGS site)
AWPF separate from VGS power plant: new administration building, site security, fence, and parking
Expand existing Balboa Pump Station for Title 22 recycled water pumping (AWPF influent and NPR distribution)
New AWPF Purified recycled water Pump Station at VGS
New AWPF backwash and concentrate pipeline to connect to VORS to bypass LAGWRP

Table ES-10: Advantages and Disadvantages for Site 3 VGS

Condition	Advantages	Disadvantages
General	• Close proximity to Hansen Spreading Grounds • Protects space at DCTWRP for future wastewater expansions • Provide space for future AWPF expansions • Physically separated from DCTWRP (Public perception)	• Need security, fence, parking, administration building • Requires demolition of existing training towers and installation of new towers at a different location • Requires larger UV system due to higher NDMA formation (results in higher capital and the highest O&M cost) • Reduced discharge flexibility if the AWPF produces off-specification water • Highest relative greenhouse gas emissions due to the larger UV size • Located in an Environmental Justice Area
Base Condition and Scenario 1	• Use existing 54-inch pipeline and Balboa Pump Station for Title 22 recycled water pumping (for AWPF influent and NPR distribution)	• Requires New 7.4-mile AWPF backwash and concentrate pipeline

Site 4: Cricket Fields

Figure ES-9: Cricket Fields Site Location

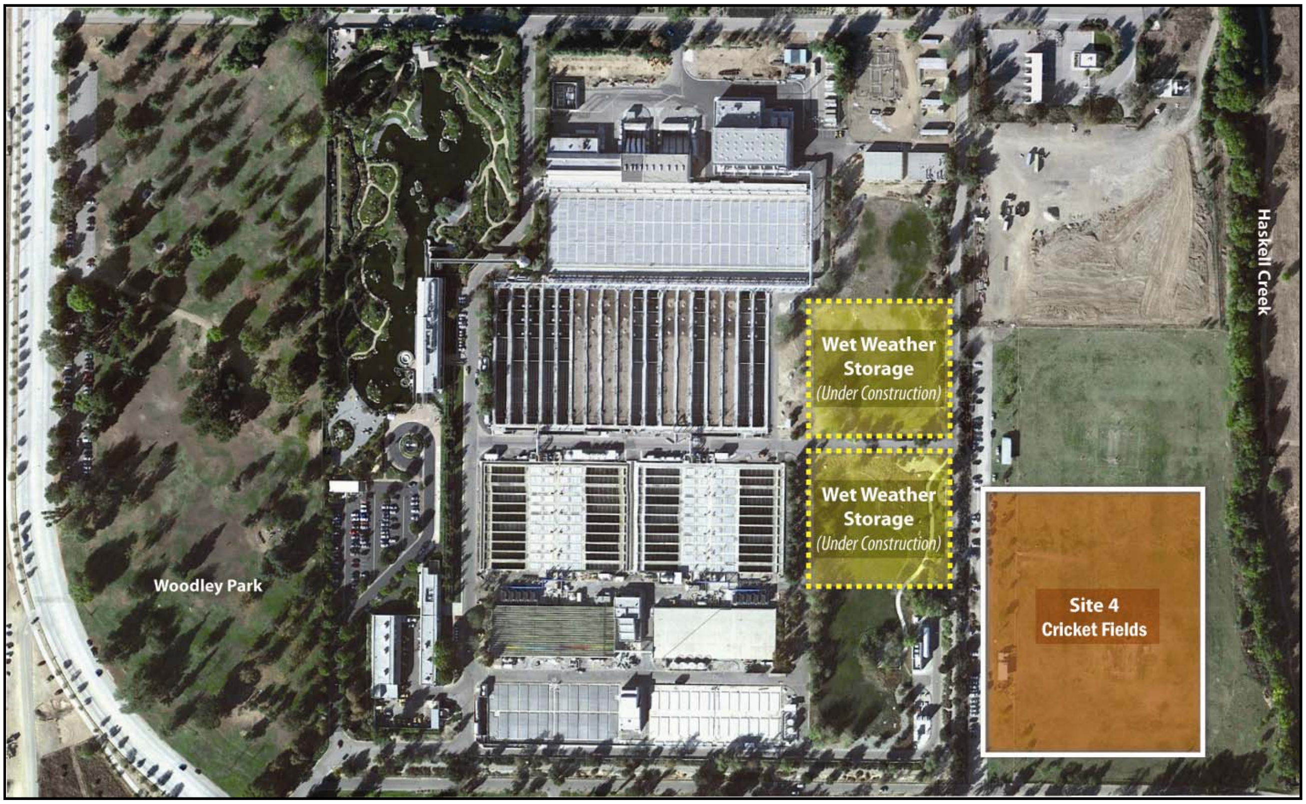


Table ES-11: Unique Features of Site 4 Cricket Fields for Base Condition and Scenario 1

Common to Base Condition and Scenario 1	
Lease land from USACE and use southern half of cricket fields	
Purchase new land to relocate cricket fields	
Raise site grade or construct a berm for 100-year flood	
Compensate for flood water storage volume off-site	
Share existing DCTWRP facilities: security, administration building	
Install new fence and parking	
AWPF backwash and concentrate discharge to AVORS on-site	
Base Condition	**Scenario 1**
Expand existing Balboa Pump Station for AWPF purified recycled water pumping (GWR only)	Expand existing Balboa Pump Station for AWPF purified recycled water pumping (GWR & NPR)
New Title 22 Pump Station and pipeline for Title 22 recycled water pumping (NPR)	--

Table ES-12: Advantages and Disadvantages for Site 4 Cricket Fields

Condition	Advantages	Disadvantages
General	• Share existing administration building with DCTWRP • Discharge flexibility if the AWPF produces off-specification water • Discharge AWPF backwash and concentrate to nearby AVORS sewer • Provides space for future AWPF expansions	• Requires negotiating lease agreement from USACE • Requires purchasing land for and building new Cricket Fields • Requires raising site to 100-year flood elevation and compensating for flood storage volume off site • Requires new fence and parking
Base Condition	• Only treat GWR water at AWPF (lower AWPF O&M costs) • Slightly higher total reuse flow (GWR + NPR = 33 mgd)	• Requires new parallel pipeline and pump station to distribute Title 22 water to customers
Scenario 1	• Use existing 54-inch pipeline and Balboa Pump Station to distribute AWPF purified recycled water to Title 22 customers and for GWR (New parallel Title 22 pipeline and pump station not needed)	• Treat Title 22 water to higher quality than required (higher AWPF O&M costs and public perception issues for other Title 22 customers within City) • Slightly lower total reuse flow (GWR + NPR = 32.5 mgd)

Site 5: Contractor Lay Down Area

Figure ES-10: Contractor Lay Down Area Site Location

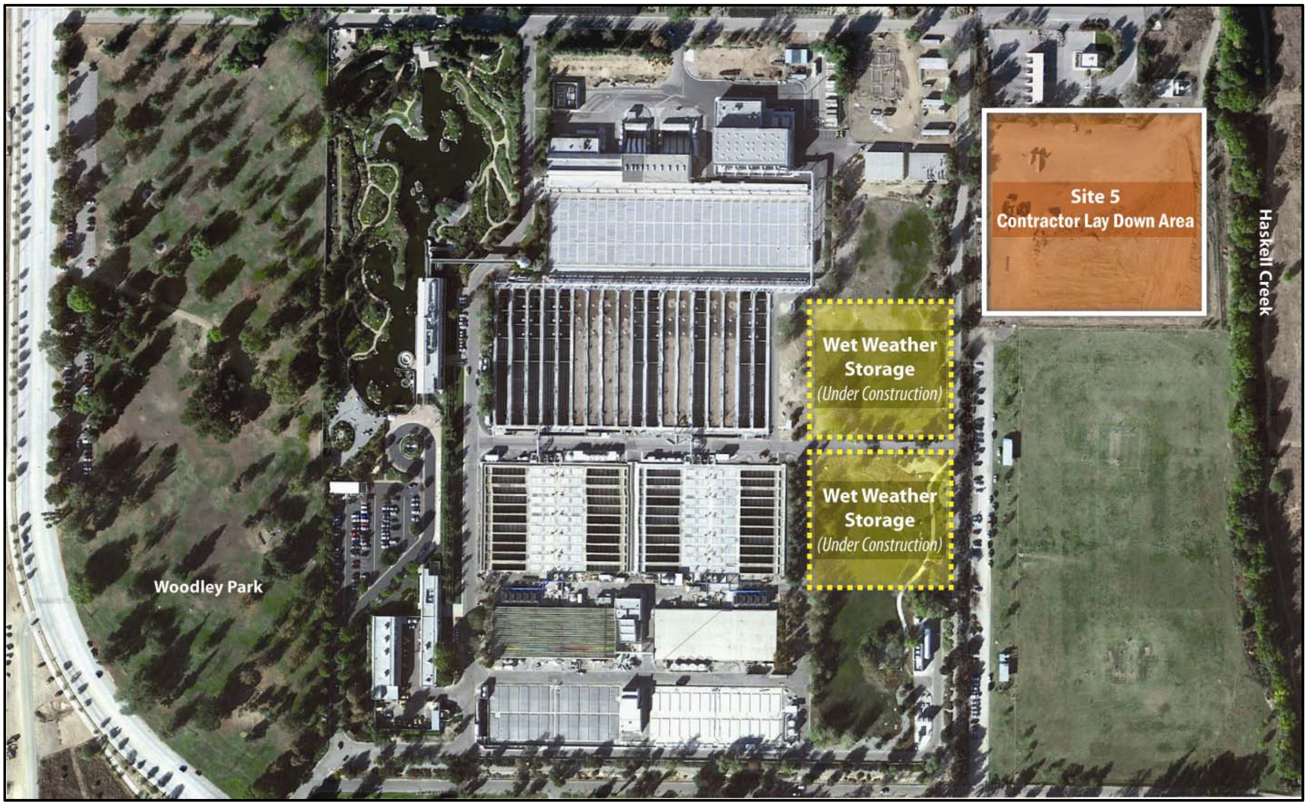


Table ES-13: Unique Features of Site 5 Contractor Lay Down Area for Base Condition and Scenario 1

Common to Base Condition and Scenario 1	
Use area north of Cricket Fields	
Raise site elevation or construct berm for 100-year flood	
Compensate for flood water storage volume off-site	
Share existing DCTWRP facilities: security, administration building	
Install new fence and parking	
AWPF backwash and concentrate discharge to AVORS on-site	
Base Condition	**Scenario 1**
Expand existing Balboa Pump Station for AWPF purified recycled water pumping (GWR only)	Expand existing Balboa Pump Station for AWPF purified recycled water pumping (GWR & NPR)
New Title 22 pump station and pipeline for Title 22 recycled water pumping (NPR)	--

Table ES-14: Advantages and Disadvantages for Site 5 Contractor Lay Down Area

Condition	Advantages	Disadvantages
General	• Share existing facilities with DCTWRP: parking and administration building • Discharge flexibility if the AWPF produces off-specification water • Discharge AWPF backwash and concentrate to nearby AVORS sewer • Protects space at DCTWRP for future wastewater expansions • Provides space for future AWPF expansions	• Requires negotiating lease agreement with USACE • Requires new security and fence • Requires raising site to 100-year flood elevation and compensating for flood storage volume off site • Adjacent to DCTWRP's Septage Receiving Facility (Potential intermittent odor issues)
Base Condition	• Only treat GWR water at AWPF (Lower AWPF O&M costs) • Slightly higher total reuse flow (GWR + NPR = 33 mgd)	• Requires new parallel pipeline and pump station to distribute Title 22 water to customers
Scenario 1	• Use existing 54-inch pipeline and Balboa Pump Station to distribute AWPF purified recycled water to Title 22 customers and for GWR (New parallel Title 22 pipeline and pump station not needed)	• Treat Title 22 water to higher quality than required (Higher AWPF O&M costs and public perception issues for other Title 22 customers within City) • Slightly lower total reuse flow (GWR + NPR = 33 mgd)

ES.6 Detailed Site Evaluation

The RWMP planning team used the CDP decision model to score and compare the candidate sites for evaluation criteria and performance measures.

The evaluation used the criteria shown in Table ES-15. Tables ES-16 and ES-17 summarize the performance measure and scores for each site for the Base Condition and Scenario 1, respectively. Detailed information about the evaluation criteria and performance measures can be found in the full Technical Memorandum, Section 6, Detailed Site Evaluation.

Table ES-15: Evaluation Criteria Used to Analyze Candidate Sites

Objectives	Evaluation Criteria
Objective 1 – Promote Cost Efficiency	• Capital cost • O&M cost
Objective 2 – Achieve Supply & Operational Goals	• Achieve 15,000 AFY for Phase 1 and 30,0000 AFY for Phase 2 • Wastewater system benefits • Operational flexibility
Objective 3 – Protect Environment	• Habitat impacts • Greenhouse gas emissions
Objective 4 – Maximize Implementation	• Public perception • Institutional partnership • Permitting • Ability to expedite implementation
Objective 5 – Promote Economic & Social Benefits	• Economic benefits • Environmental justice • Job creation
Objective 6 – Maximize Adaptability & Reliability	• Geotechnical • Expansion capability • Maximize reuse

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Table ES-16: Objectives, Evaluation Criteria, Weightings, and Scores for CDP Model for the Base Condition

Objectives		Evaluation Criteria			AWPF Site Alternatives				
Name	Weighting	Name	Sub-Weighting	Performance Measures	Site 1 DCT SE	Site 2 DCT SW	Site 3 VGS	Site 4 Cricket Fields	Site 5 Contractor Lay Down Area
Meet All Water Quality Regulations and Health & Safety Requirements, and Use Proven Technologies Provide Effective Communication and Education on Recycled Water Program		All alternatives meet these critical, threshold objectives.							
Promote Cost Efficiency	25%	Capital Cost	50%	Capital Cost ($)	$366M	$392M	$342M	$417M	$370M
		O&M Cost	50%	50-year O&M in Present Value ($)	$669M	$669M	$741M	$669M	$669M
Achieve Supply & Operational Goals	10%	Achieve 15,000 AFY for Phase 1 and 30,000 AFY for Phase 2		Non-Discriminator. All sites can accommodate 30,000 AFY AWPF.	5	5	5	5	5
		Wastewater system benefits	60%	Available Space for Future DCTWRP Wastewater Expansions (1 to 5 score)	1	4	5	4	4
		Operational flexibility	40%	Discharge Flexibility (1 to 5 score)	5	5	2	5	5
Protect Environment	10%	Habitat impacts	50%	Habitat Impacts Score (1 to 5 score)	5	5	5	3	3
		Greenhouse gas emissions	50%	Incremental GHG Emissions (metric tons CO_2 equivalents)	28,800	28,800	37,000	28,800	28,800
Maximize Implementation	30%	Public perception	25%	Separation from Wastewater Treatment (1 to 5 score)	2	3	5	4	3
		Institutional partnership	25%	Co-located with Existing BOS Facility (1 to 5 score)	5	5	1	5	5
		Permitting	25%	Permitting Score (1 to 5 score)	4	4	5	1	1
		Ability to expedite implementation	25%	Implementation Score (1 to 5 score)	5	5	4	1	2
Promote Economic & Social Benefits	5%	Economic benefits	30%	Temporary Job Creation Score (Number of Jobs)	2,000	2,200	1,900	2,100	2,000
		Environmental justice	35%	Environmental Justice Improvement Area (Yes or No)	No	No	Yes	No	No
		Job creation	35%	Permanent Job Creation (1 to 5 score)	4	4	5	4	4
Maximize Adaptability & Reduce Risk	20%	Geotechnical	30%	Geotechnical Risk Score (1 to 5 score)	5	5	4	5	5
		Expansion capability	50%	Space to AWPF Expand Beyond 30,000 AFY (1 to 5 score)	1	3	4	5	5
		Maximize reuse	20%	Distance from Burbank WRP (miles)	9.1	9.1	6.1	9.1	9.1

Footnotes:

a. For performance measures scored on a scale of 1 to 5, 5 = better and 1 = worse.
b. For quantitative measures, higher score are better and lower score worse, or vice versa, depending on the performance measure.

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Table ES-17: Objectives, Evaluation Criteria, Weightings, and Scores for CDP Model for Scenario 1

Objectives		Evaluation Criteria			AWPF Site Alternatives				
Name	Weighting	Name	Sub-Weighting	Performance Measures	Site 1 DCT SE	Site 2 DCT SW	Site 3 VGS	Site 4 Cricket Fields	Site 5 Contractor Lay Down Area
Promote Cost Efficiency	25%	Capital Cost	50%	Capital Cost ($)	$312	$338	$342	$363	$316
		O&M Cost	50%	25-year O&M in Present Value ($)	$769	$769	$741	$769	$769
Protect Environment	10%	Greenhouse gas emissions	50%	Incremental GHG Emissions (metric tons CO_2 equivalents)	32,400	32,400	37,000	32,400	32,400
Promote Economic & Social Benefits	5%	Economic benefits	30%	Temporary Job Creation Score (Number of Jobs)	1,700	1,900	1,900	1,800	1,800

Footnotes:

a. For quantitative measures, higher score are better and lower score worse, or vice versa, depending on the performance measure.

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ES.7 Decision Modeling Results

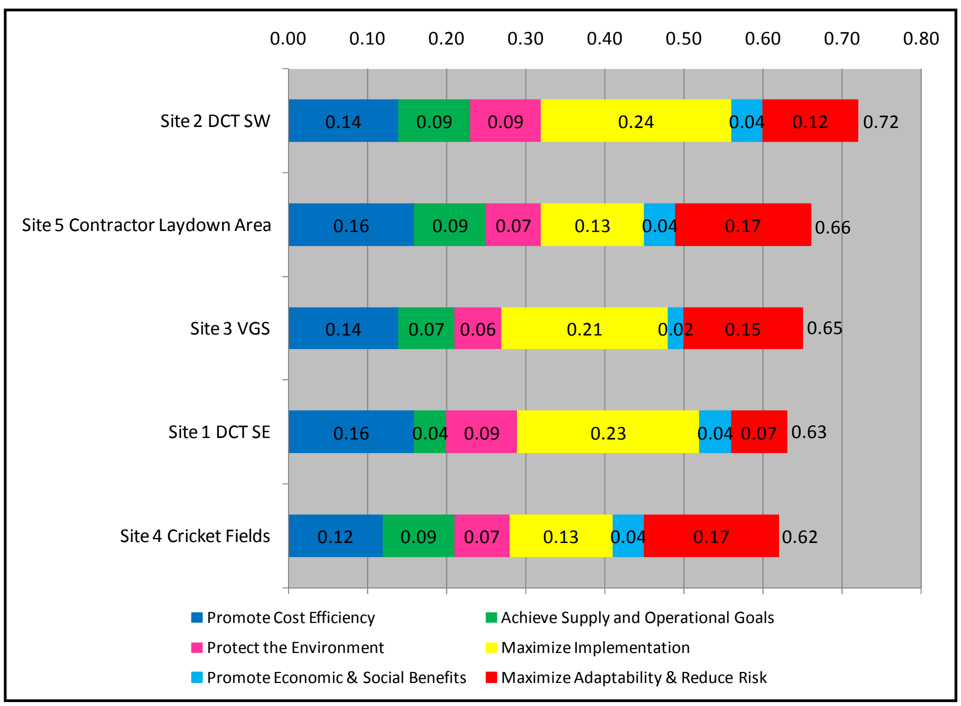
The following is a summary of the results of the decision modeling for the Base Condition, Scenario 1, and the sensitivity evaluation.

Base Condition Results

Figure ES-11 shows graphical results from the CDP model analysis for the Base Condition using the RWMP objectives weightings (Figure ES-2). The following are highlights of the results:

- Site 2 DCT SW is the highest ranked site. This site had the highest score among the alternatives in the following objectives: Maximize Implementation, Achieve Supply & Operational Goals, and Protect the Environment.
- Site 5 Contractor Lay Down Area is the second ranked alternative. Site 5 Contractor Lay Down Area scored marginally higher than Site 2 DCT SW for Promote Cost Efficiency and Maximize Adaptability & Reduce Risk. The two sites scored the same for Protect the Environment and Achieve Supply & Operational Goals.
- Site 3 VGS is the third ranked alternative. This alternative scored higher than Site 5 Contractor Lay Down Area in the Maximize Implementation objective, but lower in all other objective ratings.
- Site 1 DCT SE is the fourth ranked site alternative.
- Site 4 Cricket Fields was the lowest ranked alternative.

Figure ES-11: Base Condition Results

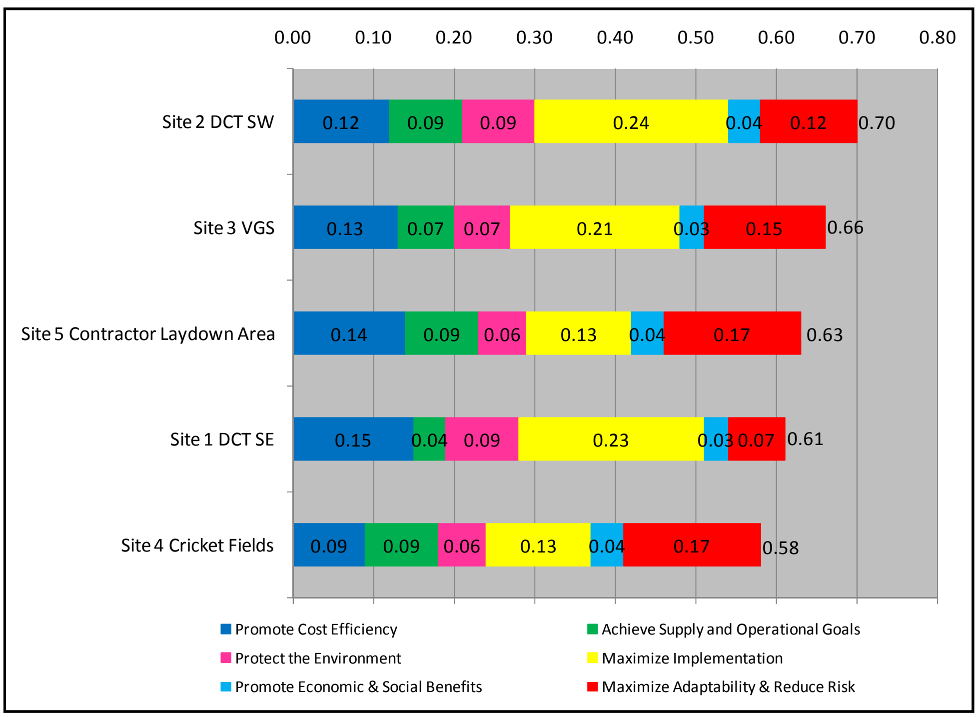


Scenario 1 Results

Figure ES-12 shows graphical results from the CDP model analysis for the Base Condition using the RWMP objectives weightings (Figure ES-2). The following are highlights of the results:

- As with the Base Condition, Site 2 DCT SW was the highest ranked alternative and received the highest scores for the following objectives: Maximize Implementation, Achieve Supply & Operational Goals, and Protect the Environment. The scoring is very similar to the Base Condition score except with a lower score for Promote Cost Efficiency since the Site 2 DCT SW costs are higher for Scenario 1.
- Site 3 VGS is the second highest ranked alternative and scored lower than Site 2 DCT SW, primarily due to its performance for Maximize Implementation. Site 3 VGS scored higher than Site 2 DCT SW on Promote Cost Efficiency and Maximize Adaptability & Reduce Risk.
- Site 5 Contractor Lay Down Area is the third ranked site. It scored higher than both Site 2 DCT SW and Site 3 VGS on Promote Cost Efficiency and Maximize Adaptability & Reduce Risk, and scored the same as Site 2 DCT SW for Achieve Supply & Operational Goals and Promote Economic & Social Benefits.
- Site 1 DCT SE is the fourth ranked site.
- Site 4 Cricket Fields was the lowest scoring alternative for Scenario 1

Figure ES-12: Scenario 1 Results



Sensitivity Runs

A series of sensitivity runs were conducted using the decision model for both the Base Condition and Scenario 1. These sensitivity runs involved altering the objectives weightings or the method of scaling the scores themselves within the CDP model to determine how robust the alternatives rankings are for the Base Condition and Scenario 1. A total of six sensitivity runs were conducted for both the Base Condition and Scenario 1. The sensitivity runs were developed based on input from the City's Recycled Water Advisory Group (RWAG), conditions developed to increase the importance of a single objective, as well as input from the City regarding performance measures scoring and evaluation criteria weighting within a specific objective. The six sensitivity runs are:

1. Average Weights: an average of all the Recycled Water Advisory Group (RWAG) inputs on weightings.
2. Environmental Emphasis: weightings based on the inputs of RWAG members who felt the environment was their primary concern.
3. Social Emphasis: weightings based on the inputs of RWAG members who felt that social issues were their chief concern.
4. Cost Emphasis: weighting cost substantially higher than the other objectives.
5. Equal weights: equal weighting for all objectives to see if the results change if none of the objectives are weighted higher than the others.
6. Modified Cost Scale: modifying the cost scale from 0.9 of the lowest score to 1.1 of the highest score to 0 as the lowest score and 1.1 of the highest score.

Based on the results of all 14 decision science model runs (Base Condition, Scenario 1, six sensitivity runs for Base Condition, and six sensitivity runs for Scenario 1), Site 2 DCT SW is the highest ranked site because it scored first on 11 of the 14 model runs. Site 5 Contractor Lay Down Area is the second highest ranked site. The results of all 14 runs are summarized in Table ES-18.

Table ES-18: Summary of CDP Results

Condition		Run Description	Site 1 DCT SE	Site 2 DCT SW	Site 3 VGS	Site 4 Cricket Fields	Site 5 Contractor Lay Down Area	Figure Number
Base Condition		Base Condition	4	1	3	5	2	7-1
	1	RWAG Average Weights	5	1	4	3	2	7-3
	2	RWAG Environment Emphasis	5	1	4	2	2	7-4
	3	RWAG Social Emphasis	3	1	5	2	4	7-5
	4	Cost Emphasis	3	1	5	4	2	7-6
	5	Equal Weights	4	1	5	3	2	7-7
	6	Modified Cost Scale	5	1	4	3	2	7-8
Scenario 1		Scenario 1	4	1	2	5	3	7-2
	1	RWAG Average Weights	5	2	3	4	1	7-9
	2	RWAG Environment Emphasis	5	1	4	2	2	7-10
	3	RWAG Social Emphasis	4	1	4	3	2	7-11
	4	Cost Emphasis	4	3	2	5	1	7-12
	5	Equal Weights	5	2	4	3	1	7-13
	6	Modified Cost Scale	1	1	3	5	4	7-14
Number of Times Ranked First			1	11	0	0	3	

ES.8 Recommendations

Determining the potential location of the AWPF is a key planning consideration for the City's recycled water program. Based on the results of the Site Assessment evaluation process, Site 2 DCT SW scored the highest of the five alternatives.

The short-list of five sites was also evaluated using three, specific critical criteria that were identified by LADWP and BOS management. These criteria include:

- BOS already has related facilities and staffing at the site to support the operation of the AWPF for GWR. Although new facilities will be built for GWR, there are benefits and economies of operation having new facilities alongside existing operational facilities and staff. This criterion is important since BOS will be leading the operations for the AWPF.
- The site is within the boundaries of the existing berm or outside of the Sepulveda Flood Control Basin to minimize the USACE permitting needs, which are anticipated to be extensive.
- The site is not in an area of potential future expansion to the existing treatment processes for producing tertiary treated effluent at DCTWRP.

Table ES-19 summarizes the capital costs, O&M costs, and compliance with the three criteria presented above. As shown in the table, only Site 2 DCT SW meets each of the three criteria.

Table ES-19: Critical Criteria for Evaluation of Five Candidate Sites

Critical Criteria	Site 1 DCT SE	Site 2 DCT SW	Site 3 VGS	Site 4 Cricket Fields	Site 5 Contractor Lay Down Area
Bureau of Sanitation (BOS) already has related facilities and staffing at the site to support the operation of the AWPF for GWR. Although new facilities will be built for GWR, there are benefits and economies of operation having new facilities alongside existing operational facilities and staff.	✓	✓		✓	✓
Site is within the boundaries of the existing berm or outside of the Sepulveda Flood Control Basin.	✓	✓	✓		
Site is not in an area of potential future expansion to the existing treatment processes for producing tertiary treated effluent at DCTWRP.		✓	✓		

Note:
✓ = Site meets criterion.

Therefore, based on the multi-criteria decision evaluation and the three critical criteria, the City selected Site 2 DCT SW as the staff-preferred location for the proposed project. Therefore, for the GWR Master Planning Report, the RWMP team assumed that the AWPF would be located at DCTWRP, within the flood control berm and in the southwest location.

All sites will be evaluated equally for environmental impacts as part of the environmental documentation. The AWPF site will be selected as part of the environmental documentation process.

1. Introduction

The purpose of this Site Assessment TM is to identify and compare potential sites for the new AWPF in the San Fernando Valley to assist the City with determining a short list of sites to consider for environmental documentation. The San Fernando Valley is the appropriate area for the AWPF because the spreading grounds, which will receive the purified recycled water, are within the San Fernando Valley. This TM describes the process to identify and pre-screen the potential sites to identify the candidate sites for detailed evaluation, the detailed evaluation of the candidate sites, and the decision model process that was employed to compare the candidate sites. Most importantly, the TM documents the advantages and disadvantages of each site as well as the site rankings based on the detailed evaluation and decision modeling.

From this site assessment process, the City selected a staff-preferred site to use for the basis of the GWR Master Planning Report. The staff-preferred site is developed further as part of the GWR Master Planning Report. The actual site selection for the AWPF will be determined as part of the environmental documentation process.

This Site Assessment TM includes preliminary capital and operations and maintenance (O&M) cost estimates for the purpose of comparing candidate sites. The RWMP process also included an integrated alternatives analysis to help determine the split of GWR and NPR to meet the City's recycled water goals. The preliminary capital and O&M cost estimates were further refined as part of the integrated alternatives analysis effort for the alternatives, each which contained varying amounts of GWR and NPR. To provide consistency between the initial RWMP documents, the following documents were updated to include the same cost estimates:

- Site Assessment TM (this document)
- Integrated Alternatives Development and Analysis TM
- Integrated Alternatives Analysis – Preliminary Cost Summary

Note that the GWR and NPR project costs were developed in more detail as part of the GWR and NPR Master Planning Reports, respectively. The most current GWR and NPR project costs developed as part of the RWMP are included in the GWR and NPR Master Planning Reports, respectively, and would not change the outcome of this analysis.

1.1 TM Overview

The remainder of this TM is organized in the following sections:

- Section 2 – Assumptions
- Section 3 – Site Assessment Approach
- Section 4 – Identify and Pre-Screen Potential Site Locations
- Section 5 – Candidate Site General Descriptions
- Section 6 – Detailed Site Evaluation
- Section 7 – Decision Modeling Results
- Section 8 – Key Findings and Recommendations

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2. Assumptions

This section outlines the general assumptions for the site assessment. A critical assumption is how the tertiary effluent from DCTWRP will be used. As described below in Section 2.1, two flow schemes, the Base Condition and Scenario 1, are used as the basis for the AWPF site assessment. The primary difference between the two conditions is whether or not Title 22 recycled water or purified recycled water is distributed to the Title 22 customers, and if separate or combined distribution systems are required.

Other assumptions outlined in this section include DCTWRP capacity, the quantity of tertiary effluent available for reuse, AWPF capacity for site layouts, the AWPF treatment processes, backwash and concentrate management, groundwater replenishment spreading basins, and storage requirements/assumptions for purified recycled water storage.

2.1 Tertiary Effluent Flow Assumptions: Base Condition and Scenario 1

A critical assumption for the AWPF site assessment is how the tertiary effluent from DCTWRP will be allocated between the various demands. In addition, there are existing demands that will continue in the future, such as Title 22 recycled water needed for in-plant reuse as well as the Lakes and Los Angeles (LA) River. Also, depending on the amount of NPR assumed from DCTWRP, it may provide more flexibility for the City to treat all of the remaining tertiary effluent through the AWPF and use the purified recycled water for both GWR and to serve existing and planned NPR users. This would eliminate the need for a separate Title 22 distribution system (pump station and pipeline) since all the purified recycled water for GWR and NPR could be distributed through the existing Balboa Pump Station and 54-inch pipeline. Both of these assumptions will impact the capital and O&M cost estimates for the site alternatives and could impact the final site selection.

It should be noted that the flow assumptions included in this TM (Base Condition and Scenario 1) were made for the purpose of evaluating candidate AWPF sites. The flow assumptions for the AWPF were updated as part of the development of the GWR Master Planning Report. The GWR Master Planning Report contains the most up-to-date flow assumptions for the project.

Therefore, based on the aforementioned considerations, the AWPF site assessment is based on the two flow scenarios described below. Note that Sites 1 through 5 that are considered for the detailed evaluation are described in Sections 4 and 5.

- Base Condition: Separate NPR and GWR distribution systems. Under this scenario, separate Title 22 and purified recycled water pump stations and distribution systems would be required for the sites at or adjacent to DCTWRP (Sites 1, 2, 4, and 5). For Site 3 VGS, the existing Balboa Pump Station and 54-inch pipeline would be used to pump Title 22 recycled water to the existing and planned NPR users and the AWPF (same as Scenario 1).
- Scenario 1: Combined NPR and GWR system where tertiary effluent is treated through the AWPF and NPR users are served with purified recycled water instead of Title 22 recycled water. Under this scenario, the existing Balboa Pump Station and 54-inch pipeline would be used to pump purified recycled water to the NPR users and the spreading basins for the sites at or adjacent to DCTWRP (Sites 1, 2, 4, and 5). For Site 3 VGS, the existing Balboa

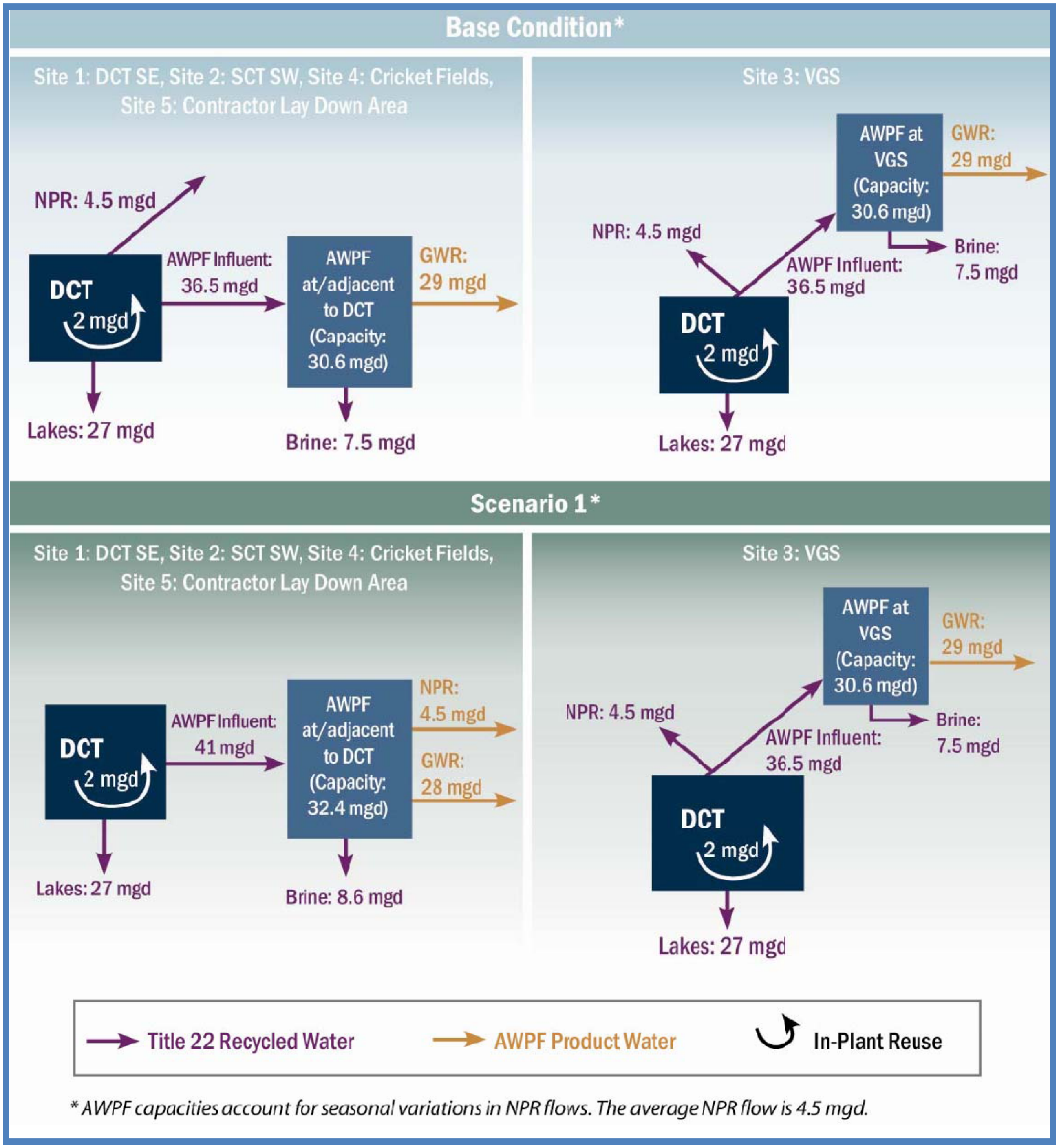
Pump Station and 54-inch pipeline would be used to pump Title 22 recycled water to the NPR users and the AWPF (same as the Base Condition).

As an option to the Base Condition and Scenario 1, some NPR customers in the Sepulveda Basin could potentially be served tertiary treated Title 22 water. The remaining NPR customers would be served purified recycled water. This is further discussed in the GWR Master Planning Report.

The Base Condition and Scenario 1 are graphically described by Figure 2-1. The flow split of the tertiary effluent for these two scenarios shown in Figure 2-1 are further described below along with the supporting assumptions necessary to determine the flow splits. The remainder of this section describes the following information:

- Assumed tertiary effluent flow available for GWR and NPR;
- Assumed NPR flow and available flow for GWR;
- Assumed tertiary effluent flow split between GWR and NPR for Base Condition and Scenario 1; and,
- AWPF cost estimating assumptions for the detailed evaluation.

Figure 2-1: Description of Base Condition and Scenario 1



Note: The Title 22 and purified recycled water flow rates shown in Figure 2-1 do not take into account an online factor. See Table 2-4 for the AWPF purified recycled water average annual production rates that take an online factor into account and are used as the basis for the O&M cost estimates.

2.1.1 Assumed Tertiary Effluent Flow Available for GWR and NPR

The tertiary effluent production capacity at DCTWRP and the existing uses were analyzed to determine the tertiary effluent flow available for GWR and NPR. Following are the assumptions regarding the tertiary effluent availability and the existing tertiary effluent uses that would continue in the future:

- **Tertiary Effluent Production Capacity:** 70 million gallons per day (mgd) based on an average of 80 mgd influent wastewater (discussed further in Section 2.2).
- **Flows for In-plant Reuse:** 2 mgd at the DCTWRP maximum capacity of 80 mgd. (Note that in the Draft DCT Maximum Flow Assessment TM (RMC/CDM Smith, Task 1.6, October 6, 2009) it was assumed that approximately 4.7 mgd of tertiary effluent would be required for in-plant reuse. BOS staff indicated the in-plant reuse demand is approximately 2 mgd at an influent wastewater flow of 80 mgd.)
- **Flows to Lakes and LA River:** Includes tertiary effluent flow to Lake Balboa, Wildlife Lake, and the Japanese Garden Lake, which all discharge into the LA River. The minimum flow assumed to the Lakes/LA River is 27 mgd.

Based on these assumptions, an average tertiary effluent flow of 41 mgd is assumed to be available for GWR and NPR (see Table 2-1).

Table 2-1: Summary of Tertiary Effluent Flow Available for GWR and NPR

Parameter	Average Tertiary Effluent Flow (mgd)
Tertiary Effluent Available for All Uses	70[a]
In-plant Reuse	-2
Lakes and LA River	-27
Tertiary Effluent Available for GWR and NPR	41

Footnotes:

a. Note that as part of the development of the GWR Master Planning Report, the estimate of tertiary effluent available for all uses was updated to 73 mgd based on the performance of the DCTWRP new cloth filters, which came on-line in December 2009 (see the GWR Master Planning Report, Table 3-6). This change does not impact the results of the Site Assessment Evaluation since it affects all sites the same.

2.1.2 NPR Flow Assumption and Available Flow for GWR

The following assumptions form the basis for determining the split of tertiary effluent between GWR and NPR:

- **NPR:** Continue to meet the existing NPR demands and expand the system to serve planned customers, which combined will result in a total annual average of approximately 4.5 mgd. It is assumed that the NPR flows would peak at approximately 8 mgd in summer months and potentially drop to as low as 2 mgd in winter months.
- **GWR:** The remainder of the tertiary effluent (approximately 36.5 mgd) would be routed to the AWPF to produce purified recycled water for groundwater replenishment. The AWPF would treat less tertiary effluent in the summer when NPR demands are high

(approximately 33 mgd tertiary effluent) and more water in the winter when NPR demands are low (approximately 39 mgd tertiary effluent).

These flows are summarized in Table 2-2.

Table 2-2: Tertiary Effluent Flow Split between GWR and NPR

Parameter	Average Tertiary Effluent Flow (mgd)
Tertiary Effluent Available for GWR and NPR	41
NPR Existing and Planned Customers	-4.5
Remaining for GWR (AWPF Influent)	36.5

2.1.3 Tertiary Effluent Flow Split between GWR and NPR for Base Condition and Scenario 1

Table 2-3 summarizes the assumed tertiary effluent flow split between GWR and NPR for the Base Condition and Scenario 1.

Table 2-3: Assumed Tertiary Effluent Flow Split between GWR and NPR for Base Condition and Scenario 1

Parameter	Flow Scenarios	
	Base Condition	Scenario 1[b]
Assumption	Separate GWR and NPR distribution systems[a]	Combined GWR and NPR distribution system (purified recycled water used for both GWR and NPR and is distributed through a single distribution system)
Tertiary Effluent Available for GWR and NPR	41 mgd	41 mgd
AWPF		
Influent	36.5 mgd	41 mgd for DCT sites and 36.5 mgd for VGS site
Product	29 mgd	28 mgd for DCT sites and 29 mgd for VGS site
Flow Distribution		
Existing and Planned NPR Customers	4.5 mgd (served with Title 22 recycled water)	4.5 mgd (served with purified recycled water for DCT sites and Title 22 recycled water for VGS site)
GWR	29 mgd	28 mgd for DCT sites and 29 mgd for VGS site
Total	33.5 mgd	32.5 mgd for DCT sites and 33.5 mgd for VGS site

Footnotes:

a. Except for Site 3 VGS. Since the AWPF would be at VGS, the existing Balboa Pump Station and 54-inch pipeline would be used to distribute Title 22 recycled water to NPR users and the AWPF at VGS.

b. For Site 3 VGS the flow distribution would be the same as the Base Condition. Since the AWPF would be at VGS, the existing Balboa Pump Station and 54-inch pipeline would be used to distribute Title 22 recycled water to NPR users and the AWPF at VGS. The NPR users would continue to receive Title 22 recycled water.

2.1.4 AWPF Cost Estimating Assumptions for the Detailed Evaluation

For the capital cost estimates, the AWPF production capacity is assumed to be 30.6 mgd for DCT sites under the Base Condition, 32.4 mgd for the DCT sites under Scenario 1, and 30.6 mgd for the VGS site under both the Base Condition and Scenario 1. Even though the AWPF would have an annual average production of 29 mgd under the Base Condition, the AWPF itself would be constructed with a higher capacity to be able to treat more tertiary effluent in winter months when NPR demands are low.

The O&M estimates are based on the annual production capacity, which is 26.9 mgd for both the DCT sites under Base Condition and the VGS site under Base Condition and Scenario 1, and 31.3 mgd for the DCT sites under Scenario 1. For the DCT sites under Base Condition and the VGS site , the AWPF would treat more flow in winter when the NPR demands are lower and would treat less flow in the summer when NPR demands are higher to average at 26.9 mgd over a year. For DCT sites under Scenario 1, the AWPF would produce a constant effluent of 31.3 mgd throughout the year, but the distribution of purified recycled water between the NPR users and the spreading basins would vary depending on the season.

These AWPF cost estimating assumptions are summarized in Table 2-4.

Table 2-4: AWPF Cost Estimating Assumptions

Cost Element	AWPF Cost Estimating Assumptions	
	Base Condition	Scenario 1
Capital Cost	AWPF sized for 30.6 mgd[a] purified recycled water capacity. AWPF will treat less in summer and more in winter so AWPF needs to be sized larger than annual average water production.	AWPF sized for 32.4 mgd[b] purified recycled water capacity for the DCT sites and 30.6 mgd[a] purified recycled water capacity for the VGS site
O&M Costs	Based on annual average purified recycled water production of 26.9 mgd[c].	Based on annual average purified recycled water production of 31.3 mgd[d] for the DCT sites and 26.9 mgd[c] for the VGS site.

Footnotes:

a. The AWPF purified recycled water capacity for the Base Condition (DCT sites and VGS site) and the VGS site for Scenario 1 takes into account an AWPF online factor of 93% and NPR seasonal flow variations.
b. The AWPF purified recycled water capacity for the DCT sites for Scenario 1 takes into account an AWPF online factor of 96% and NPR seasonal flow variations.
c. The average annual purified recycled water production for the Base Condition (DCT sites and VGS site) and the VGS site for Scenario 1 takes into account a 93% AWPF online factor (26.9 mgd = 29 mgd average annual production times 93%).
d. The average annual purified recycled water production for the Scenario 1 DCT sites takes into account a 96% AWPF online factor (31.3 mgd = 32.5 mgd average annual production (combined GWR and NPR) times 96%).

2.2 DCTWRP Capacity and Primary Flow Equalization Storage Volume

DCTWRP is an 80 mgd treatment plant. As documented in the Draft DCT Maximum Flow Assessment TM, at an influent of 80 mgd, the plant produces approximately 70 mgd of tertiary effluent (87 percent of the influent flow rate).

Raw wastewater tributary to DCTWRP is currently being diverted away from DCTWRP in the East Valley Interceptor Sewer (EVIS). If these flows are rerouted to DCTWRP, then the 2008 DCTWRP influent flow is estimated to be approximately 78 mgd and the 2022 flow (when Phase 1 is planned to come on-line) is estimated to above 80 mgd. It is assumed that, by the time the AWPF is in operation in 2022, there will be sufficient raw wastewater conveyed to DCTWRP such that the City will be able to treat 80 mgd at DCTWRP. See the GWR Master Planning Report for more information.

DCTWRP limits the flow rate through the treatment plant to 80 mgd due to process restrictions within the plant. These restrictions include the secondary treatment process (aeration basins and clarifiers) as well as a permit restriction on the maximum flow rate allowed through the chlorine contact basins. Since the treatment plant does not treat the daily peak flows, the average production capacity from the plant is less than 70 mgd.

To maximize tertiary effluent production from the treatment plant, DCTWRP uses primary equalization to store peak flows during the day to bleed wastewater back into the treatment process at night. DCTWRP currently has 3.24 million gallons (MG) of primary equalization volume, which will be expanded to 4.68 MG as part of the DCTWRP In-Plant Wet Weather Storage Project. The ideal amount of primary equalization storage to produce a constant effluent of 70 mgd was estimated to be 12.12 MG as part of the Draft GWR Master Planning Report.

2.3 AWPF Capacity Assumption for Site Layouts

When the site layouts were developed, the amount of tertiary effluent available for recycling was unknown (in development), so a conservative assumption was made to ensure that the sites would have sufficient space for the AWPF. In general, it is better to plan for a larger plant than necessary to select a site that allows for the flexibility to increase the size of the plant in the future.

The AWPF is envisioned to have an initial, Phase 1 capacity of 15,000 acre-feet per year (AFY) and an expanded, Phase 2 capacity of 30,000 AFY. For the site layouts, a conservative AWPF capacity was assumed to make sure that there would be sufficient space for the process facilities. The assumed capacities for the AWPF for the site layouts are as follows:

- 20 mgd purified recycled water per phase
- Initial plant capacity of 20 mgd purified recycled water (Phase 1)
- Ultimate plant capacity of 40 mgd purified recycled water (Phases 1 and 2)

Therefore, the site layouts are based on an AWPF production capacity of 40 mgd, which is more conservative than the flow assumptions for the Base Condition and Scenario 1 outlined in Section 2.1. The AWPF capacity and phasing were further refined as part of the GWR Master Planning Report.

2.4 AWPF Treatment Processes

The AWPF treatment processes are described in detail in the Draft GWR Master Planning Report. The treatment processes include the following:

- Microfiltration (MF) or ultrafiltration (UF);
- Reverse osmosis (RO);
- Advanced oxidation process (AOP) using ultraviolet light (UV) with hydrogen peroxide (H_2O_2); and,
- Post-treatment for purified recycled water stabilization.

These treatment processes and ancillary facilities, such as chemical storage and delivery, process tanks, and electrical buildings, are used as the basis for the site layouts. In addition, site-specific work, such as roadways, parking, fences, and an administration building are considered as appropriate. Sites at or adjacent to DCTWRP would use the DCTWRP administration building and would not require a separate administration building. Sites separate from DCTWRP would have their own administration building.

2.5 AWPF Backwash and Concentrate Management

For this evaluation and for the Draft GWR Master Planning Report, it is assumed that the AWPF sidestreams (including MF/UF backwash waste and RO concentrate) would be discharged to the outfall sewers downstream of DCTWRP and conveyed for treatment at the Hyperion Treatment Plant (HTP). GWR Spreading Basins

Based on the preliminary groundwater replenishment evaluations completed at the time of the initial development of the Site Assessment TM (Fall/Winter 2009), it was determined that there should be sufficient recharge capacity at the `1 (HSG) adjacent to the Valley Generating Station (VGS) for Phases 1 and 2.

As part of development of the GWR Master Planning Report, it was determined that there is a fault downgradient of HSG that limits the amount of purified recycled water that can be recharged at HSG to about 20,000 AFY. When the City expands to Phase 2 (30,000 AFY), the purified recycled water will need to be recharged at HSG and the Pacoima Spreading Grounds (PSG), and possibly injection wells and Strathern Pit. Similar amounts of infrastructure will be required to convey purified recycled water to PSG, injection wells, and Strathern Pit for each site alternatives, and, therefore, would be a non-discriminator between the sites.

2.6 Title 22 and AWPF Purified Recycled Water Storage

It is assumed that the existing Title 22 operational storage tank at VGS would continue to serve the NPR system, and that the operational storage would be expanded as required to provide sufficient operating flexibility within the Title 22 system.

At this time, AWPF purified recycled water storage is not assumed. If there are restrictions on groundwater replenishment at the HSG, which will be experienced during wet weather conditions when there is sufficient stormwater runoff to fill the infiltration basins, then the AWPF would be shut down until the stormwater has infiltrated. These periods are expected to be for several weeks at a time and, therefore, it would not be feasible to store the purified recycled water during these periods for infiltration at a later date. For example, assuming purified recycled water production of 28-29 mgd, a storage volume of approximately 400 million gallons (MG) would be required to store the water produced over a two-week period. During these periods it would be more cost effective to shut down the AWPF and discharge Title 22 effluent to the LA River than to continue to operate the AWPF and store the purified recycled water.

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3. Site Assessment Approach

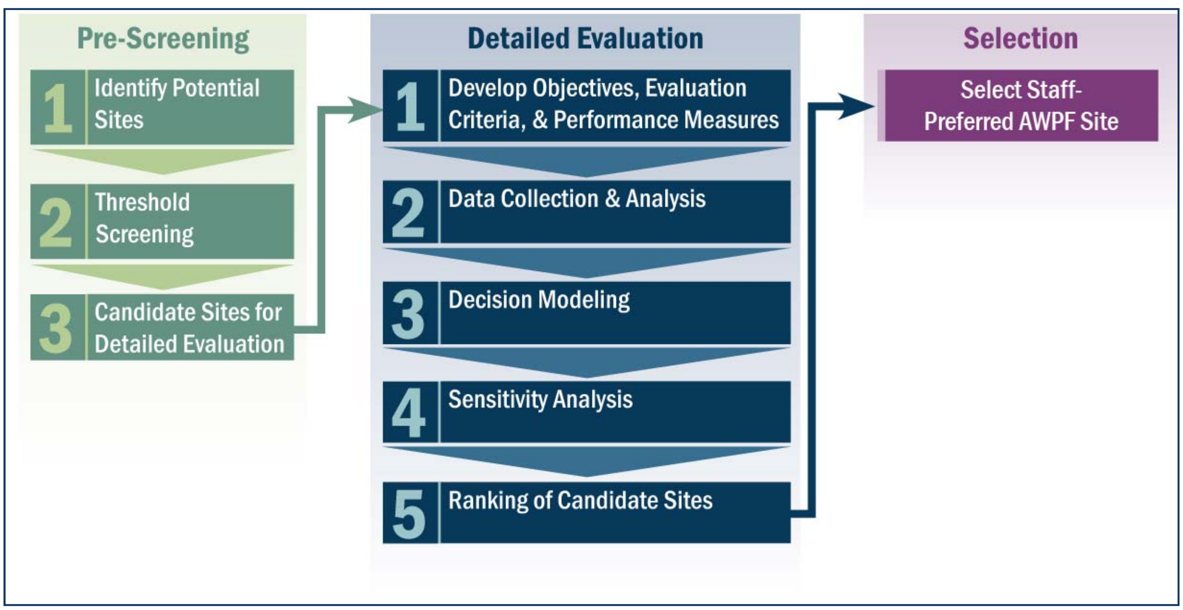
Selection of the AWPF site is a complex task that requires an objective process that considers multiple site alternatives and compares them using multiple criteria. The potential sites all have benefits and trade-offs that need to be considered as part of an objective evaluation process. An evaluation approach, including pre-screening of potential sites and detailed evaluation of candidate sites, was developed to guide the process. Objectives, evaluation criteria, and performance measures were identified and used to define the candidate sites for the detailed evaluation. By explicitly defining and weighting criteria and then giving scores to the alternatives for those criteria the decision process is systemized, making the identification of the ultimate decision easier and more objective.

This section outlines the overall approach for the AWPF site assessment from identification of potential sites to the detailed evaluation of a short-list of candidate sites. This section also describes the framework used for the detailed evaluation, including the decision model.

3.1 Approach

The site evaluation process involves site identification and pre-screening to develop a list of candidate sites, and detailed evaluation of the candidate sites. The overall site evaluation process is presented in Figure 3-1, and described in detail in the following sub-sections.

Figure 3-1: Overall Site Evaluation Process



3.1.1 Site Identification and Pre-Screening

The goal of site identification and pre-screening is to identify a thorough list of potential AWPF sites and reduce it to a short list of candidate sites for detailed evaluation. There are three steps in this process:

- **Step 1 – Identify Potential Sites:** This step involves identifying a list of potential sites that satisfy the following two criteria: (1) located in close proximity to the existing 54-inch recycled water pipeline, and (2) have limited development on the site. Both city-owned and non-city-owned sites are considered. The details of these two criteria and the results of site identification process are described in Section 4.1.
- **Step 2 – Threshold Screening:** This step is used to reduce the list of potential sites to the short list of candidate sites, by eliminating sites that do not meet the threshold screening criteria. For example, sites that are zoned as residential, located adjacent to residential zones on two or more sides, smaller than 200,000 square feet (sf) in developable area, or determined not developable due to obvious site features/existing uses are eliminated from further consideration. The details of threshold screening criteria and the results of threshold screening are described in Section 4.2.
- **Step 3 – Candidate Sites for Detailed Evaluation:** This is the result of the pre-screening process. The candidate sites for detailed evaluation are identified through the threshold screening step.

3.1.2 Detailed Evaluation

The detailed evaluation is completed once the candidate sites are identified through the pre-screening process. The detailed evaluation includes the following steps:

- **Step 1 – Develop Evaluation Criteria & Performance Measures:** This step involves establishing the framework of the detailed evaluation, including setting evaluation criteria for each RWMP evaluation objective, and then selecting appropriate performance measures to use for each evaluation criterion. This step also involves pre-setting weights for each objective, evaluation criterion, and performance measure depending on its importance to the site assessment. This framework for the detailed evaluation is described in detail in Section 3.2.
- **Step 2 – Data Collection & Analysis:** This step involves collecting and analyzing data to determine performance measure inputs for the decision modeling tool. The data collection and analysis includes planning-level AWPF site layout design and pipeline alignment evaluation, and planning-level cost estimates. This step also includes planning-level evaluation of the following: wastewater system benefits, operational flexibility, habitat impacts, greenhouse gas emissions, institutional partnership, permitting process complexity, ability to expedite implementation, economic benefits, environmental justice, job creation, geotechnical review, expansion capability, opportunities to maximize reuse, etc.
- **Step 3 – Decision Modeling:** This step involves entering the objectives, evaluation criteria, and performance measures inputs into the decision model to determine which site rates the highest when all objectives, evaluation criteria and performance measures are considered. Systematizing the decision process by explicitly defining and weighting criteria and then giving scores to the alternatives for those criteria makes the ultimate decision easier and more objective.

- **Step 4 – Sensitivity Analysis:** This step involves running the decision model adjusting one input (e.g., objective or evaluation criteria weighting, performance measure inputs, etc.) at a time to determine how the overall site rankings change.
- **Step 5 – Ranking of Candidate Sites:** Using the results of the decision modeling and sensitivity analyses, the candidate sites can be ranked in terms of how well the sites meet the objectives established for the RWMP. In addition, the advantages and disadvantages for each site are identified to summarize the benefits and trade-offs associated with each site.

Once the candidate sites are ranked, then the City can select the staff-preferred AWPF site for the purpose of master planning. The actual AWPF site will be selected as part of the environmental documentation process.

The detailed evaluation is described in Sections 5, 6, and 7 of this report. Key findings from the detailed evaluation are presented in Section 8.

3.2 Framework for Detailed Evaluation: Objectives, Evaluation Criteria, and Performance Measures

Due to the complexity of the decision making related to the AWPF site assessment, the detailed evaluation process was developed to allow comparison of multiple site alternatives using multiple criteria. Objectives, evaluation criteria, and performance measures were identified and used to define the candidate sites for the detailed evaluation. This section outlines the objectives, evaluation criteria and performance measures, and describes the decision model process.

3.2.1 Objectives

Six overall objectives, and two threshold objectives, were established for the RWMP at the start of the planning process. Objectives are important as they support the goals of the RWMP and help to establish criteria by which alternatives can be compared against each other. All of the evaluations completed as part of the RWMP will use the same objectives, but evaluation criteria and performance measures specific to those evaluations will be established.

There are several guidelines that are used when establishing objectives. These include that the objectives must be easy to understand, are non-redundant, can be measured with evaluation criteria, and are concise in numbers, generally no more than five to eight objectives. It is also important to note that objectives are not solutions. Objectives define what we are trying to achieve with the RWMP and solutions (i.e., site alternatives) represent how we will get there.

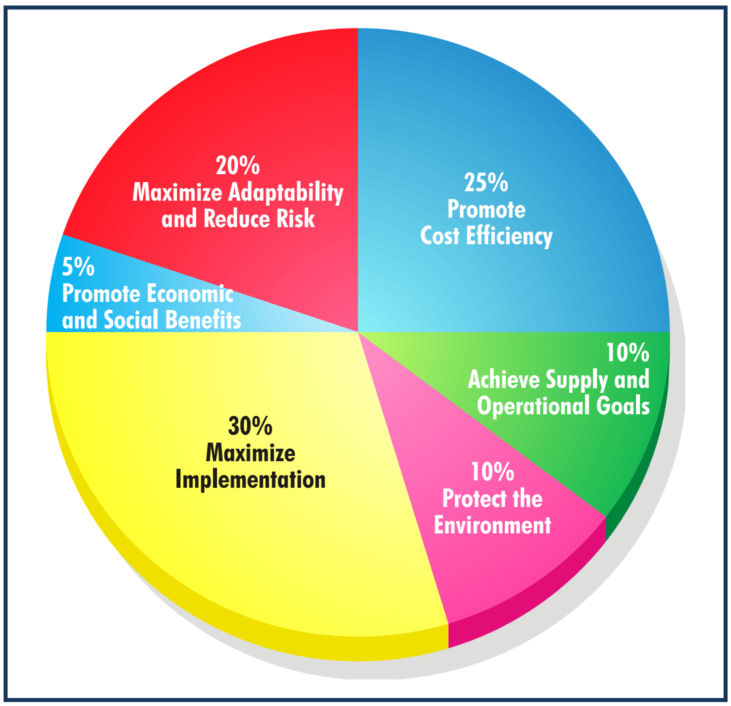
The following objectives are being used for the RWMP evaluations:

- **Threshold Objective 1** – Meet all water quality regulations and health and safety requirements, and use proven technologies.
- **Threshold Objective 2** – Provide effective communication and education about the recycled water program.
- **Objective 1 - Promote Cost Efficiency** – Meet the goals of the recycled water program in a cost-effective manner, considering both City and recycled water customer costs

- **Objective 2 – Achieve Supply and Operational Goals** – Meet or exceed water supply targets and operational goals established by the City
- **Objective 3 – Protect Environment** – Develop projects that not only protect the environment, but also provide opportunities to enhance it
- **Objective 4 - Maximize Implementation** – By minimizing typical hurdles including institutional partnership, permitting challenges, and maximizing customer acceptance
- **Objective 5 - Promote Economic and Social Benefits** – Provide economic and social benefits in the implementation and operation of recycled water projects
- **Objective 6 – Maximize Adaptability and Reduce Risk** – To be able to adapt to uncertainties and to reduce risk of operations once projects are implemented

To determine the relative weights of the objectives, the team established preliminary weightings for the RWMP tasks. Different objectives weightings were established for each task because certain objectives are more critical for certain tasks than others. For example, for the AWPF site assessment, maximize implementation is ranked higher than the other five objectives because implementing the GWR project is critical to meeting City's recycled water goals. The objectives weightings for the AWPF site assessment re presented graphically in Figure 3-2. In addition, the Recycled Water Outreach team also conducted a weighting exercise with the members of the Recycled Water Advisory Group (RWAG) at their first meeting in December 2009. This information was considered in the sensitivity analysis and is presented in Section 7.

Figure 3-2: Objectives Weighting for the AWPF Site Assessment



The threshold criteria are not presented in this chart because all candidate sites need to meet this important criterion in order to be considered for the detailed evaluation.

For each objective, evaluation criteria (or sub-objectives) were established to further define the meaning of the objectives. A performance measure was defined for each evaluation criterion to determine how well a site alternative meets a given objective. The evaluation criterion and performance measures selected for the AWPF site assessment are presented in Table 3-1. The evaluation criteria and performance measures are described in the next section.

Table 3-1: Objectives, Evaluation Criteria, and Performance Measures

Objectives Name	Objectives Weighting	Evaluation Criteria Name	Evaluation Criteria Weighting	Performance Measures
Meet All Water Quality Regulations and Health & Safety Requirements, and Use Proven Technologies Provide Effective Communication and Education on Recycled Water Program				
1. Promote Cost Efficiency	25%	Capital Cost	50%	Capital Cost ($M)
		O&M Cost	50%	50-year O&M in Present Value ($M)
2. Achieve Supply & Operational Goals	10%	Achieve 15,000 AFY for Phase 1 and 30,000 AFY for Phase 2	0%	Non-Discriminator. All sites can accommodate 30,000 AFY AWPF.
		Wastewater System Benefits	60%	Available Space for Future DCTWRP Wastewater Expansions Score (1 to 5 score)
		Operational Flexibility	40%	Discharge Flexibility (1 to 5 score)
3. Protect Environment	10%	Habitat Impacts	50%	Habitat Impacts Score (1 to 5 score)
		Greenhouse Gas (GHG) Emissions	50%	Incremental GHG Emissions (metric tons CO_2 equivalents)
4. Maximize Implementation	30%	Public Perception	25%	Separation from Wastewater Treatment (1 to 5 score)
		Institutional Partnership	25%	Co-located with Existing BOS Facility Score (1 to 5 score)
		Permitting	25%	Permitting Score (1 to 5 score)
		Ability to Expedite Implementation	25%	Implementation Score (1 to 5 score)
5. Promote Economic & Social Benefits	5%	Economic Benefits	30%	Temporary Job Creation Score (Number of Jobs)
		Environmental Justice	35%	Environmental Justice Improvement Area (Yes or No)
		Job Creation	35%	Permanent Job Creation Score (1 to 5 score)
6. Maximize Adaptability & Reduce Risk	20%	Geotechnical	30%	Geotechnical Risk Score (1 to 5 score)
		Expansion Capability	50%	Space to Expand Beyond 30,000 AFY Score (1 to 5 score)
		Maximize Reuse	20%	Distance from Burbank Water Reclamation Plant (WRP) (miles)

Footnotes: 5 = better, 1 = worse

3.2.2 Evaluation Criteria and Performance Measures

Evaluation criteria were defined for each objective to evaluate the AWPF candidate sites. This section describes the evaluation criteria and the associated performance measures. Since the threshold criteria must be met by all sites in order to proceed, these criteria are not included in Table 3-1.

As shown in Table 3-1, the performance measures are measured both qualitatively (i.e., relative score of 1 to 5) and quantitatively (i.e., capital cost, O&M costs, etc.). When a qualitative score is used, a score of 5 is better and a score of 1 worse.

These are general descriptions of how the performance measures will be scored for each evaluation criterion. The candidate sites are described in Section 5 and the specific performance measures for each site are described in Section 6.

Objective 1 – Promote Cost Efficiency

Two evaluation criteria are used for Objective 1 – Promote Cost Efficiency:

- Capital cost; and,
- O&M costs.

Capital Cost

The total construction cost for the AWPF facilities, transmission pump stations and pipelines, administration buildings (if applicable), site security (if applicable), and land purchase costs (if applicable) are estimated for each site. A 30 percent contingency is included, which is appropriate for this planning level estimate. Since these costs are being used to compare the candidate sites, 2011 costs are used without escalation to mid-point of construction. Construction cost estimates for project concepts are assumed to have an accuracy of +50 percent to -30 percent.

The construction costs for the base AWPF facilities are based on the AWPF construction cost estimate developed for the "Tillman Advanced Treatment System Basis of Design and Cost Estimate TM", dated June 27, 2006, and prepared by CH:CDM Smith as part of the Phase II Integrated Resources Plan for the Wastewater Program. Additional cost elements, such as the need for a two-story building, are estimated separately and added to the base AWPF construction cost.

A 30 percent implementation costs are added to the total construction cost to develop the total capital cost. The implementation costs include allowances for planning, environmental documentation, permitting, engineering services, construction management, legal and administrative services, and market adjustment factors.

This Site Assessment TM includes preliminary capital and O&M cost estimates for the purpose of comparing candidate sites. The RWMP process also included an integrated alternatives analysis to help determine the split of GWR and NPR to meet the City's recycled water goals. The preliminary capital and O&M cost estimates were further refined as part of the integrated alternatives analysis effort for the alternatives, each which contained varying amounts of GWR and NPR. To provide consistency between the initial RWMP documents, the costs in this Site Assessment TM were updated to be consistent with the Integrated Alternatives Development and Analysis TM and the Integrated Alternatives Analysis – Preliminary Cost Summary.

Both the Base Condition and Scenario 1 do not include pipeline costs to the PSG or injection wells, since these are common to all alternatives. These costs are included in the GWR Master Planning Report.

Note that the GWR and NPR project costs were developed in more detail as part of the GWR and NPR Master Planning Reports, respectively. The most current costs produced as part of the RWMP are included in the GWR and NPR Master Planning Reports.

Operation and Maintenance (O&M) Costs

For analysis, a 50-year O&M cost in present value was determined for the candidate sites. This value was calculated by estimating the annual energy, chemical, equipment maintenance and replacement of consumables, and labor cost and converting the 50-year lifecycle into a present day value. Components that have high O&M costs would result in higher life-cycle costs. O&M costs are also impacted by changing prices for consumables, such as the fluctuating cost of energy. In this evaluation, a unit power cost of $0.12 per kilowatt hour (kWh) is used, based on the information provided by the City, which was the average electricity cost at DCTWRP in December 2009.

The O&M costs are based on the AWPF O&M costs estimate developed for the "Tillman Advanced Treatment System Basis of Design and Cost Estimate TM" developed for the IRP. Additional O&M cost elements, such as the additional power needed for pumping and UV treatment are estimated separately and added to the base AWPF O&M cost.

Objective 2 – Achieve Supply & Operational Goals

Three evaluation criteria are used for Objective 2 – Achieve Supply & Operational Goals:

- Achieve 15,000 AFY for Phase 1 and 30,000 AFY for Phase 2;
- Wastewater system benefits; and,
- Operational flexibility.

Achieve 15,000 AFY for Phase 1 and 30,000 AFY for Phase 2

All of the site alternatives are designed to meet 15,000 AFY for Phase 1 and 30,000 AFY for Phase 2. Therefore, this criterion is a non-discriminator as all sites provide an equal volume of treated water and the same ability to expand from Phase 1 to Phase 2.

Wastewater System Benefits

For this analysis, each site is evaluated on whether or not the site occupies land that could be used for future wastewater system projects. The likelihood of each site being utilized for future projects is also evaluated. Table 3-2 will be used for scoring the different site alternatives.

Table 3-2: Scoring of Site Alternatives for Wastewater System Benefits

Score	Description of Options
1	Uses only area that could otherwise have been easily used for future projects
2	Uses open space but leaves some neighboring land for future projects
3	Uses open space but leaves ample neighboring land for future projects
4	Site is somewhat unlikely to be used for future projects
5	Site is very unlikely to be used for future wastewater projects

Operational Flexibility

Operational flexibility relates to how easily a site alternative can correct a disruption to normal operation. Specifically, in the event that the AWPF is not operating correctly, the site alternatives are scored based on how easy it is to handle the purified recycled water that is off-specification through storage or discharge, correct the problem, and resume operation. Typically if there is a long-term issue with the AWPF, such as restrictions on groundwater replenishment activities or long-duration maintenance needs, the AWPF would be shut-down. This criterion measures how the site location might impact short-term operational flexibility to avoid a long-term plant shut down for minor operational issues. The scorings outlined in Table 3-3 are used to score the different site alternatives.

Table 3-3: Scoring of Site Alternatives for Operational Flexibility

Score	How Easily an Alternative Can Correct a Malfunction
1	No discharge pipeline or storage
2	Minimal storage available
3	Moderate storage available
4	Substantial storage available
5	Adequate nearby sewer to discharge the entire plant capacity

Objective 3 – Protect Environment

Two evaluation criteria are used for Objective 3 – Protect Environment:

- Habitat impacts; and,
- Greenhouse gas emissions.

Habitat Impacts

The habitat impacts analysis not only evaluates a candidate site's negatives effects on the environment, but also estimates to what extent these effects may increase the difficulty of the permitting process for each site. The following indicators are used to measure habitat impacts:

- Los Angeles City and Los Angeles County General Plan's Significant Ecological Area (SEA) designations

- Development is not prohibited in these areas, but would only be permitted "where no alternative site or alignment is feasible" (County of Los Angeles, 1993)
- California Department of Fish and Game's California Natural Diversity Database (CNDDB) and Biogeographic Information and Observation System (BIOS)
- CNDDB/BIOS provides biological field data, including the locations of observations of rare and endangered plant and wildlife species and habitat conditions
- Geographic Proximity to Open Space and/or Habitat
- Quantifies the site's impact on nearby habitats
- On-site Ecological Resources
- Highlights important ecological resources that would be eliminated, harmed, or otherwise negatively impacted by construction at a particular site

Based on this evaluation, each site will be given a rating from 1 to 5, with a rating of 1 reflecting a high potential for ecological impacts that would present difficulty in permitting, and a rating of 5 reflecting a low potential for ecological impacts and therefore no anticipated permitting issues in this regard.

Greenhouse Gas Emissions

A greenhouse gas (GHG) is a gas in the atmosphere that absorbs and emits radiation, which creates a blanket effect that warms the earth. To counteract this effect, efforts are being made to control the increase of GHG emissions. For this evaluation parameter, a GHG emissions inventory was completed for each site alternative. Since the same size AWPF is being considered for each of the sites, only the greenhouse gas emissions from the different facilities are being considered in the site assessment. These include the differences in electricity use for pumping, the UV system, and an administrative building at each candidate site. Greenhouse gas emissions are measured in metric tons of carbon dioxide (CO_2) equivalents.

The increase in greenhouse gas emissions associated with the overall AWPF operation, as well as the reduction in greenhouse gases that will be realized by pumping less imported water to the City of Los Angeles, will be considered as part of the analysis. Since each tie assumes the same amount of purified recycled water production, these greenhouse gas emission components are non-discriminators for this analysis and are not included in the evaluation.

The emissions analysis included the three main GHG in most regulatory and voluntary reporting programs: CO_2, methane (CH_4), and nitrous oxide (N_2O). These components were combined into metric tons of CO_2 equivalents.

Emissions of GHG were calculated following procedures in the Local Government Operations Protocol (LGOP), a joint document developed by the California Air Resources Board (CARB), the California Climate Action Registry (CCAR), ICLEI – Local Governments for Sustainability, and The Climate Registry (CARB 2008). The LGOP provides methodologies for calculating GHG emissions from a variety of sources, including purchased electricity. The LGOP also identifies various scopes of emissions that identify the ownership and control of emission sources. Purchased electricity is known as an indirect/Scope 2 emission source, meaning that a facility does not directly generate emissions, but is indirectly responsible for emissions.

It was assumed that LADWP would be the primary electricity provider at each of the locations. Since the LADWP voluntarily reports to CCAR, the most recent CCAR report, in this case for 2007, was used to estimate the CO_2 emission factor. Since the public reports do not provide emission factors for CH_4 and N_2O for total electricity deliveries, emission factors in the LGOP were used for these two pollutants for the most recent year available (2004).

Objective 4 – Maximize Implementation

Five evaluation criteria are used for Objective 4 – Maximize Implementation:

- Public perception;
- Institutional partnership;
- Permitting; and,
- Ability to expedite implementation.

Public Perception

One of the negative perceptions that any groundwater replenishment project struggles with is the public associating their drinking water with raw wastewater. One way to mitigate this issue is to build the AWPF as a distinctly separate facility from the wastewater treatment plant from which it receives tertiary effluent. In this case, DCTWRP will be providing the tertiary effluent. Therefore, an option would score lower if, in the public's eye, it was associated with DCTWRP. Table 3-4 contains the scores for each candidate site.

Table 3-4: Scoring of Public Perception

Score	Description of Options
1	Completely integrated within wastewater processes at DCTWRP
2	Located within DCTWRP fencing and easily associated with it
3	Located close to DCTWRP but not easily associated with it
4	Located within 3 miles of DCTWRP
5	Located beyond 3 miles from DCTWRP

Institutional Partnership

Institutional partnership provides a measure to evaluate sites where sister agencies will be working together because the AWTP will be co-located with an existing BOS facility. If the AWPF will be co-located with a BOS facility, the alternative will be scored a 1. If the AWPF is not co-located with a BOS facility, the alternative will be scored a 5.

Permitting

Permitting will be scored based on the ease of obtaining United States Army Corps of Engineers (USACE) approval for building an AWPF at the site. This score is different for each site in question depending on the location of the site relevant to the flood protection berm.

If the parcel is not located on USACE land, there will be no approval required by the USACE so the score will be a 5. If the parcel is located within the flood protection berm and located on USACE land, the score will be a 4. If the parcel is located outside of the flood protection berm and is on USACE land, the score will be a 1.

Table 3-5 will be used to score the different site alternatives.

Table 3-5: Scoring of Site Alternatives for Permitting

Score	Description of Options Regarding Obtaining a CUP
1	Parcel is located on USACE land and is outside of the flood protection berm
4	Parcel is located on USACE land and is within the flood protection berm
5	Parcel is not located on USACE land

Ability to Expedite Implementation

Each of the sites will also be evaluated based on anticipated work that may need to be done that would add time to the overall project schedule. There is on site work (e.g. demolition, site grading) and off site work (e.g. relocating facilities/buildings) that may affect the project schedule. The specific preliminary work for each site alternative will be discussed in detail in Section 6. Table 3-6 will be used to score the different alternatives.

Table 3-6: Scoring of Site Alternatives for Ability to Expedite Implementation

Score	Amount of Preliminary Work
1	Substantial on project site and offsite
2	Substantial on project site or offsite
3	Moderate on project site and offsite
4	Moderate on project site or offsite
5	Minimal on project site or offsite

Objective 5 – Promote Economic & Social Benefits

Three evaluation criteria are used for Objective 5 – Promote Economic & Social Benefits:

- Economic benefits;
- Environmental justice; and,
- Job creation.

Economic Benefits

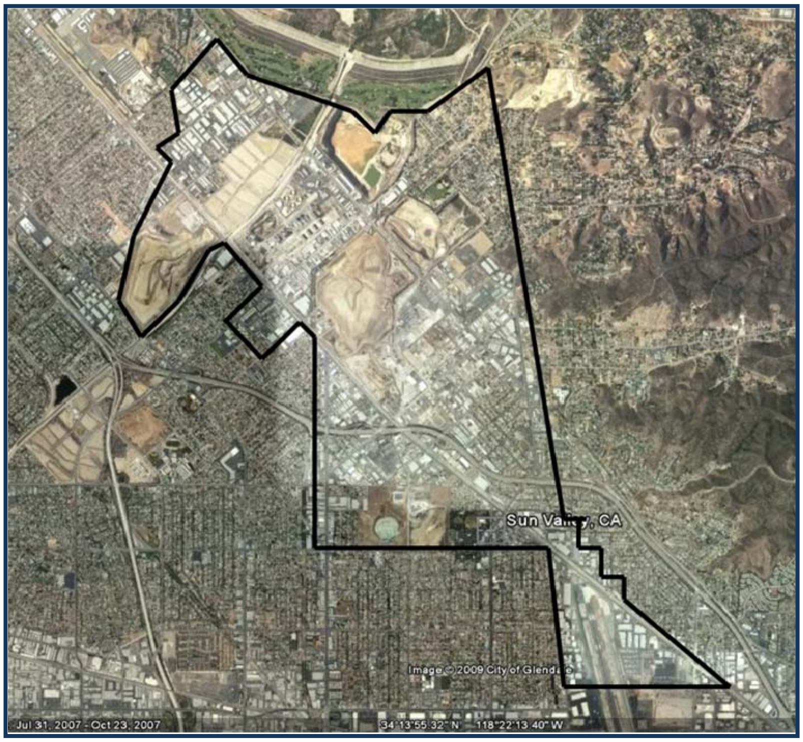
In economic development studies, job creation is used as an indicator of economic benefit. Economic benefit for each of the possible AWPF locations will be gauged by the number of temporary jobs that will be created for the design and construction of the plant. Temporary jobs were deemed to be directly related to the capital cost of the project.

This method is similar to the one used by the United States Committee on Transportation and Infrastructure in the "Jobs on Main Street Act, 2010" that was developed on December 16, 2009. In this act, it is estimated that 7.2 direct, on-site jobs will be created for every $1 million spent in capital costs, under the Clean Water State Revolving Funds category. This factor will be used for this analysis. It is assumed that 7.2 direct and indirect jobs are created for every million dollars in construction spending, where a job is defined as one year of full-time work. This factor comes from the *Estimated San Francisco Jobs Created by Capital Spending* document written by the Office of the City Administrator in San Francisco on February 25, 2009. It references the REMI Policy Insight Model. This factor is supported by the American Recovery and Reinvestment Act as part of the Senate Stimulus Bill, which allocates $1.4 billion of capital investment for "water reclamation and reuse projects." The bill estimates that this money will generate 11,500 direct new private sector jobs or 8.2 direct jobs per million dollars of capital investment. In this TM, a factor of 7.2 direct jobs per million dollars of capital investment is used, since it is a more conservative estimate than 8.2.

Environmental Justice

On November 19, 2003 the Los Angeles City Council passed a motion designating a portion of Sun Valley as an Environmental Justice Improvement Area. This motion was passed in an effort to rectify the disproportionate amount of industrial activity in that area. As a result, any industrial land use applications that are filed for sites within the Environmental Justice Improvement Area must be forwarded to the Environmental Affairs Department, the Fire Department – Risk Management Department and the City Planning Department, Community Planning Bureau, Valley Office. These agencies will comment on the impacts of the proposed use and recommend mitigation measures. Therefore, constructing the AWPF within the Environmental Justice Improvement Area creates a more lengthy permitting process and being within the area could potentially have a negative impact on construction of the AWPF. Environmental justice will be scored based on whether or not a site alternative is within this Environmental Justice Improvement Area (i.e., yes or no): no is a better score and yes is a worse score. Figure 3-3 shows the extent of the improvement area.

Figure 3-3: Sun Valley Environmental Justice Improvement Area



Job Creation

Job creation is defined by the number of permanent jobs that will be created for continual operation of the AWPF. Since it is unknown exactly how many employees would be required to run the AWPF, a qualitative scoring of 1 to 5 will be used. The score will be based on if the AWPF will likely be able to share staff with a neighboring treatment plant or if it will be a stand-alone facility with a unique staff. Therefore, sites near DCTWRP will score slightly lower than a stand-alone facility because some staff positions, such as administrative staff, could be shared between DCTWRP and the AWPF. A stand-alone facility would score the highest because it has the highest potential for creating more jobs.

Creation of permanent jobs was separated from creation of temporary jobs, which were looked at in Economic Benefits, to avoid double-counting.

Objective 6 – Maximize Adaptability & Reduce Risk

Three evaluation criteria are used for Objective 6 – Maximize Adaptability & Reduce Risk:

- Geotechnical;
- Expansion capability; and,
- Maximize reuse.

Geotechnical

Geotechnical risks will be evaluated for each site. This section does not cover construction costs for mitigating these risks, but simply the likelihood of these risks affecting the site. The highest rated sites will have the lowest risk of any negative geological impacts. Analysis of each site was performed by the LADWP Geotechnical Group. The following geologic hazards were examined for each site: fault rupture, liquefaction, landslide/rockfall, debris flow, flood, methane, and earthquake induced landslide area. The site analysis also examined the following items: depth to high groundwater (feet), ground motion (PGA (g)), geologic materials, and location of nearby faults.

Sites will be rated 1 to 5 based on the severity of the risk of being negatively impacted by geologic hazards. A scoring of 1 would signify a site with too high of a risk to make construction advisable, while a scoring of 5 would signify no risk or risks that could be remediated by construction considerations.

Expansion Capability

Each site is large enough to construct the Phase 2 AWPF, which can achieve 30,000 AFY, as determined in the Achieve Supply & Operational Goals Objective. Expansion capability measures the availability of additional space for future expansions beyond Phase 2 (30,000 AFY). A score of 1 indicates that a site has no room for expansion. A score of 3 indicates that a site has some expansion capability, but the site would require some special design considerations in order to make the expansion fit on the site. A score of 5 indicates that there is ample area for expansion without any appreciable design changes.

Maximize Reuse

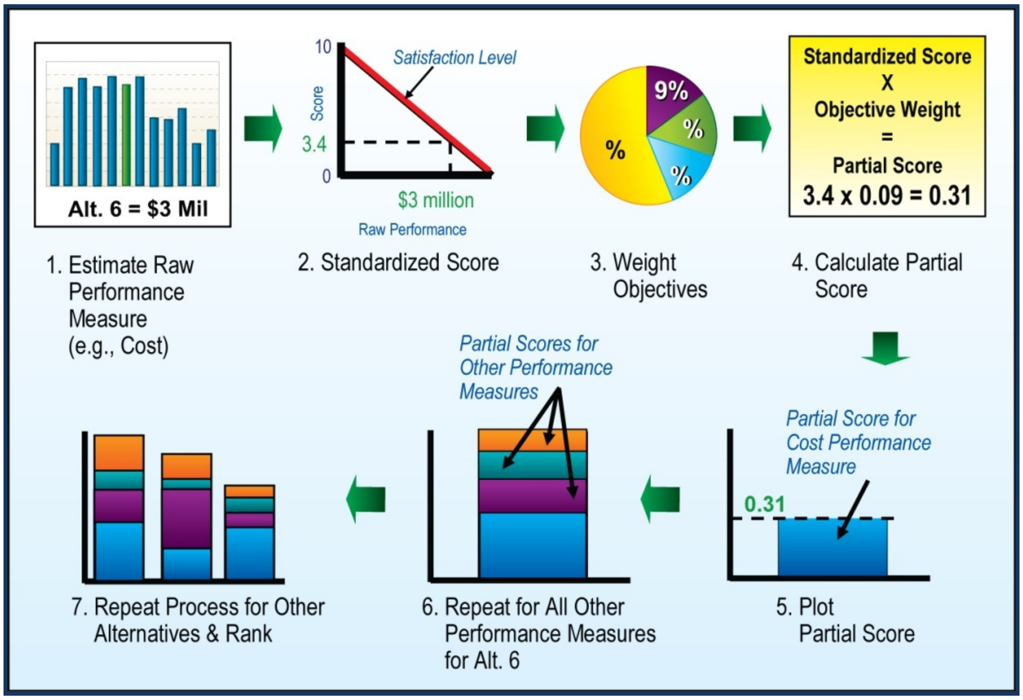
The AWPF will be designed to take full advantage of the available wastewater flows to DCTWRP, while balancing other DCTWRP effluent uses. In the future, maximizing reuse beyond the effluent available from DCTWRP may be achieved by incorporating tertiary effluent flows from the Burbank Water Reclamation Plant (WRP) and/or the Los Angeles-Glendale Water Reclamation Plant (LAGWRP). The distance from the candidate sites to the Burbank WRP is used as an indicator of the relative cost to connect the effluent from these two plants to the AWPF (e.g., a longer distance indicates a higher pipeline cost and a shorter distance indicates a shorter pipeline cost). Distance would be directly correlated to the cost of the pipeline that would need to be constructed. Shorter pipelines signify lower costs and are therefore, more desirable.

3.2.3 Decision Model Process

To support the selection of a preferred site for the AWPF, a decision model was developed based on the multi-attribute rating methodology. The objectives, evaluation criteria, and performance measures for each of the candidate sites carried forward to the detailed evaluation are the inputs to the decision model. Developing such a decision model is wise when there are multiple alternatives that can be measured differently against multiple criteria, and when no single alternative clearly performs the best in all areas. In these cases, systematizing the decision process by explicitly defining and weighting criteria and then giving scores to the alternatives for those criteria can make the ultimate decision easier and more objective.

The decision model based on the multi-attribute rating methodology was developed using the commercial software Criterium® DecisionPlus® (CDP). This software was developed by Infoharvest Inc., and was selected to rank the sites for the new AWPF because of its sophistication, ease of understanding and use, and its ability to conduct sensitivity analyses. There are seven basic steps of the multi-attribute rating technique, which are shown in Figure 3-4.

Figure 3-4: Multi-Attribute Rating Technique for Evaluating Alternatives



The seven steps in Figure 3-4 are described as follows:

- **Step 1:** First, the engineering analysis provides information about the raw performance of each site alternative with respect to each of the criteria. The performance score can either be quantitative or qualitative in nature. For example, the objective to Protect Environment uses Habitat Impacts evaluation criterion that uses a qualitative performance measure based on a numeric scale from 1 to 5 as determined by expert opinion, and GHG Emissions evaluation criterion that uses a quantitative performance measure of the metric tons of CO_2 equivalents emissions per year. For quantitative performances measures, a range of possible scores must be set. In the CDP model, the range of possible scores was set from 0.9 of the lowest score to 1.1 of the highest score. This is the standard practice in CDP.
- **Step 2:** Because different criteria are measured in different units (e.g., capital cost estimate is measured in dollars; wastewater system benefits is ranked on a 1 to 5 scale, etc.), it is necessary to standardize the raw performance measures into comparable numeric scores. This ensures that all scores are additive (the higher the score, the better the performance of

the alternative). In this example, the capital cost estimate is an inverse function—meaning that the higher the cost, the lower the performance and vice versa. Based on a min-max technique using the capital cost of all alternatives in question, a linear satisfaction curve is generated. The raw performance of a certain cost for an alternative translates into a standardized score (where the score of 1 indicates the worst performance, and the score of 5 indicates the best performance).

- **Step 3:** Since decision makers place different levels of importance on the criteria (or objectives), it is important to weight the criteria.
- **Step 4:** A standardized score is multiplied by its relative weight of importance in order to get a partial score for a particular alternative.
- **Step 5:** The partial score is then plotted on a graph for an alternative.
- **Step 6:** This procedure is repeated for all of the other criteria for an alternative until a total score for the alternative is calculated.
- **Step 7:** Finally, the total score for an alternative is compared to the total scores of the other alternatives in order to get a ranking or prioritization for implementation.

The decision model results are presented in Section 7.

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4. Identify and Pre-Screen Potential Site Locations

This section outlines the site identification and pre-screening steps, the first task in the overall AWPF site assessment process as shown in Figure 3-1, which includes:

- Step 1 – Identify Potential Sites
- Step 2 – Threshold Screening
- Step 3 – Candidate Sites for Detailed Evaluation

4.1 Pre-Screening Step 1 – Identify Potential Sites

The first step in the site assessment process was to identify potential sites for evaluation. To be selected, both City-owned and non-City owned sites had to fit the following criteria:

- Located within 3 miles of the 54-inch Title 22 pipeline that conveys water from DCTWRP to the 7 MG Hansen Tank at VGS. This was done because treated water from the AWPF will be spread at the HSG next to VGS. Therefore, it is important to locate the new facility within a reasonable distance of the 54-inch pipeline, which will be used in some capacity for the new AWPF effluent (e.g., conveying tertiary effluent to the AWPF or purified recycled water to the Hansen Spreading Grounds).
- Either open space or abandoned or with limited structures on site.

4.1.1 City-Owned Sites

To identify City-owned sites that met the above criteria, the following resources were used:

- City of Los Angeles City-owned parcel geographic information system (GIS) layer
- City of Los Angeles Building Book

Two additional sites were identified in the Building Book that were not shown on the GIS coverage. These were the East Valley Refuse Collection Yard, a Bureau of Sanitation (BOS) site, and the former Anthony Office Building, a LADWP site. Upon further investigation, it was discovered that both of these sites were sold in the last few years and are no longer City-owned. Therefore, these sites were not considered further.

The GIS layer was used to create a map of all City-owned properties with the current zoning for each site (Figure 4-1). Based on these maps, a total of 50 possible City-owned sites were identified, which are summarized in Table 4-1 and shown in Figure 4-2.

In addition, DCTWRP, VGS, and the Sepulveda Basin Cricket Fields (located adjacent to DCTWRP) were considered as potential sites.

4.1.2 Non-City Owned Sites

To identify non-City owned sites, satellite images were visually scanned in a 3-mile radius around the 54-inch pipeline from DCTWRP to VGS. Sites were selected that either had open space or abandoned structures that could easily be demolished. Additionally, industrial zoned areas in the vicinity of the 54-inch pipeline were assessed.

These two steps resulted in the identification of nine additional sites (numbered N1-N9) shown in Table 4-1 and Figure 4-2.

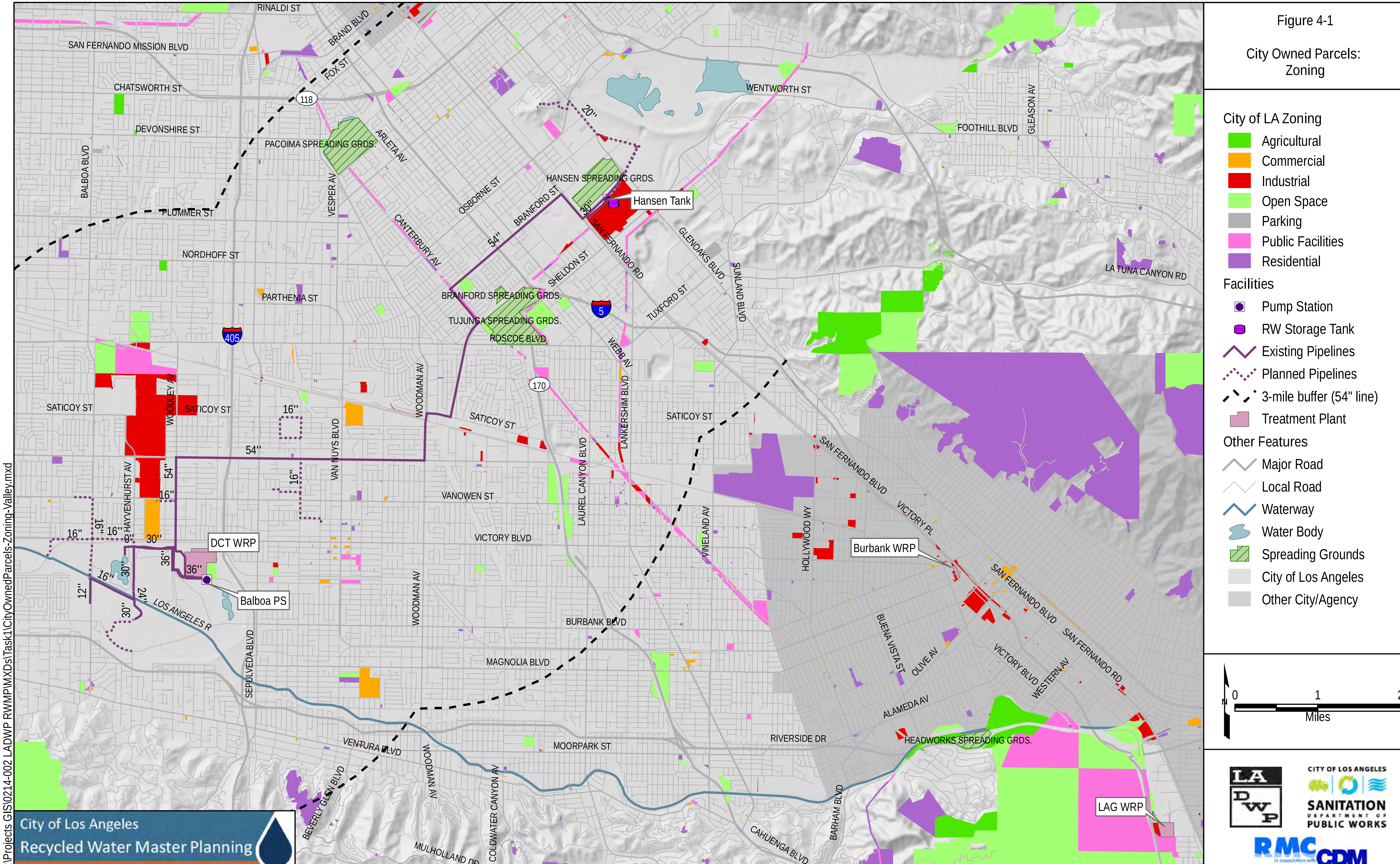

Figure 4-1
City Owned Parcels: Zoning

Data Sources: USGS, LADWP, City of Los Angeles BOS

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Table 4-1: Potential AWPF Sites

Site No.	Address	Description
1	7140 Louise Ave Reseda 91406	Louise Park
2	16400 Victory Bl Van Nuys 91406	Van Nuys Golf Course
3	15110 Erwin St Van Nuys 91411	Delano Park
4	14101 Husto St Van Nuys 91423	Sherman Oaks Rec & Parks Service
5	11430 Chandler Blvd N Hollywood 91601	North Hollywood Park
6	11117 Vicotry Bl N Hollywood 91606	Victory/Vineland Park
7a	7100 Whitsett Ave Sun Valley 91605	Valley Plaza Park-open space
7b	7100 Whitsett Ave Sun Valley 91605	Valley Plaza Park-recreation space
8	13101 Erwin St Van Nuys 91401	Erwin Park
9	14301 Vanowen Ave Van Nuys 91405	Van Nuys Recreation Center
10	14345 Arminta St Panorama City 91402	Fire Station #81
11	16400 Roscoe Bl LA 91406	Sod Farm
12	17141 Nordhoff St Northridge 91325	Dearborn Park
13	16730 Chatsworth St Granada Hills 91344	Granada Hills Park & Rec Center
14	11121 N Sepulveda Bl Mission Hills 91345	North Valley Police Station
15	14841 Brand Bl Los Angeles 91345	Brand Park
16	10940 Sepulveda Bl Mission Hills 91345	Andres Pico Adobe Park
17	13925 Paxton St Pacoima 91331	Paxton Park & Recreation Center
18	10230 Woodman Av Mission Hills 91345	Devonwood Park
19	8798 Parthenia Pl Los Angeles 91343	Landscape Median Island
20	8737 Kester Ave Van Nuys 91402	Sepulveda Recreation Center
21	8600 Hazeltine Ave Panorama City 91402	Panorama Recreation Center
22	13306 Branford Pk Arletta 91331	Branford Park
23	8787 Sharp Ave Sun Valley 91352	Sheldon-Arleta Landfill
24	8851 Laurel Canyon Sun Valley 91352	Fernangeles Rec Center
25	12541 Blythe St Sun Valley 91605	Strathern Park
26	8122 Fair Ave Sun Valley 91352	Sun Valley Park & Rec Center
27	8360 San Fernando Rd Los Angeles 91352	Parking Lot Sun Valley Metrolink
28	9121 Cabrini Dr Sun Valley 91504	Verdugo Mountain Park
29	9224 Sunland Bl Sun Valley 91352	New Fire Station #77
30	11225 Wicks St Sun Valley 91352	Stonehurst Park

Footnotes:

a. Sites 1 through 50 are City-owned sites and Sites N1 through N9 are non-City owned sites.

Table 4-2: Potential AWPF Sites (Continued)

Site No.	Address	Description
31	12453 Osborne St Sun Valley 91352	Roger Jessup Park
32	11798 Foothill Bl Sun Valley 91342	Hansen Dam Golf Course/Park
33	11502 Foothill Bl Sun Valley 91342	Hansen Dam Golf Course/Park
34	Wheatland Ave Los Angeles 91342	Big Tujunga Mitigation Bank
35	Water and Power Rd Los Angeles 91342	Green Verdugo Reservoir
36	16244 Nordhoff St North Hills 91343	Nordhoff Rec Center/Youth Center
37	14832 Raymer St Van Nuys 91405	Raymer St Car Shelter
38	14401 Saticoy St Van Nuys 91405	LADWP Valley Service/Metrolink Parking
39	12730 Saticoy St N Hollywood 91605	LADWP East Valley Yard
40	12544 Saticoy St N Hollywood 91605	Parking Enforcement Valley Area
41	11761 Roscoe Bl Sun Valley 91352	LADWP Sun Valley Water Yard
42	6240 Sylmar Ave Van Nuys 91401	City Hall, Court House, Police Station
43	14651 Oxnard St Van Nuys 91411	LADOT/BOS and St. Services
44	14400 Oxnard St Van Nuys 91411	Metro Buildings and Parking
45	11000 Pendleton St Sun Valley 91352	Pendleton Gravel Pit
46	12760 Osborne St Pacoima 91331	Foothill Police Station
47	16461 Sherman Way Van Nuys 91406	Van Nuys Airport
48	6100 Woodley Ave Van Nuys 91406	DCTWRP
49	11801 Sheldon St Sun Valley 91352	VGS
50	6100 Woodley Ave Van Nuys 91406	Sepulveda Basin Cricket Fields
N1	12746 Burbank Bl Los Angeles 91607	3-50,000 Watt Radio Towers
N2	7004 Vineland Ave Burbank 91605	Runway Protection Zone for Burbank Airport
N3	17106 Victory Bl Los Angeles 91406	Open Space near Military Recruitment Center
N4	17490 Oxford St Los Angeles 91406	Agricultural Plot near Encino Velodrome
N5	16454 Burbank Bl Los Angeles 91316	Agricultural Plot near Sevulveda Dam
N6	13466 Paxton St Los Angeles 91331	Lowes Hardware Building
N7	14800 Lassen St Los Angeles 91345	4-30,000 Watt Radio Towers
N8	12234 Osborne St Lake View Terraces 91342	Open Space near Hansen Dam Park
N9	7500 Tyrone Ave Van Nuys 91405	Time Warner Cable Building

Footnotes:

a. Sites 1 through 50 are City-owned sites and Sites N1 through N9 are non-City owned sites.

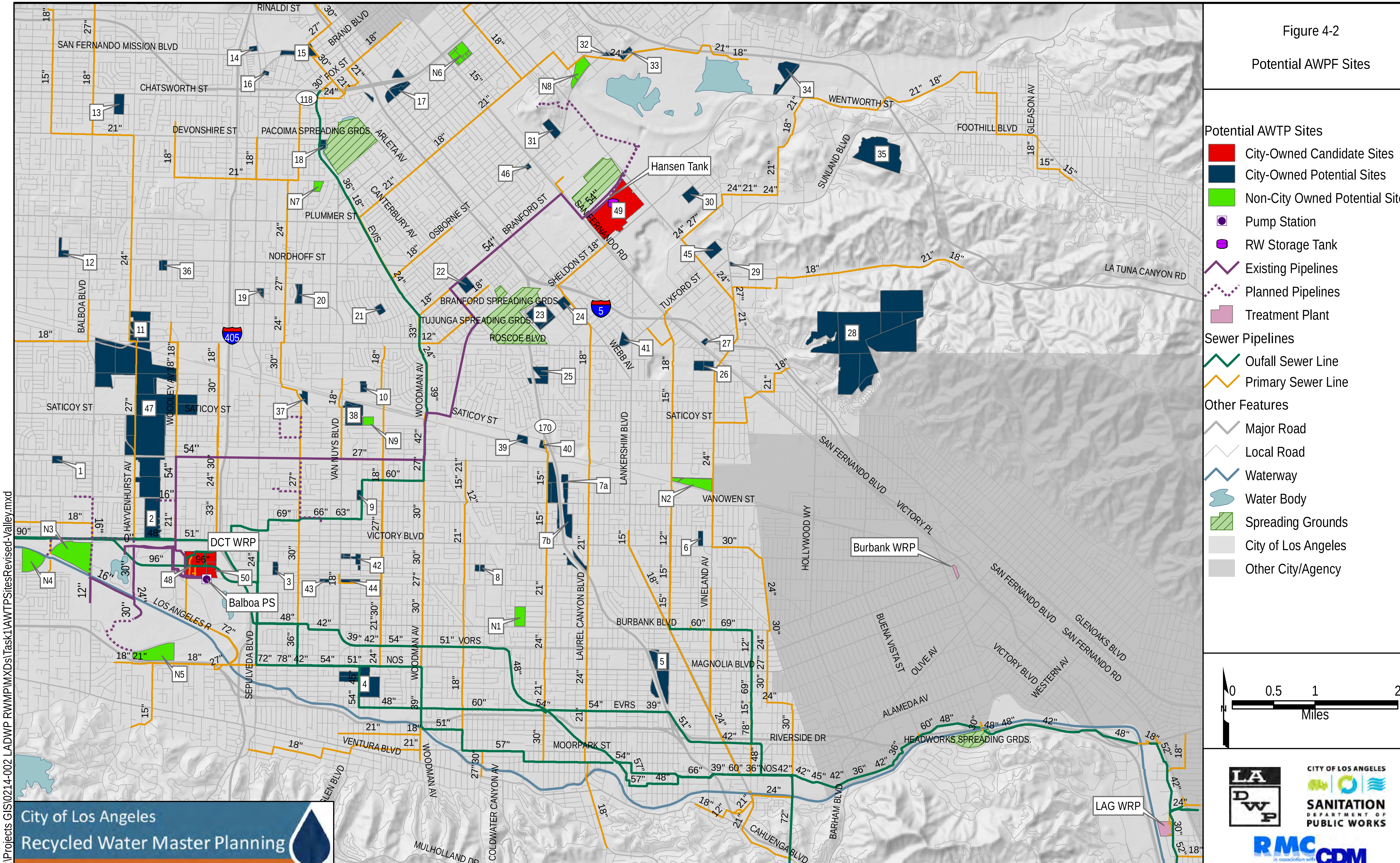

Figure 4-2

Potential AWPF Sites

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Data Sources: USGS, LADWP, City of Los Angeles BOS

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4.2 Pre-Screening Step 2 – Threshold Screening

Once the potential sites were identified, then the threshold screening was completed to identify candidate sites. This section presents the threshold screening criteria and results.

4.2.1 Threshold Screening Criteria

Threshold screening criteria, summarized in Table 4-3, were used to screen the potential sites (Table 4-1) to eliminate sites that are not feasible for the AWPF. These criteria were applied to each of the potential sites using a pass-fail analysis. If a site did not pass all of the criteria in Table 4-2, then the site was eliminated and not considered further. The list of all potential sites and the pass-fail evaluation for the threshold screening criteria are presented in Attachment A.

Table 4-3: Threshold Screening Criteria

Threshold Criteria	Description
Residential zoning	Sites zoned as residential were eliminated from further consideration
Adjacent to residential	Sites adjacent to residential areas on two or more sides of the site were eliminated from further consideration
Available size	Sites less than 300,000 square feet were eliminated from further consideration
Developable	Sites with an obvious feature/existing use that renders the site non-developable were eliminated from further consideration. This includes issues/uses such as airports, fire stations, buildings, golf courses, parks, former landfills, within a flood plain, and geotechnical issues.

Note: The typical AWPF site layout is 314,000 square feet, but an area of 300,000 square feet was used for the threshold screening assuming that the layout could be optimized for a smaller site using two-story structures.

After the threshold screening, three City-owned sites and three non-City sites remained. The City-owned sites include:

- Site 48 — DCTWRP
- Site 49 — VGS
- Site 50 — Sepulveda Basin Cricket Fields

The three non-City owned sites include:

- N3 — Open space near Military Recruitment Center
- N4 — Agricultural Plot near Encino Velodrome
- N8 — Open space near Hansen Dam Park

Sites N3 and N4 are both designated as prime farmland by the City. They also contain a portion of the LA River and so they are subject to the LA River Revitalization Master Plan. This plan restricts construction 300-feet on either side of the LA River to recreation space and other facilities that will directly enhance the community. Site N8 is separated from Hansen Dam Park by Osborne Street.

Since these three sites are not City owned, they have a higher potential to impact the implementation schedule.

Industrial zoned areas within the San Fernando Valley were also considered as potential areas for the AWPF. The team did consider moving forward with evaluating a generic site within these industrial zoned areas. If the general site in one of the industrial zoned areas was shown to be favorable as part of the detailed evaluation, then the next step would be to identify a specific property that could be used for the AWPF. Since no open sites in the industrial zoned areas were identified as part of the City-owned and non-City owned evaluations, a site with a structure would have to be considered. As noted above for the non-City owned sites, a generic site in the industrial zoned areas would have a higher potential to impact the implementation schedule.

4.2.2 Pre-Screening Step 3 – Candidate Sites for Detailed Evaluation

The results of the threshold evaluation were discussed with the City at the RWMP November Monthly Management Meeting on November 18, 2009. At that meeting the City agreed to move forward with the following site alternatives for the detailed evaluation:

- Site 48 — DCTWRP
- Site 49 — VGS
- Site 50 — Sepulveda Basin Cricket Fields

Following the meeting, two additional sites at DCTWRP were identified by BOS that were added to the detailed evaluation:

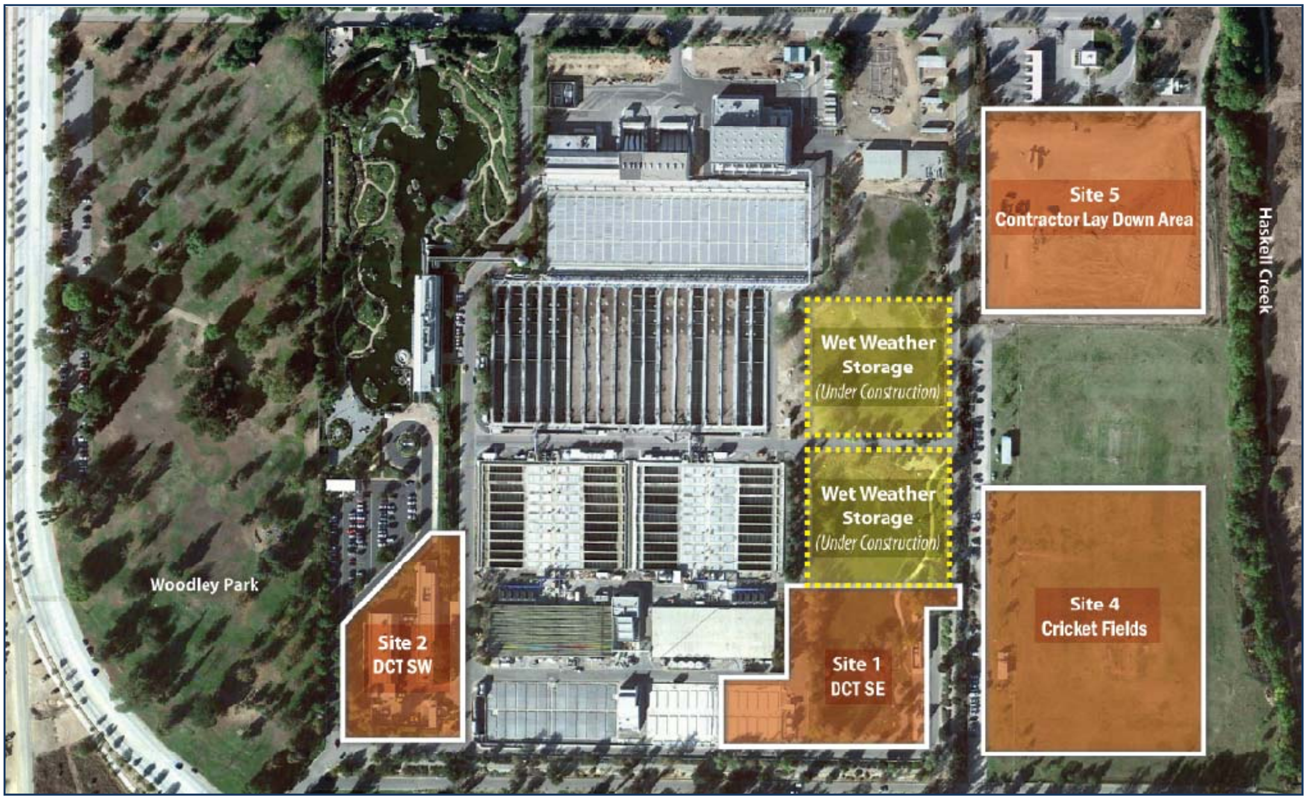
- DCT southwest (SW) which is in the area of the existing DCTWRP maintenance building.
- Contractor Lay Down Area, which is the area north of the Cricket Fields and south of the DCTWRP Septage Receiving Facility

The candidate sites for detailed evaluation are listed in Table 4-4. The locations of Sites 1, 2, 4, and 5, which are all at or adjacent to DCTWRP, are shown in Figure 4-3. The candidate sites for detailed evaluation are described in Section 5.

Table 4-4: Candidate Sites for Detailed Evaluation

Pre-Screening		Detailed Evaluation	
Site No.	**Site Name**	**Site No.**	**Site Name**
48	DCTWRP Southeast	1	DCT SE
48	DCTWRP Southwest	2	DCT SW
49	VGS	3	VGS
50	Sepulveda Basin Cricket Fields	4	Cricket Fields
48	DCTWRP (Contractor Lay Down Area)	5	Contractor Lay Down Area

Figure 4-3: DCTWRP Site Alternatives Aerial Photograph



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5. Candidate Site General Descriptions

This section describes the five candidate sites selected in Section 4. The general background, preliminary site layouts, pipelines and pump station requirements, and the advantages and disadvantages of each site are provided, to be used as the basis for detailed evaluation described in Section 6.

As described in Section 2.1, there are two tertiary effluent flow assumptions being considered for the AWPF site assessment: the Base Condition and Scenario 1. This section describes the different facilities required for these two flow scenarios.

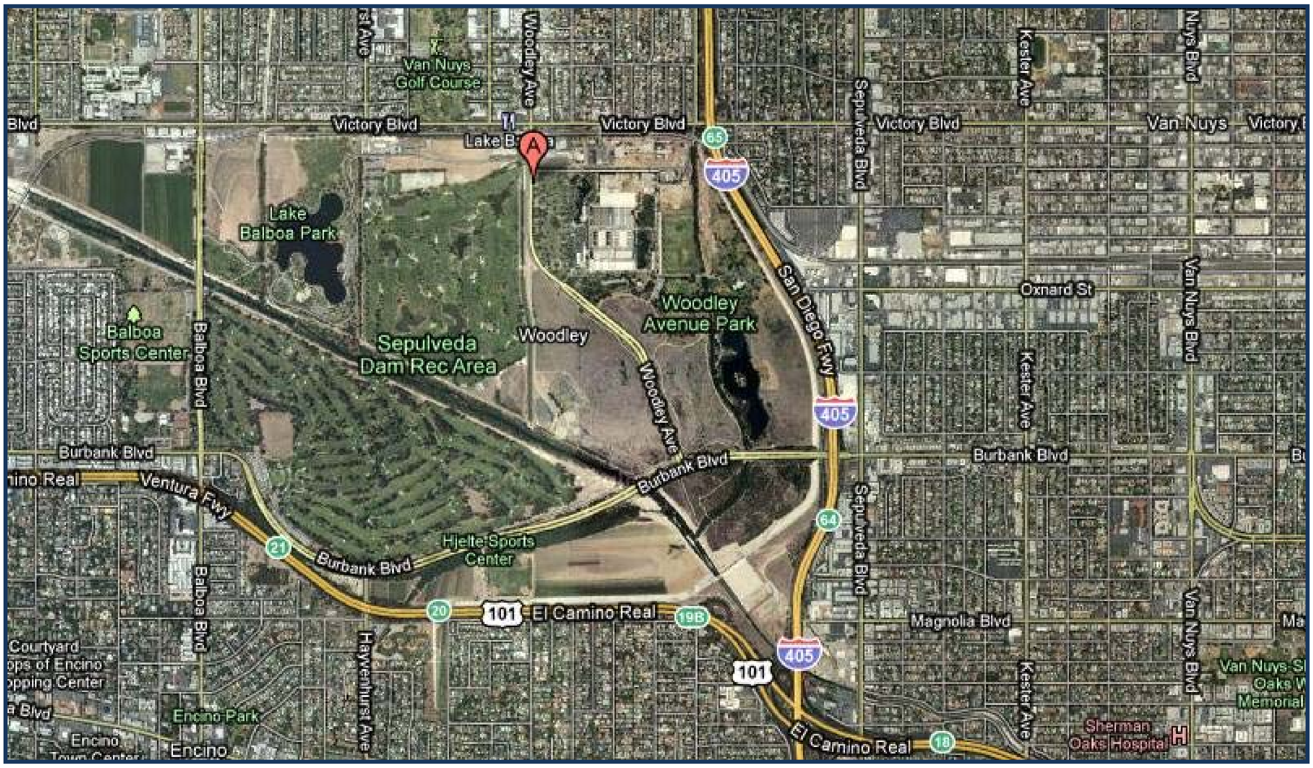
5.1 Site 1 – DCTWRP Southeast (DCT SE)

5.1.1 General Background

The general background is same for all sites located at or adjacent to DCTWRP (Site 1 DCT SE, Site 2 DCT SW, Site 4 Cricket Fields, and Site 5 Contractor Lay Down Area).

DCTWRP is located at 6100 Woodley Avenue, Van Nuys, CA, near the intersection of the 101 Freeway and the 405 Freeway. It is closely bounded by Densmore Avenue to the north, Woodley Avenue Park to the south, Woodley Avenue to the west, and the 405 Freeway to the east. The vicinity map of DCTWRP is shown in Figure 5-1.

Figure 5-1: Vicinity Map of DCTWRP



Source: Google Maps

DCTWRP is currently zoned as Open Space and Public Facilities.

DCTWRP land, including the Cricket Fields and the Contractor Lay Down Area, is owned by USACE who owns all of Sepulveda Flood Basin, and leased by the City of Los Angeles.

5.1.2 Proposed AWPF Site Layout

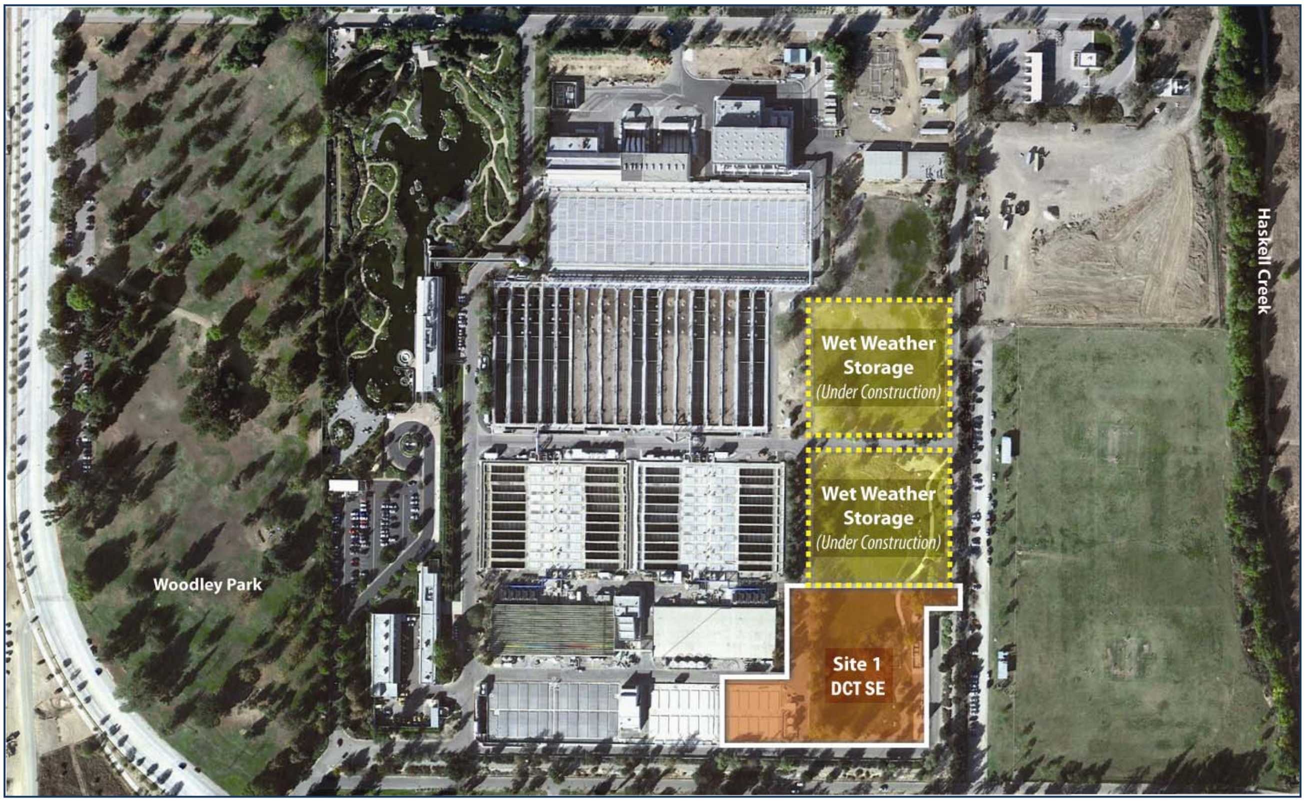
Site Boundaries

As shown in Figure 5-2, Site 1 DCT SE is located in the southeast corner of DCTWRP, within the existing property line. It is bordered by the new wet-weather storage basins (to be constructed) to the north, the Phase II tertiary filters and chlorine contact basin (CCB) to the west, the southern access road to the south, and the Balboa Pump Station to the east.

Available Space

The space available for the AWPF at Site 1 DCT SE is approximately 126,000 square feet (sf), approximately half of the space available at the other four sites.

Figure 5-2: DCT SE Site Location



Process Facilities Common to All Sites

As discussed in Section 2.4, this site assessment assumed that the main AWPF treatment processes include MF/UF, RO, AOP using UV with H_2O_2, and post-treatment for purified recycled water stabilization. A list of major process equipment/facilities and approximate space requirements is summarized in Table 5-1. These equipment/facilities are common to all sites.

Table 5-1: List of Major Process Equipment/Facilities and Approximate Space Requirements

Facility [a]	Approx. Space Requirement [b]	
	Size (ft x ft)	Area (sf)
MF/UF System including: Pre-filters, Feed Pumps [c], Electrical Room, Blowers and Air Compressors, CIP Tanks and Pumps, and CIP Chemicals (Sodium Hypochlorite, Sodium Bisulfite, Citric Acid, and Caustic Soda)	130 x 245	31,900
MF/RO Break Tank [d]	60 x 75	4,500
Ammonia Storage and Feed System	30 x 40	1,200
RO Transfer Pumps	35 x 65	2,300
Cartridge Filters	30 x 40	1,200
Anti-Scalant Storage and Feed System	30 x 40	1,200
Sulfuric Acid Storage and Feed System	50 x 70	3,500
RO System including: RO Feed Pumps, Electrical Room, and CIP Tanks and Pumps	130 x 245	31,900
UV System including: Electrical Room	70 x 100	7,000
Hydrogen Peroxide Storage and Feed System	30 x 40	1,200
Decarbonators and RO Flush Tanks [e]	50 x 90	4,500
Lime System [f] including: Lime Silos, Lime Saturators, Polymer System, and Control Room	85 x 105	8,900
Caustic Soda Storage and Feed System for pH Control and RO CIP	25 x 45	1,100
Citric Acid Storage and Feed System for RO CIP	25 x 45	1,100

Footnotes:

a. This table includes only process facilities that are common to all sites. Site-specific features, such as administration buildings, site security, and parking, are not included in this table.
b. Assumed 40 mgd facility to estimate approximate space requirements, as discussed in Section 2.3. For capital cost estimates, assumed a 30.6 mgd facility for the Base Condition, as discussed in Section 2.4.
c. Assumes pressure MF/UF system.
d. Excludes Site 1 DCT SE. For Site 1 DCT SE, assumed that eastern half of existing Phase II CCB would be modified and used for MF/RO Break Tank.
e. Assumes RO Flush Tanks would be installed below the decarbonators. Further process evaluation is necessary to determine whether decarbonators are necessary. This will be determined in Phase 3b.
f. Further process evaluation is necessary to determine if replacing the lime system may be replaced by calcium chloride system is appropriate. This will be determined in Phase 3b.

Process Facilities for Site 1 DCT SE

Site 1 DCT SE has the most space constraints of the five candidate sites, and requires the following design elements to fit a 40 mgd capacity AWPF in the available space of 126,000 sf:

- Construct a two-story MF/RO building to reduce the space requirement for MF and RO buildings by half.
- Modify existing Phase II CCB to: 1) use the eastern half of the CCB as MF/RO break tank, and 2) use the space above for RO transfer pumps, cartridge filters, and UV building. The modifications would involve constructing a new interior wall to separate the existing CCB into two, and adding structural supports and a new slab to construct on top of the existing CCB.

The eastern half of the Phase II CCB could be used for the purpose listed above, because when the AWPF is constructed at or adjacent to DCTWRP, the portion of DCTWRP effluent that would be used for AWPF influent is not required to meet the Title 22 requirements and, therefore, does not require chlorination. If only Phase I of the AWPF is constructed, then the AWPF influent would be approximately 20.5 mgd (29 percent of total DCTWRP effluent) and approximately one quarter of the CCB volume would be available for use.

For the above scheme to work, the Phase I and Phase II flows need to be combined upstream of the Phase I and Phase II CCBs to allow both CCBs to be fully utilized. The Phase I and Phase II flows are currently separated until downstream of the CCBs, based on the existing as-built drawings for DCTWRP. In addition, provisions need to be made to allow chlorination of full DCTWRP effluent flow, in the event the AWPF is taken out of service and the tertiary effluent needs to be discharged to the LA River.

Ancillary Facilities and Site Features

Since Site 1 DCT SE is located within the property line of DCTWRP, no new fence or site security features are needed. It is assumed that existing parking and administration building would be shared between DCTWRP and the AWPF. In addition, since Site 1 DCT SE is located within the existing 100-year flood berm, no additional flood control measures are needed.

Site Layout

The preliminary site layout for Site 1 DCT SE is shown in Figure 5-3.

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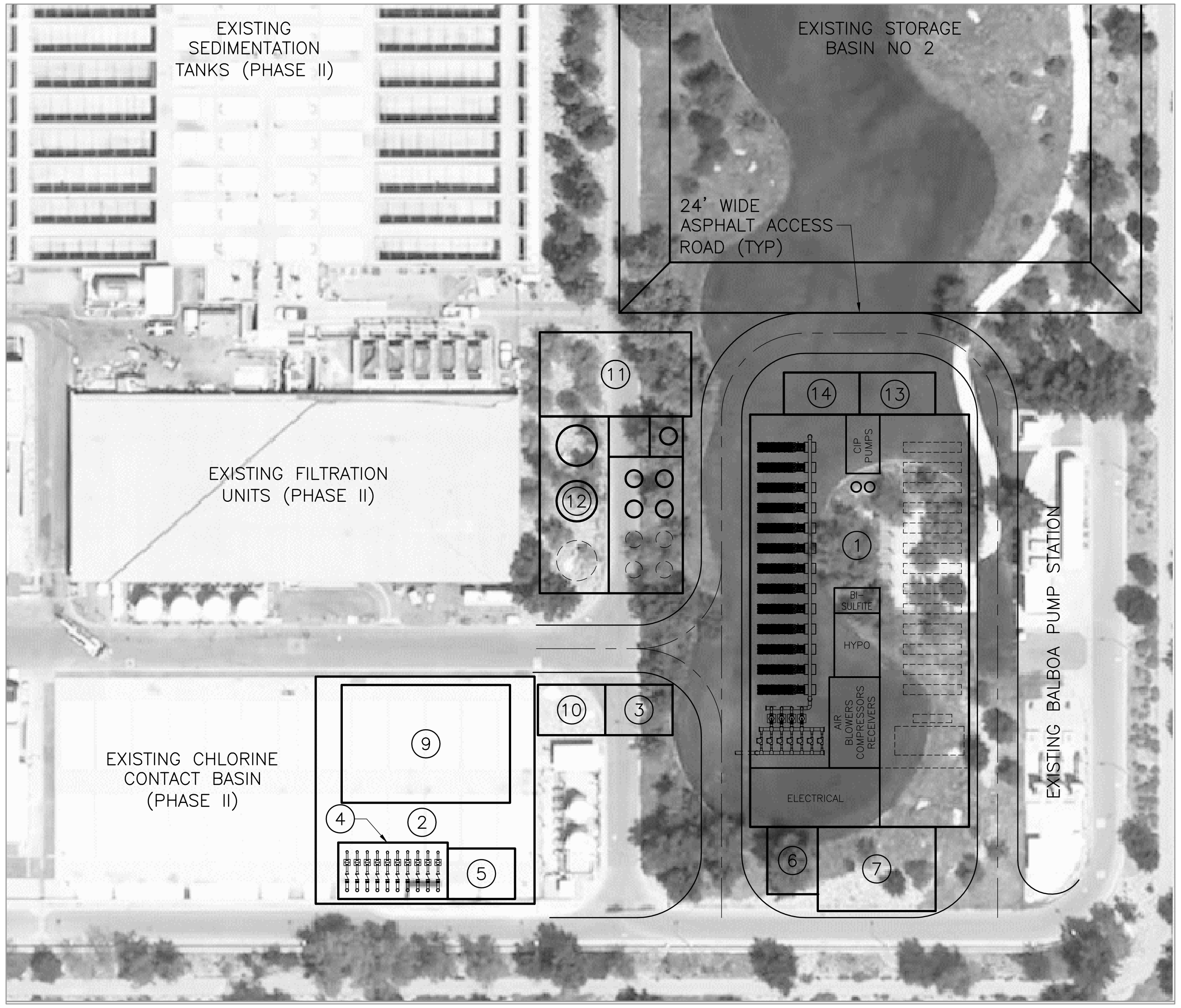
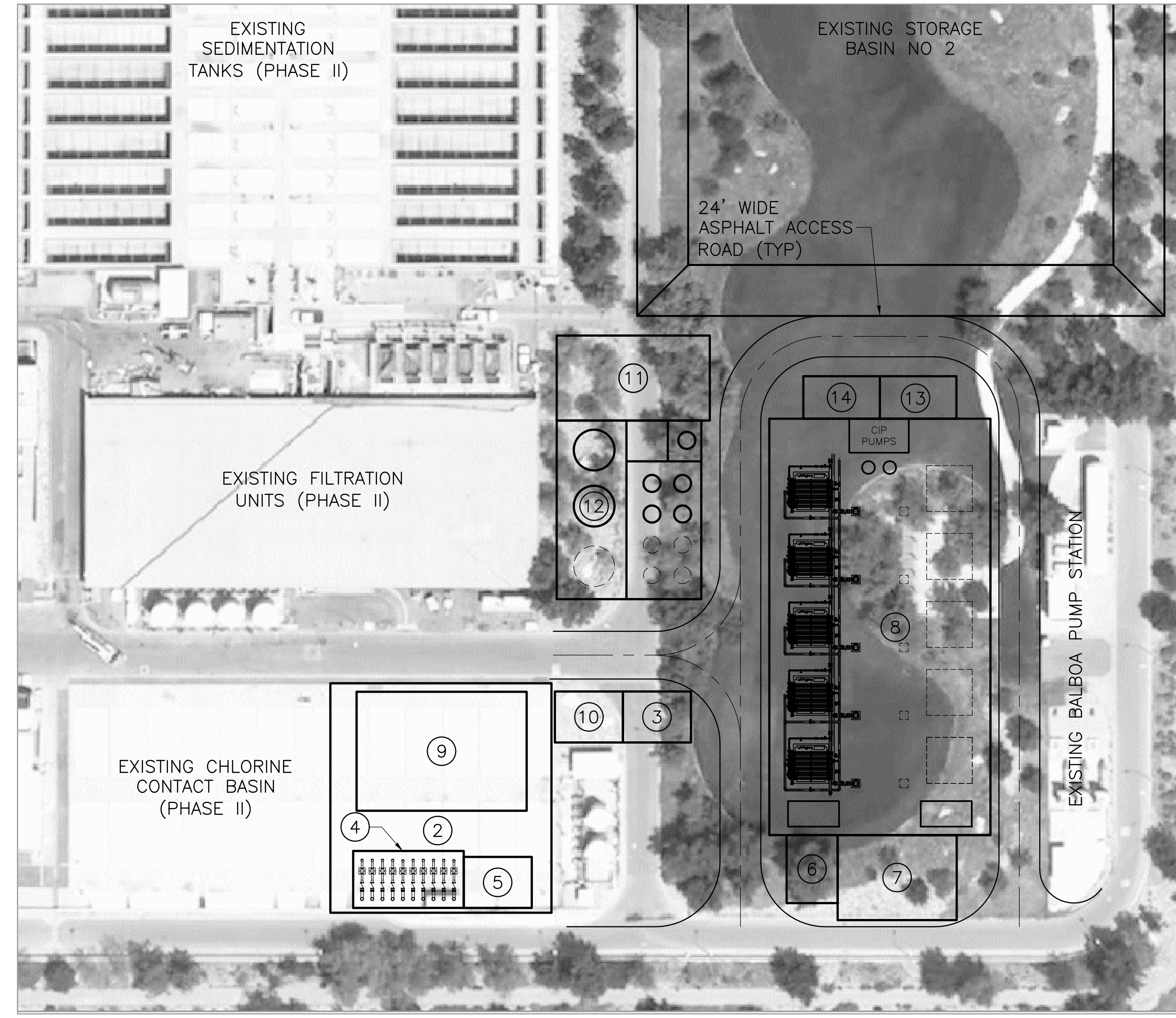


MF LEVEL

BOTTOM PLAN



RO LEVEL

TOP PLAN

LEGEND

1. MF SYSTEM (130'x245')
2. MF/RO BREAK TANK (130'x135')
3. AMMONIA (30'x40')
4. RO TRANSFER PUMPS (35'x65')
5. CARTRIDGE FILTERS (30'x40')
6. ANTI-SCALANT (30'x40')
7. SULFURIC ACID (50'x70')
8. RO SYSTEM (130'x245')
9. UV BUILDING (70'x100')
10. HYDROGEN PEROXIDE (30'x40')
11. DECARBONATORS AND RO FLUSH TANKS (50'x90')
12. LIME (85'x105')
13. CAUSTIC SODA FOR PH CONTROL AND RO CIP (25'x45')
14. CITRIC ACID (25'x45')

——— PHASE I AWTP

– – – – PHASE II AWTP

NOTES:

1. ASSUMES 20 MGD PRODUCT WATER CAPACITY FOR PHASE I AND ADDITIONAL 20 MGD CAPACITY FOR PHASE II. FOR PRELIMINARY SITE LAYOUT REFERENCE SECTION 2.3.
2. WHERE PHASE II IS NOT SPECIFICALLY SHOWN, FACILITY IS SIZED FOR PHASE I AND PHASE II.

N

1" = 50'

25 0 50

0" 1" VERIFY SCALES BAR IS ONE INCH LONG ON FULL SIZE DRAWING. IF NOT ONE INCH LONG ON THIS DRAWING, ADJUST SCALES ACCORDINGLY	RMC in association with CDM	REV / DATE / BY / APVD / DESCRIPTION	DESIGNED ES DRAWN RU CHECKED	SUBMITTED: RMC PROJ ENGR C APPROVED: RMC ENGR C	CITY OF LOS ANGELES - RECYCLED WATER MASTER PLAN FIGURE 5-3 SITE 1 - DCT SE PRELIMINARY SITE LAYOUT	DWG NO SHEET NO OF PROJ NO 0000-000 DATE JANUARY 2010

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5.1.3 Pipelines and Pumping for Base Condition

The four sites at or adjacent to DCTWRP (Site 1 DCT SE, Site 2 DCT SW, Site 4 Cricket Fields, and Site 5 Contractor Lay Down Area) have similar pipeline and pumping needs for the Base Condition. The pipeline needs for Sites 1, 2, 4, and 5 for the Base Condition are shown in Figure 5-4 and described below.

Title 22 Recycled Water

For the Base Condition, the Title 22 recycled water would continue to be distributed to the existing and planned NPR users separately from the purified recycled water for GWR (See Figure 2-1). Since the existing 54-inch pipeline from DCTWRP to the HSG would be used to convey the purified recycled water, a new pipeline and pump station would be required to serve the NPR users. A new 10.3 mile, 18-inch pipeline would be constructed parallel to the existing 54-inch pipeline, and a new Title 22 pump station would be required to convey Title 22 recycled water from DCTWRP to serve the NPR users. The new Title 22 pump station is assumed to have three 400 horsepower (hp) pumps, two duty and one standby.

The existing 7 MG Recycled Water Storage Tank at VGS would be tied into the new Title 22 recycled water distribution system. Additional operational storage and distribution system required for the Title 22 recycled water system is assumed to be same for all site options and, therefore, is not considered in the detailed site evaluation.

Purified Recycled Water

For the Base Condition, the purified recycled water would be conveyed from the AWPF located at or near DCTWRP to the HSG using the existing 54-inch pipeline. The ground elevation at existing Balboa Pump Station is approximately 710 ft, and the maximum water surface elevation at HSG is approximately 950 ft.

The existing Balboa Pump Station, which currently has three 1,000 hp pumps, would be expanded by adding one 800 hp pump to have a total of four pumps, three duty and one standby. The expanded Balboa Pump Station would have the capacity to pump up to 30.6 mgd of AWPF purified recycled water (to be able to treat and pump more water for GWR during the winter months when NPR demands are low, See Section 2.1.2) at 290 ft of total dynamic head (TDH) (240 ft of static head, and 50 ft of piping losses). However, on average, the expanded Balboa Pump Station would be operated to pump 26.9 mgd of AWPF purified recycled water to the HSG.

AWPF Backwash and Concentrate

For the Base Condition, the AWPF backwash and concentrate (i.e., MF/UF backwash waste and RO concentrate) is assumed to discharge to the Additional Valley Outfall Relief Sewer (AVORS) pipe to be treated at HTP. A new 450-foot, 27-inch PVC pipe would be constructed to bypass the DCTWRP into the AVORS. The new 27-inch gravity pipe is sized to convey up to 8.1 mgd of AWPF backwash and concentrate during the winter months when the NPR demand is low and the AWPF is operated at full capacity. The 27-inch gravity pipe is sized assuming half pipe flow, minimum pipe slope of 0.0044, and manning's coefficient of 0.014, in accordance with the City's engineering guidelines.

5.1.4 Pipelines and Pumping for Scenario 1

The four sites at or adjacent to DCTWRP (Site 1 DCT SE, Site 2 DCT SW, Site 4 Cricket Fields, and Site 5 Contractor Lay Down Area) have similar pipeline and pumping needs for Scenario 1. The pipeline needs for Sites 1, 2, 4, and 5 for Scenario 1 are shown in Figure 5-4 and described below.

Title 22 Recycled Water

For Scenario 1, the purified recycled water would be used for both GWR and NPR (See Figure 2-1). Therefore, no new pipeline or pump station is required to convey Title 22 recycled water.

Purified Recycled Water

For Scenario 1, the purified recycled water would be used for both GWR and NPR (See Figure 2-1). The existing 54-inch pipeline would be used to convey all of the purified recycled water from the AWPF located at or near DCTWRP to the HSG and the existing and planned NPR users along the way.

The existing 7 MG Recycled Water Storage Tank at VGS would be tied into the purified recycled water distribution system for NPR users. Additional operational storage and distribution system for the NPR system is assumed to be same for all site options, and, therefore, is not considered in the detailed site evaluation. The ground elevation at existing Balboa Pump Station is approximately 710 ft, and the maximum water surface elevation in the 7 MG Recycled Water Storage Tank is approximately 966 ft.

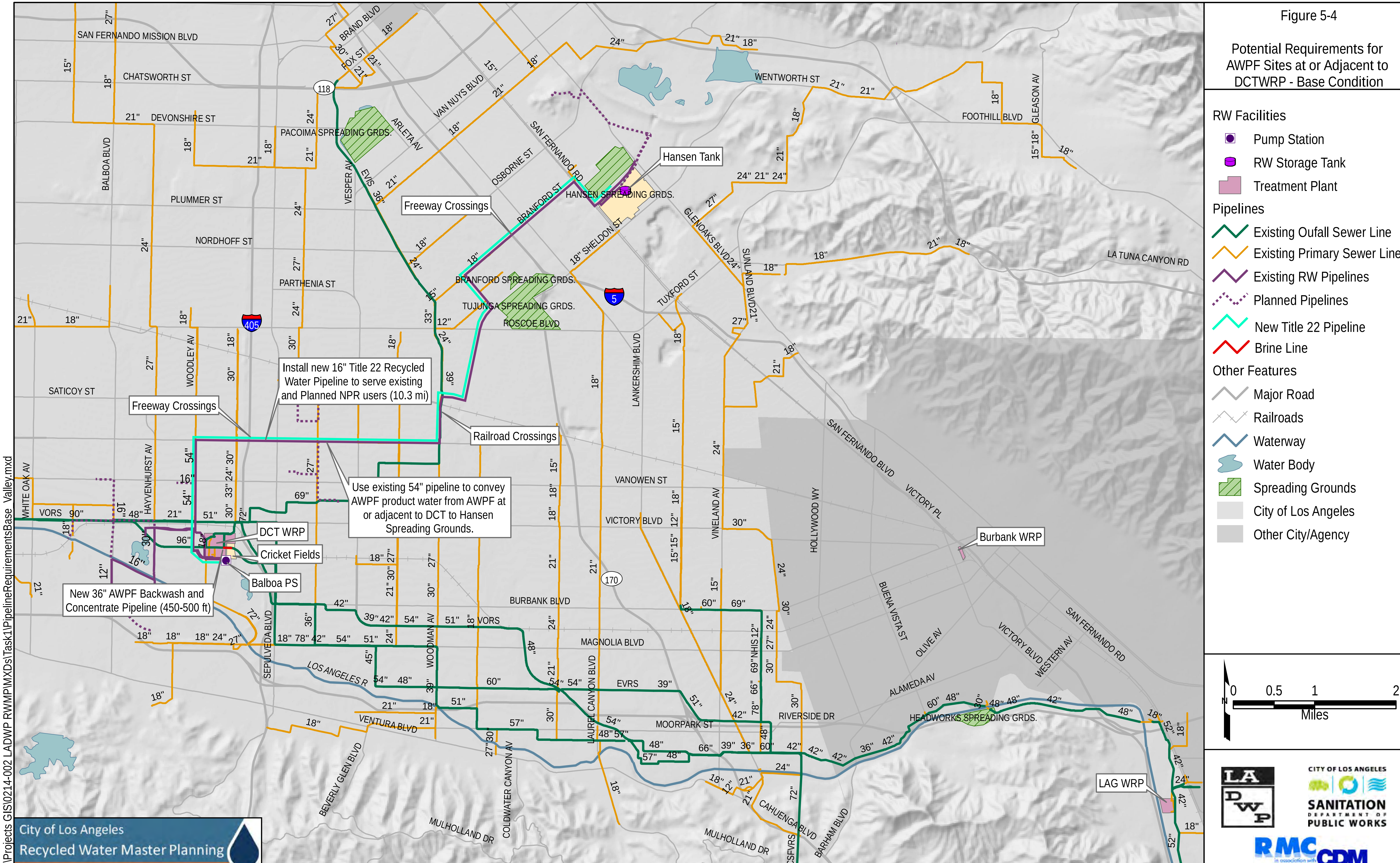
The existing Balboa Pump Station, which currently has three 1,000 hp pumps, would be expanded by adding one 800 hp pump to have a total of four pumps, three duty and one standby. The expanded Balboa Pump Station would have the capacity to pump 32.4 mgd of purified recycled water at 306 ft of TDH (256 ft of static head, and 50 ft of piping losses). On average, the expanded Balboa Pump Station would be operated to pump 31.3 mgd of purified recycled water to the HSG and the existing and planned NPR users along the way.

AWPF Backwash and Concentrate

For Scenario 1, the AWPF backwash and concentrate is assumed to discharge to the AVORS pipe to be treated at HTP. A new 450-foot, 27-inch PVC pipe would be constructed to bypass the DCTWRP into the AVORS. The new 27-inch gravity pipe is sized to convey up to 8.6 mgd of AWPF backwash and concentrate for the 32.4-mgd capacity AWPF. The 27-inch gravity pipe is sized assuming half pipe flow, minimum pipe slope of 0.0044, and manning's coefficient of 0.014, in accordance with the City's engineering guidelines.

Figure 5-4

Potential Requirements for AWPF Sites at or Adjacent to DCTWRP - Base Condition



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Data Sources: USGS, LADWP, City of Los Angeles BOS

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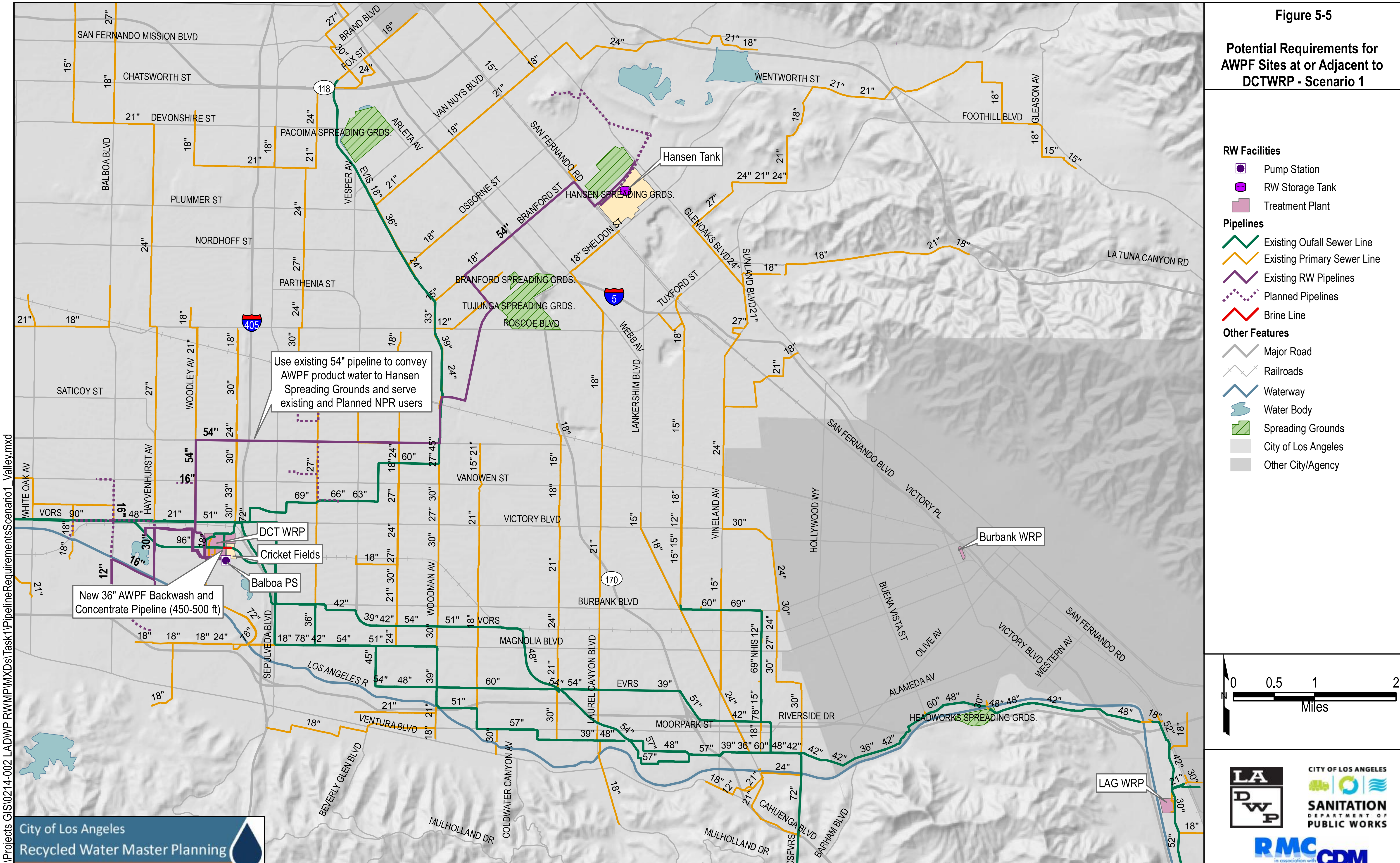

Figure 5-5

Potential Requirements for AWPF Sites at or Adjacent to DCTWRP - Scenario 1

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Data Sources: USGS, LADWP, City of Los Angeles BOS

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5.1.5 Summary

The unique features of Site 1 DCT SE, including unique features of process and ancillary facilities, and pipelines and pumping requirements, are summarized in Table 5-2 for the Base Condition and Scenario 1.

Table 5-2: Unique Features of Site 1 DCT SE for the Base Condition and Scenario 1

Base Condition	Scenario 1
Use southeast area of DCTWRP within property line	
Two-story MF/RO building	
Modify eastern half of Phase II CCB to use as MF/RO break tank and to build treatment processes on top	
Share existing DCTWRP facilities: security, fence, parking, administration building	
AWPF backwash and concentrate discharge to AVORS on-site	
Expand existing Balboa Pump Station for purified recycled water pumping (GWR only)	Expand existing Balboa Pump Station for purified recycled water pumping (GWR & NPR)
New Title 22 Pump Station and pipeline for Title 22 recycled water pumping (NPR)	--

5.1.6 Advantages and Disadvantages

The advantages and disadvantages of Site 1 DCT SE are summarized in Table 5-3. The advantages and disadvantages are summarized in terms of general advantages and disadvantages of the site, as well as the advantages and disadvantages associated with the Base Condition and Scenario 1.

Table 5-3: Advantages and Disadvantages for Site 1 DCT SE

Condition	Advantages	Disadvantages
General	• Share existing facilities with DCTWRP: security, fence, parking, administration building • Discharge flexibility if the AWPF produces off-specification water • Discharge AWPF backwash and concentrate to nearby AVORS sewer • Located within flood control berm (No additional flood control measures necessary) • Ability to expedite implementation, since it does not require a new lease agreement with USACE	• Usable space is approximately half of space available at other four sites, so would need two-story MF/RO building, and would need to modify existing Phase II CCB to build treatment processes on top • Uses space that could be available for future DCTWRP wastewater expansions • Provides the least amount of adjacent space for future AWPF expansions. • It is located within DCTWRP, near existing wastewater processes, which could possibly affect public perception of the source of AWPF
Base Condition	• Only treat GWR water at AWPF (Lower AWPF O&M costs) •	• Requires new parallel pipeline and pump station to distribute Title 22 water to NPR users
Scenario 1	• Use existing 54-inch pipeline and Balboa Pump Station to distribute purified recycled water for GWR and NPR (New parallel Title 22 pipeline and pump station not needed)	• Treat NPR recycled water to higher quality than required (Higher AWPF O&M costs and possible public perception issues for other Title 22 customers within City) •

5.2 Site 2 – DCTWRP Southwest (DCT SW)

5.2.1 General Background

The general background is same for all sites located at or adjacent to DCTWRP (Site 1 DCT SE, Site 2 DCT SW, Site 4 Cricket Fields, and Site 5 Contractor Lay Down Area). See Section 5.1.1 for general background information.

5.2.2 Proposed AWPF Site Layout

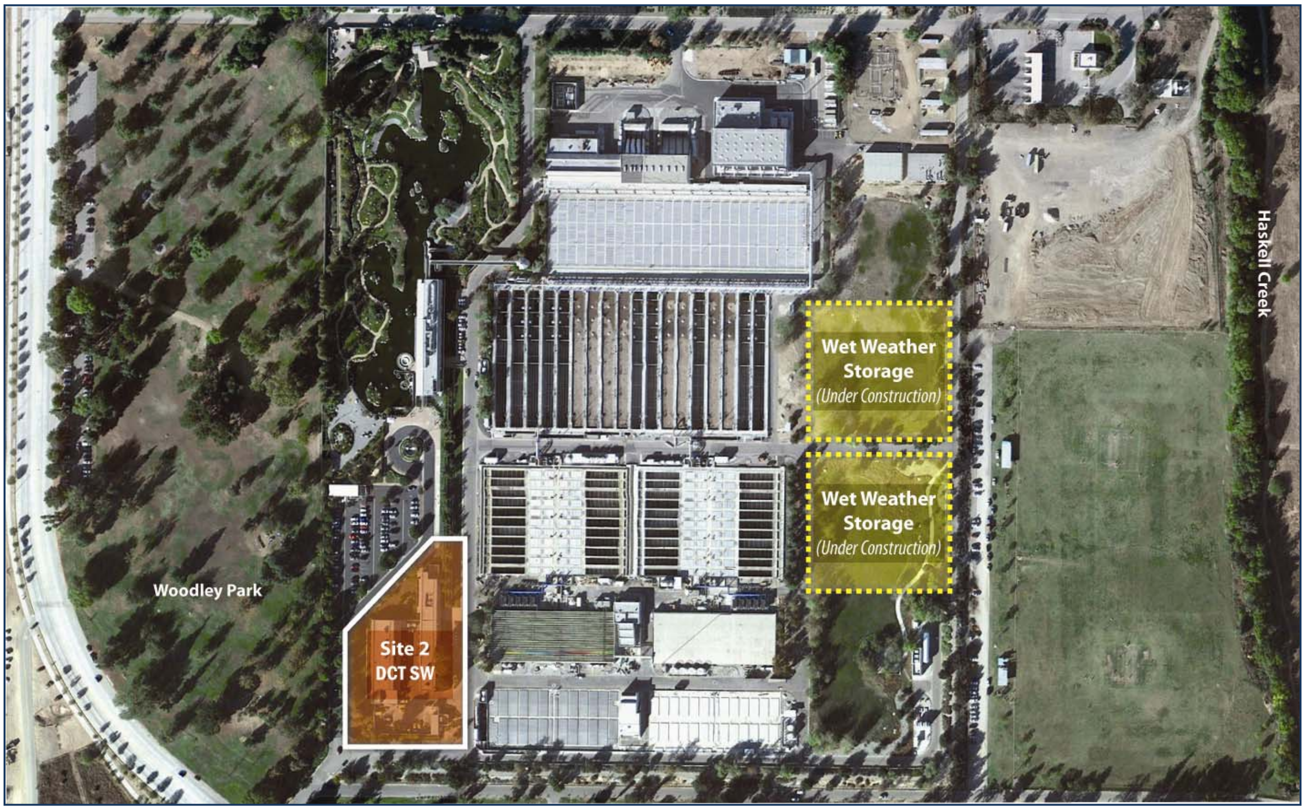
Site Boundaries

As shown in Figure 5-6, Site 2 DCT SW is located in the southwest area of DCTWRP, within the existing property line. It is bordered by the Japanese Gardens and administration building to the north, the property line to the west, and access roads to the south and east.

Available Space

The space available for the AWPF at Site 2 DCT SW is approximately ~~259,000~~ sf, approximately two times the space available at Site 1 DCT SE.

Figure 5-6: DCT SW Site Location



Process Facilities

Site 2 DCT SW requires the following design elements to fit a 40 mgd capacity AWPF in the available space.

- Construct a two-story MF/RO building to reduce the space requirement for MF and RO buildings by half. Even though Site 2 DCT SW is larger than Site 1 DCT SE, there still is not sufficient space for a single-story plant.

Ancillary Facilities and Site Features

Site 2 DCT SW requires the following site work to fit a 40 mgd capacity AWPF in the available space:

- Demolish existing maintenance building and warehouse, located west of the Phase I CCBs, and reconstruct at the northern area of DCTWRP near the blower building.

Since Site 2 DCT SW is located at DCTWRP, it is assumed that existing administration building would be shared between DCTWRP and the AWPF.

Site Layout

The preliminary site layout for Site 2 DCT SW is shown in Figure 5-7.

5.2.3 Pipelines and Pumping for Base Condition

The four sites at or adjacent to DCTWRP (Site 1 DCT SE, Site 2 DCT SW, Site 4 Cricket Fields, and Site 5 Contractor Lay Down Area) have similar pipeline and pumping needs for the Base Condition, which are shown in Figure 5-4 and described in Section 5.1.3.

5.2.4 Pipelines and Pumping for Scenario 1

The four sites at or adjacent to DCTWRP (Site 1 DCT SE, Site 2 DCT SW, Site 4 Cricket Fields, and Site 5 Contractor Lay Down Area) have similar pipeline and pumping needs for Scenario 1, which are shown in Figure 5-5 and described in Section 5.1.4.

5.2.5 Summary

The unique features of Site 2 DCT SW, including unique site features and pipelines and pumping requirements, are summarized in Table 5-4 for the Base Condition and Scenario 1.

Table 5-4: Unique Features of Site 2 DCT SW for Base Condition and Scenario 1

<table>
<tr><th>Base Condition</th><th>Scenario 1</th></tr>
<tr><td colspan="2">Use southwest area of DCTWRP partly within property line</td></tr>
<tr><td colspan="2">Two-story MF/RO building</td></tr>
<tr><td colspan="2">Demolish existing maintenance building and warehouse and reconstruct near existing blower building</td></tr>
<tr><td colspan="2">Share existing administration building with DCTWRP</td></tr>
<tr><td colspan="2">AWPF backwash and concentrate discharge to AVORS on-site</td></tr>
<tr><td>Expand existing Balboa Pump Station for purified recycled water pumping (GWR only)</td><td>Expand existing Balboa Pump Station for purified recycled water pumping (GWR & NPR)</td></tr>
<tr><td>New Title 22 Pump Station and pipeline for Title 22 recycled water pumping (NPR)</td><td>--</td></tr>
</table>

5.2.6 Advantages and Disadvantages

The advantages and disadvantages of Site 2 DCT SW are summarized in Table 5-5. The advantages and disadvantages are summarized in terms of general advantages and disadvantages of the site, as well as the advantages and disadvantages associated with the Base Condition and Scenario 1.

Table 5-5: Advantages and Disadvantages for Site 2 DCT SW

Condition	Advantages	Disadvantages
General	• Share existing administration building with DCTWRP • Discharge flexibility of AWPF procures off-specification water • Discharge AWPF backwash and concentrate to nearby AVORS sewer • Located within flood control berm (no additional flood control measures necessary) • Protects space at DCTWRP for future wastewater expansions.	• Requires demolition of existing maintenance building and warehouse and reconstruction near existing blower building
Base Condition	• Only treat GWR water at AWPF (Lower AWPF O&M costs)	• Requires new parallel pipeline and pump station to distribute Title 22 water to customers
Scenario 1	• Use existing 54-inch pipeline and Balboa Pump Station to distribute purified recycled water to Title 22 customers and for GWR (new parallel Title 22 pipeline and pump station not needed)	• Treat Title 22 water to higher quality than required (higher AWPF O&M costs and possible public perception issues for other Title 22 customers within City)

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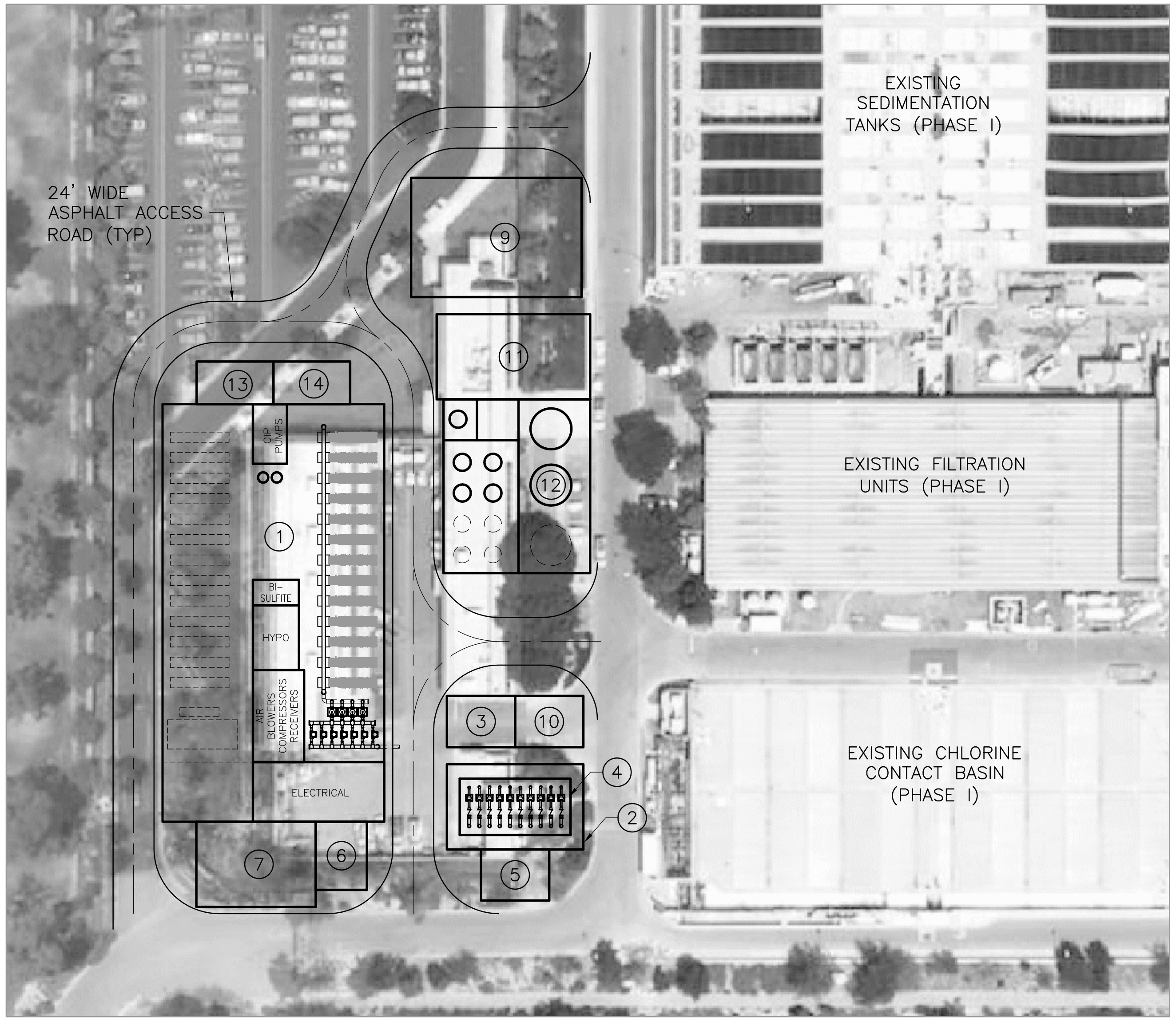
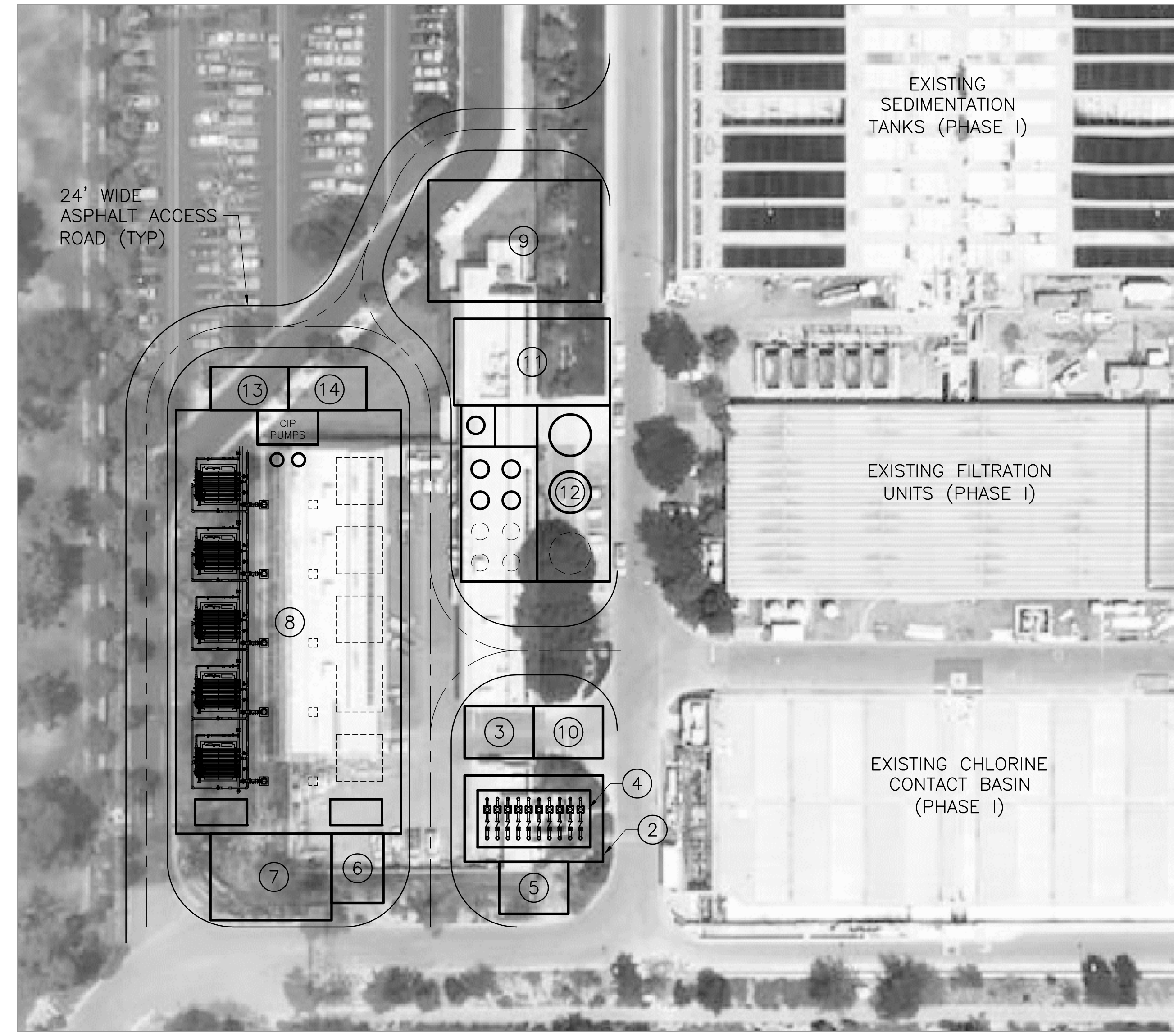


MF LEVEL

BOTTOM PLAN



RO LEVEL

TOP PLAN

LEGEND

1. MF SYSTEM (130'x245')
2. MF/RO BREAK TANK (130'x135')
3. AMMONIA (30'x40')
4. RO TRANSFER PUMPS (35'x65')
5. CARTRIDGE FILTERS (30'x40')
6. ANTI-SCALANT (30'x40')
7. SULFURIC ACID (50'x70')
8. RO SYSTEM (130'x245')
9. UV BUILDING (70'x100')
10. HYDROGEN PEROXIDE (30'x40')
11. DECARBONATORS AND RO FLUSH TANKS (50'x90')
12. LIME (85'x105')
13. CAUSTIC SODA FOR PH CONTROL AND RO CIP (25'x45')
14. CITRIC ACID (25'x45')

——— PHASE I AWTP

- - - - - PHASE II AWTP

NOTES:

1. ASSUMES 20 MGD PRODUCT WATER CAPACITY FOR PHASE I AND ADDITIONAL 20 MGD CAPACITY FOR PHASE II. FOR PRELIMINARY SITE LAYOUT REFERENCE SECTION 2.3.
2. WHERE PHASE II IS NOT SPECIFICALLY SHOWN, FACILITY IS SIZED FOR PHASE I AND PHASE II.

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APPROVED: RMC ENGR C____

CITY OF LOS ANGELES - RECYCLED WATER MASTER PLAN

FIGURE 5-7
SITE 2 - DCT SW
PRELIMINARY SITE LAYOUT

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DATE JANUARY 2010

FILENAME: Figure 5-7- DCT Site (SW) 1-11-12 02:53pm Bilderbackce || XREFS: X-LADWP-TBLK | Original Site Plan | RO_MF Bldg (DCT Opt1) | RO_MF Bldg (VGS_DCT Opt2) |<--

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5.3 Site 3 – VGS

5.3.1 General Background

VGS is located in the Sun Valley area of the City of Los Angeles. It is bounded by the HSG to the north, Sheldon Street to the south, San Fernando Road to the west, and Glenoaks Boulevard to the east. The vicinity map of VGS is shown in Figure 5-8.

VGS is currently zoned as Public Facilities. VGS is also located within an area designated as Environmental Justice Improvement Area.

VGS land is currently owned by the City of Los Angeles.

Figure 5-8: Vicinity Map of VGS

Source: Google Maps

5.3.2 Proposed AWPF Site Layout

<u>Site Boundaries</u>

As shown in Figure 5-9, Site 3 VGS is located in the northwest area of VGS, within the property line. It is bordered by the HSG to the north, an access road to the south, San Fernando Road to the west, and a gravel pit to the east.

Available Space

The space available for the AWPF at Site 3 VGS is approximately 256,000 sf, approximately two times the space available at Site 1 DCT SE.

Figure 5-9: VGS Site Location

Process Facilities

The AWPF process facilities for Site 3 VGS are similar to the AWPF process facilities for the sites at or adjacent to DCTWRP, except for the UV system.

For sites at or adjacent to DCTWRP (Site 1 DCT SE, Site 2 DCT SW, Site 4 Cricket Fields, and Site 5 Contractor Lay Down Area), DCTWRP effluent before chloramination would be used for AWPF influent, and therefore NDMA formation would not be a significant problem. For sites at or adjacent to DCTWRP, the AOP system using UV and H_2O_2 is sized assuming 1.2 log reduction of NDMA.

For Site 3 VGS, DCTWRP effluent chloraminated to meet Title 22 requirements is used for AWPF influent, since NPR users need to be served with Title 22 recycled water along the way. Therefore, higher NDMA concentrations will need to be treated with an AWPF at Site 3 VGS, for which the AOP system using UV and H_2O2 is sized assuming 1.7 log reduction (to reduce NDMA to 10 ppt) to 2.1 log reduction (to reduce NDMA to non-detect) of NDMA. The larger UV system results in higher capital cost and O&M cost for Site 3 VGS.

Other treatment options to reduce NDMA or minimize NDMA formation include: 1) sequential chlorination, and 2) chloramination using pre-form chloramines. Because these treatment options require further evaluation, for this evaluation it was assumed that existing chloramination processes at DCTWRP would continue and the NDMA reduction levels discussed above were used for the site assessment.

Ancillary Facilities and Site Features

Site 3 VGS currently has six training towers that would need to be demolished or relocated to provide space for the AWPF.

For Site 3 VGS, it is assumed that the AWPF would be an independent facility, separate from the existing power plant at VGS. Therefore, the AWPF at Site 3 VGS would be constructed with a new administration building (assumed 9,000 sf footprint), new security including a fence and a guard shack, and a new parking lot.

Site Layout

The preliminary site layout for Site 3 VGS is shown in Figure 5-10.

5.3.3 Pipelines and Pumping

For Site 3 VGS, the pipeline and pumping requirements are the same for the Base Condition and Scenario 1 (See Figure 2-1). The pipeline and pumping requirements for Site 3 VGS are shown in Figure 5-11 and described below.

Title 22 Recycled Water

For the Base Condition and Scenario 1, the Title 22 recycled water would be conveyed using the existing 54-inch pipeline from DCTWRP to the AWPF at VGS and delivered to existing and planned NPR users along the way.

The existing 7 MG Recycled Water Storage Tank (maximum water elevation of 966 ft) at VGS would be tied into the new Title 22 recycled water distribution system. Additional operational storage and distribution system for the Title 22 recycled water system is assumed to be same for all site options, and, therefore, is not considered in the detailed site evaluation. The ground elevation at existing Balboa Pump Station is approximately 710 ft, and the maximum water surface elevation in the 7 MG Recycled Water Storage Tank is approximately 966 ft.

The existing Balboa Pump Station, which currently has three 1,000 hp pumps, would be expanded by adding two 800 hp pumps to have a total of five pumps, four duty and one standby. The expanded Balboa Pump Station would have the capacity to pump up to 41 mgd of Title 22 recycled water at 330 ft of TDH (256 ft of static head, and 74 ft of piping losses).

Purified Recycled Water

For the Base Condition and Scenario 1, the purified recycled water would be conveyed from the AWPF at VGS to the nearby HSG, using a new 500-foot, 42-inch steel pipeline.

A new purified recycled water pump station would also be required to pump from the AWPF (ground elevation of 925 ft) to the HSG (maximum water level of 950 ft). The purified recycled water pump station is assumed to have four 60 hp pumps, three duty and one standby. The purified recycled water pump station would have the capacity to pump up to 30.6 mgd of purified recycled water (to be able to treat and pump more water for GWR during the winter months when NPR demands are low, See Section 2.1.2). However, on average, the purified recycled water pump station would be operated to pump 26.9 mgd to the HSG.

AWPF Backwash and Concentrate

For the Base Condition and Scenario 1, the AWPF backwash and concentrate is assumed to discharge to the Valley Outfall Relief Sewer (VORS) pipe to be treated at HTP. A new 7.4-mile, 18-inch PVC forcemain and a pump station with two 200-hp pumps (one duty and one standby) would be constructed to discharge the AWPF backwash and concentrate to VORS to bypass the LA-Glendale Water Reclamation Plant (LAGWRP).

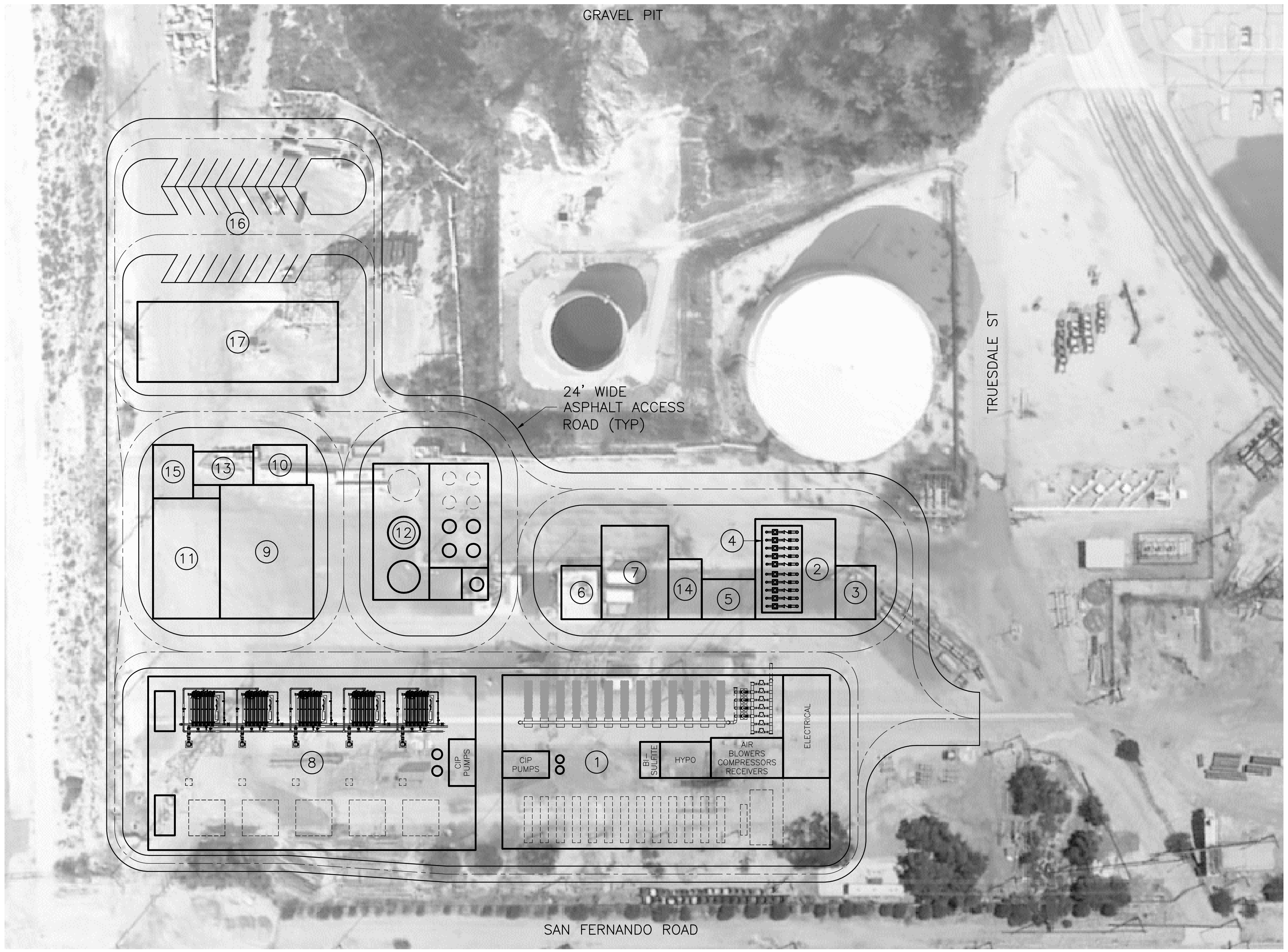
In addition to the 7.4-mile gravity pipe option, an alternate option of storing the AWPF backwash and concentrate on-site and discharging to multiple primary sewer pipelines near VGS at night during low sewer flow conditions was also investigated. This option, if determined viable, would have involved constructing a new AWPF backwash and concentrate storage tank with approximately 9 MG storage capacity, and approximately 7.2 miles of gravity pipes ranging from 15 inches to 27 inches in size to connect to four primary sewer line connection points located near VGS. However, this option was determined to not be viable, because the nearby primary sewers did not have sufficient excess capacity to accept the approximately 36 mgd of AWPF backwash and concentrate (assuming discharging 9 MG over six hours at night).

5.3.4 Summary

The unique features of Site 3 VGS, including unique features of process and ancillary facilities, and pipelines and pumping requirements, are summarized in Table 5-6 for the Base Condition and Scenario 1.

Table 5-6: Unique Features of Site 3 VGS for the Base Condition and Scenario 1

Base Condition and Scenario 1
Larger UV system than the other four site at or near DCTWRP
Use training towers area (northwest of VGS site)
AWPF separate from VGS power plant: new administration building, site security, fence, and parking
Expand existing Balboa Pump Station for Title 22 recycled water pumping (AWPF influent and NPR distribution)
New Purified Recycled Water Pump Station at VGS
New AWPF backwash and concentrate pipeline to connect to VORS to bypass LAGWRP



LEGEND

1. MF SYSTEM (130'x245')
2. MF/RO BREAK TANK (130'x135')
3. AMMONIA (30'x40')
4. RO TRANSFER PUMPS (35'x65')
5. CARTRIDGE FILTERS (30'x40')
6. ANTI-SCALANT (30'x40')
7. SULFURIC ACID (50'x70')
8. RO SYSTEM (130'x245')
9. UV BUILDING (70'x100')
10. HYDROGEN PEROXIDE (30'x40')
11. DECARBONATORS AND RO FLUSH TANKS (50'x90')
12. LIME (85'x105')
13. CAUSTIC SODA FOR PH CONTROL AND RO CIP (25'x45')
14. CITRIC ACID (25'x45')
15. FINISH WATER PUMP STATION (20'x30')
16. PARKING (30 SPACES)
17. LAB AND OPERATIONS BUILDING (60'x150')

——— PHASE I AWTP

- - - - PHASE II AWTP

NOTES:

1. ASSUMES 20 MGD PRODUCT WATER CAPACITY FOR PHASE I AND ADDITIONAL 20 MGD CAPACITY FOR PHASE II. FOR PRELIMINARY SITE LAYOUT REFERENCE SECTION 2.3.
2. WHERE PHASE II IS NOT SPECIFICALLY SHOWN, FACILITY IS SIZED FOR PHASE I AND PHASE II.

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APPROVED: RMC ENGR C

CITY OF LOS ANGELES - RECYCLED WATER MASTER PLAN

FIGURE 5-10
SITE 3 - VGS
PRELIMINARY SITE LAYOUT

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DATE JANUARY 2010

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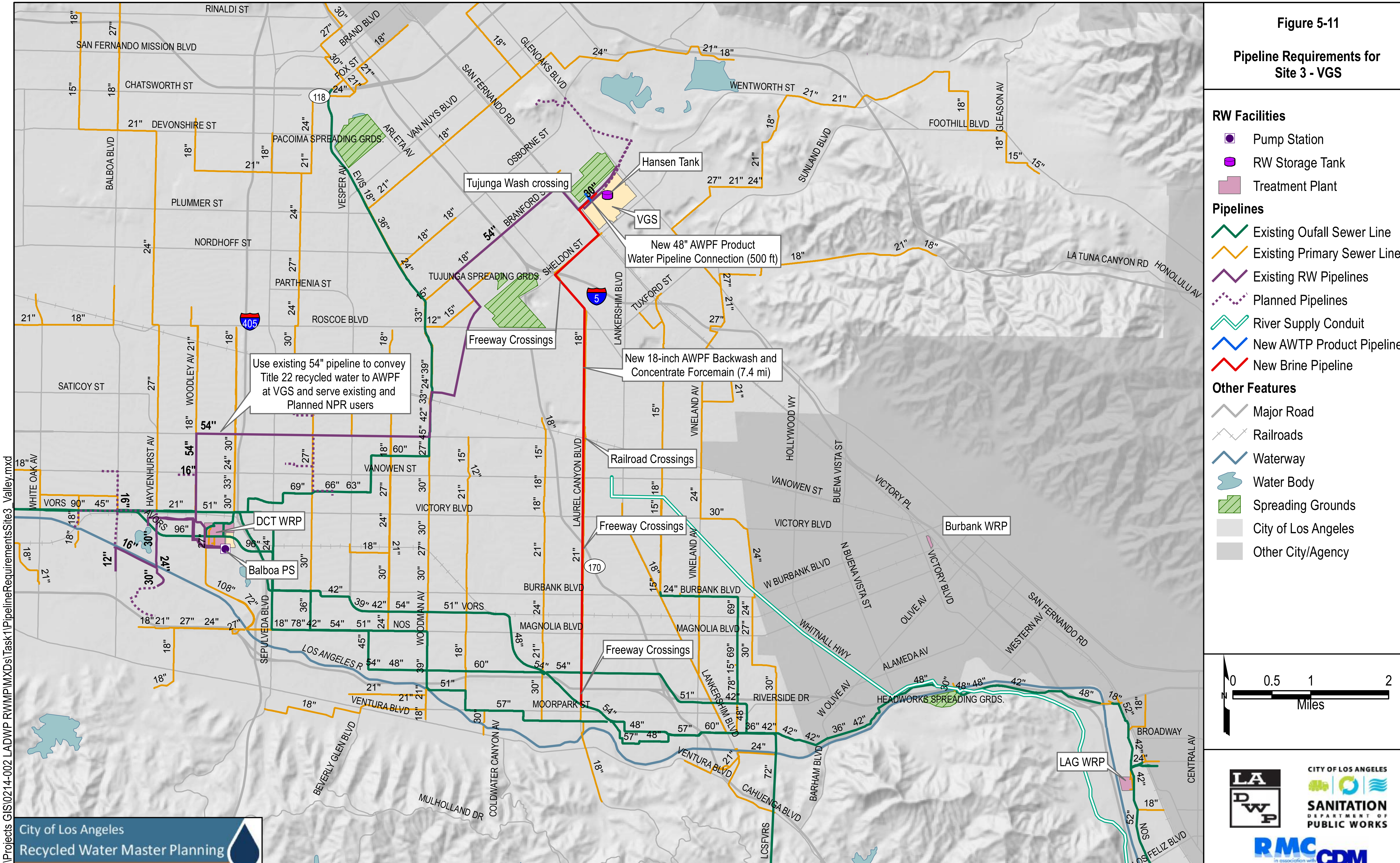

Figure 5-11

Pipeline Requirements for Site 3 - VGS

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Data Sources: USGS, LADWP, City of Los Angeles BOS

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5.3.5 Advantages and Disadvantages

The advantages and disadvantages of Site 3 VGS are summarized in Table 5-7. The advantages and disadvantages are summarized in terms of general advantages and disadvantages of the site, as well as the advantages and disadvantages associated with the Base Condition and Scenario 1 (which are the same for VGS).

Table 5-7: Advantages and Disadvantages for Site 3 VGS

Condition	Advantages	Disadvantages
General	• Close proximity to HSG • Protects space at DCTWRP for future wastewater expansions • Provide space for future AWPF expansions • Physically separated from DCTWRP (Public perception)	• Need security, fence, parking, administration building • Requires demolition of existing training towers and installation of new towers at a different location • Requires larger UV system due to higher NDMA formation (results in higher capital and the highest O&M cost) • Reduced discharge flexibility if the AWPF produces off-specification water • Highest relative greenhouse gas emissions due to the larger UV size • Located in an Environmental Justice Area
Base Condition and Scenario 1	• Use existing 54-inch pipeline and Balboa Pump Station for Title 22 recycled water pumping (for AWPF influent and NPR distribution)	• Requires New 7.4-mile AWPF backwash and concentrate pipeline

5.4 Site 4 – Cricket Fields

5.4.1 General Background

Site 4 Cricket Fields is located to the east of the DCTWRP. See Section 5.1.1 for general background information.

Site 4 Cricket Fields consists of a large open space with turf, currently being used as cricket fields by the local Cricket teams. The cricket fields were built in the late 1970s to early 1980s as a replacement for the cricket fields in Griffith Park, which were demolished to build the 1984

Summer Olympics Equestrian Center. They are owned by the USACE and are operated by the City of Los Angeles Department of Recreation and Parks. The local Cricket teams practice during the weekdays and have organized games during the weekends. There are no lights on the Cricket Fields so use is limited to daytime only.

Site 4 Cricket Fields is located within the Sepulveda Flood Control Basin, which has the 100-year flood elevation of 712 ft. The average ground elevation at Site 4 Cricket Fields is approximately 704 ft.

5.4.2 Proposed AWPF Site Layout

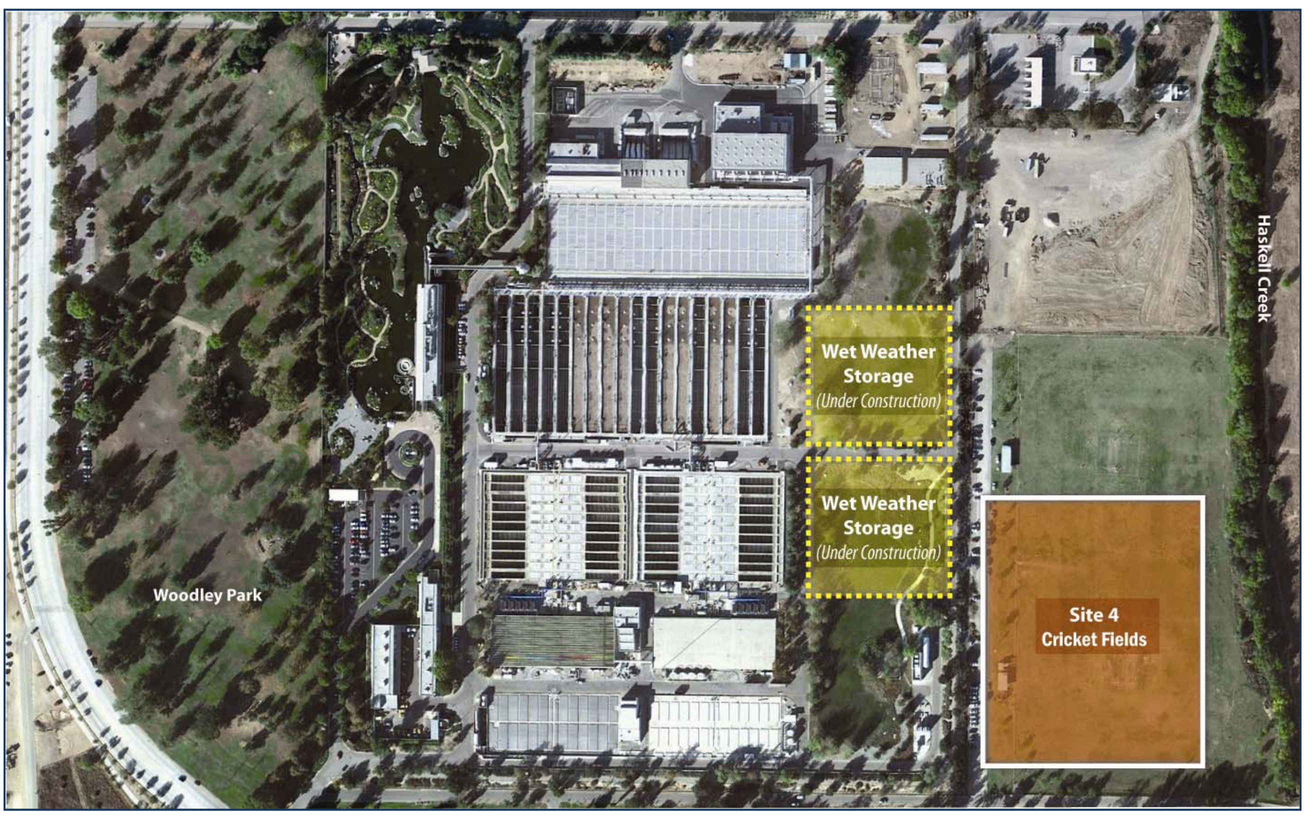
Site Boundaries

As shown in Figure 5-12, Site 4 Cricket Fields is located on the east side of DCTWRP, beyond the property line. It is bordered by DCTWRP septage intake area to the north, Woodley Park to the south, DCTWRP Balboa Pump Station to the west, and the Sepulveda Wildlife Area to the east.

Available Space

The two cricket fields have a combined area of 500,000 sf. However, only the southern half of the cricket fields needs to be used for the AWPF. The space used for the AWPF at Site 4 Cricket Fields, as shown in Figure 5-12, is 328,000 sf.

Figure 5-12: Cricket Fields Site Location



Process Facilities

Site 4 Cricket Fields has sufficient space and does not require unique features for process facilities.

Ancillary Facilities and Site Features

The two cricket fields would need to be removed to provide space for the AWPF. Therefore, new land needs to be purchased or leased by the City to replace the two cricket fields. Approximately 11.5 acres (500,000 sf) of new land would be required to replace the two cricket fields.

Since Site 4 Cricket Fields is located within the Sepulveda Flood Control Basin and the average ground elevation is lower than the 100-year flood elevation of 712 ft, the site requires the following design elements:

- Raise the overall site grade by 8 ft (from average ground elevation of 704 ft to the 100-year flood elevation of 712 ft), or construct a berm (approximately 10 ft tall to have a minimum of 2 ft freeboard above the 100-year flood elevation) on the perimeter of the AWPF site.
- Excavate additional flood water storage volume off-site in the Sepulveda Flood Control Basin to compensate for the storage volume lost when raising the site grade or constructing a berm around Site 4 Cricket Fields.

In addition, it is assumed that new fence and parking would be provided since Site 4 Cricket Fields is located outside of the existing DCTWRP property line. However, since Site 4 Cricket Fields is located close to DCTWRP, it is assumed that the existing administration building would be shared between DCTWRP and the AWPF.

Site Layout

The preliminary site layout for Site 4 Cricket Fields is shown in Figure 5-13.

5.4.3 Pipelines and Pumping for Base Condition

The four sites at or adjacent to DCTWRP (Site 1 DCT SE, Site 2 DCT SW, Site 4 Cricket Fields, and Site 5 Contractor Lay Down Area) have similar pipeline and pumping needs for the Base Condition, which are shown in Figure 5-4, and described in Section 5.1.3.

5.4.4 Pipelines and Pumping for Scenario 1

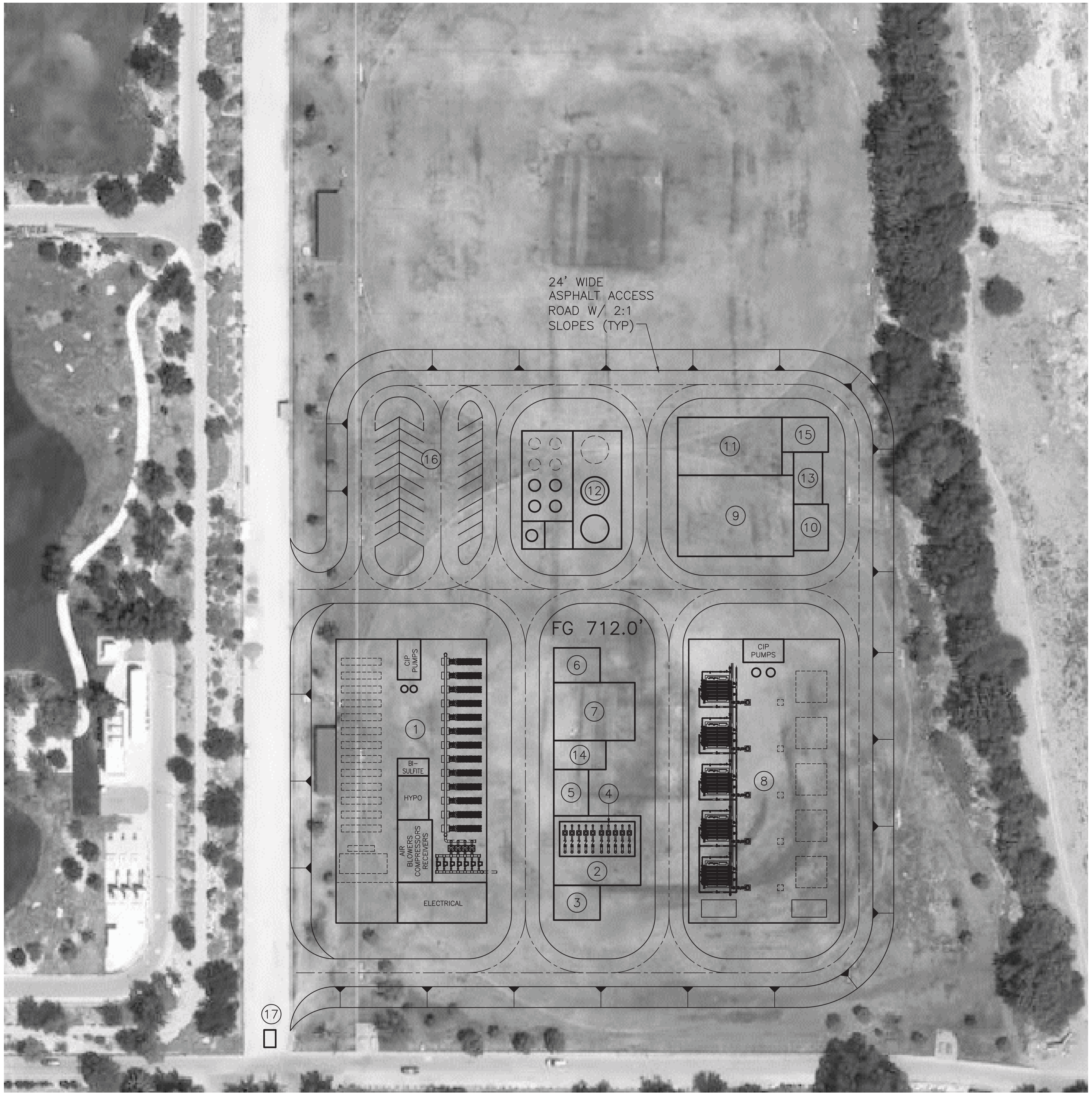
The four sites at or adjacent to DCTWRP (Site 1 DCT SE, Site 2 DCT SW, Site 4 Cricket Fields, and Site 5 Contractor Lay Down Area) have similar pipeline and pumping needs for Scenario 1, which are shown in Figure 5-5, and described in Section 5.1.4.

5.4.5 Summary

The unique features of Site 4 Cricket Fields, including unique site features and pipeline and pumping requirements, are summarized in Table 5-8 for the Base Condition and Scenario 1.

Table 5-8: Unique Features of Site 4 Cricket Fields for Base Condition and Scenario 1

Base Condition	Scenario 1
Lease land from USACE and use southern half of cricket fields	
Purchase new land to relocate cricket fields	
Raise site grade or construct a berm for 100-year flood	
Compensate for flood water storage volume off-site	
Share existing DCTWRP facilities: security, administration building	
Install new fence and parking	
AWPF backwash and concentrate discharge to AVORS on-site	
Expand existing Balboa Pump Station for purified recycled water pumping (GWR only)	Expand existing Balboa Pump Station for purified recycled water pumping (GWR & NPR)
New Title 22 Pump Station and pipeline for Title 22 recycled water pumping (NPR)	--



LEGEND

1. MF SYSTEM (130'x245')
2. MF/RO BREAK TANK (130'x135')
3. AMMONIA (30'x40')
4. RO TRANSFER PUMPS (35'x65')
5. CARTRIDGE FILTERS (30'x40')
6. ANTI-SCALANT (30'x40')
7. SULFURIC ACID (50'x70')
8. RO SYSTEM (130'x245')
9. UV BUILDING (70'x100')
10. HYDROGEN PEROXIDE (30'x40')
11. DECARBONATORS AND RO FLUSH TANKS (50'x90')
12. LIME (85'x105')
13. CAUSTIC SODA FOR PH CONTROL AND RO CIP (25'x45')
14. CITRIC ACID (25'x45')
15. FINISH WATER PUMP STATION (20'x30')
16. PARKING (30 SPACES)
17. GUARD SHACK (10'x15')

——— PHASE I AWTP

- - - - - PHASE II AWTP

NOTES:

1. ASSUMES 20 MGD PRODUCT WATER CAPACITY FOR PHASE I AND ADDITIONAL 20 MGD CAPACITY FOR PHASE II. FOR PRELIMINARY SITE LAYOUT REFERENCE SECTION 2.3.
2. WHERE PHASE II IS NOT SPECIFICALLY SHOWN, FACILITY IS SIZED FOR PHASE I AND PHASE II.

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CITY OF LOS ANGELES - RECYCLED WATER MASTER PLAN

FIGURE 5-13
SITE 4 - CRICKET FIELD
PRELIMINARY SITE LAYOUT

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5.4.6 Advantages and Disadvantages

The advantages and disadvantages of Site 4 Cricket Fields are summarized in Table 5-9. The advantages and disadvantages are summarized in terms of general advantages and disadvantages of the site, as well as the advantages and disadvantages associated with the Base Condition and Scenario 1.

Table 5-9: Advantages and Disadvantages for Site 4 Cricket Fields

Condition	Advantages	Disadvantages
General	• Share existing administration building with DCTWRP • Discharge flexibility if the AWPF produces off-specification water • Discharge AWPF backwash and concentrate to nearby AVORS sewer • Provides space for future AWPF expansions	• Requires negotiating lease agreement from USACE • Requires purchasing land for building new Cricket Fields • Requires raising site to 100-year flood elevation and compensating for flood storage volume off site • Requires new fence and parking
Base Condition	• Only treat GWR water at AWPF (lower AWPF O&M costs)	• Requires new parallel pipeline and pump station to distribute Title 22 water to customers
Scenario 1	• Use existing 54-inch pipeline and Balboa Pump Station to distribute purified recycled water to Title 22 customers and for GWR (New parallel Title 22 pipeline and pump station not needed)	• Treat Title 22 water to higher quality than required (higher AWPF O&M costs and possible public perception issues for other Title 22 customers within City)

5.5 Site 5 – Contractor Lay Down Area

5.5.1 General Background

Site 5 Contractor Lay Down Area is located to the east of the DCTWRP, south of the DCTWRP Septage Receiving Facility. See Section 5.1.1 for general background information.

Site 5 Contractor Lay Down Area is currently leased by BOS from the USACE, and used by DCTWRP contractors as a staging area for trucks and construction equipment. Site 5 Contractor Lay Down Area is located within the Sepulveda Flood Control Basin, which has the 100-year flood elevation of 712 ft. The ground elevation at Site 5 Contractor Lay Down Area ranges from 710 ft to 714 ft.

5.5.2 Proposed AWPF Site Layout

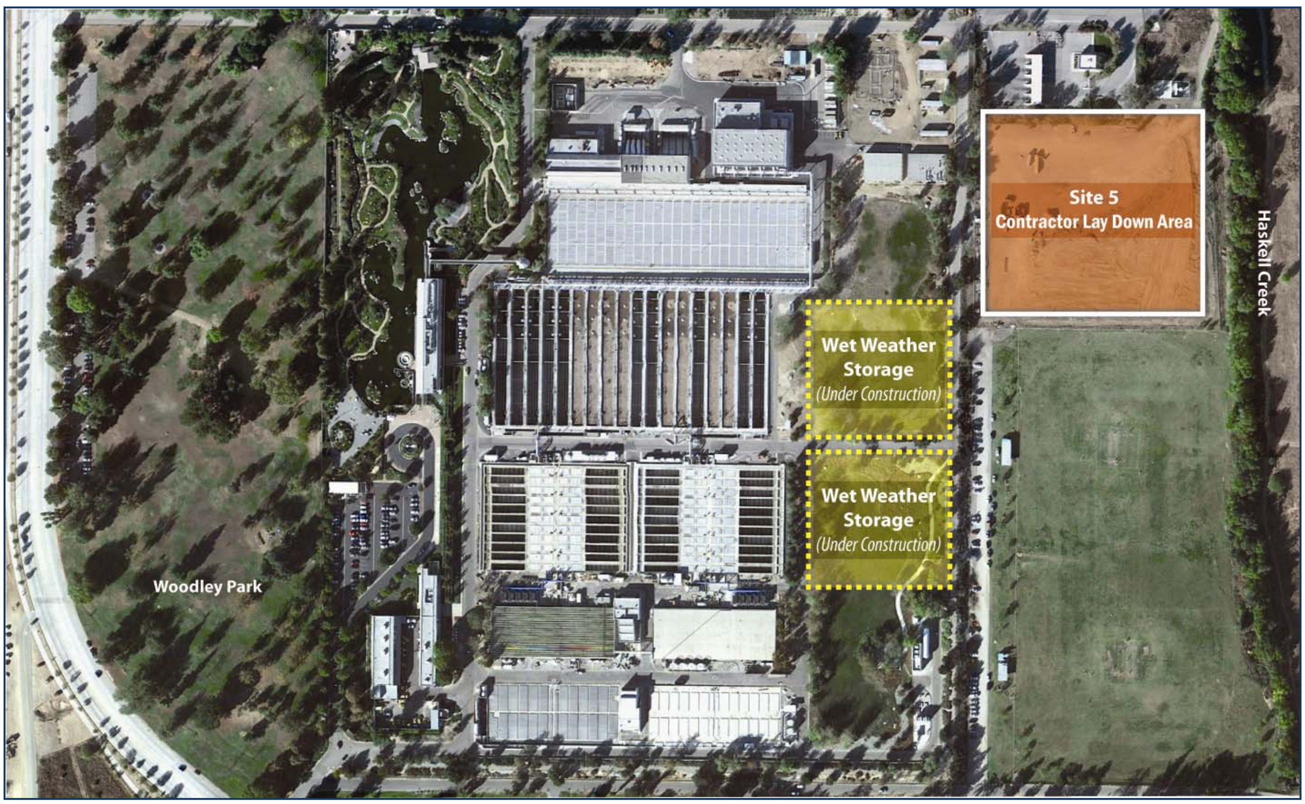
Site Boundaries

As shown in Figure 5-14, Site 5 Contractor Lay Down Area is located on the east side of DCTWRP, beyond the property line. It is bordered by DCTWRP on the north and west, the Cricket Fields to the south, and the Sepulveda Wildlife Area to the east.

Available Space

The space available for the AWPF at Site 5 Contractor Lay Down Area is 240,000 sf.

Figure 5-14: Contractor Lay Down Area Site Location



Process Facilities

Site 5 Contractor Lay Down Area does not require unique features for process facilities.

Ancillary Facilities and Site Features

Since Site 5 Contractor Lay Down Area is located within the Sepulveda Flood Control Basin and some areas of the site are lower than the 100-year flood elevation of 712 ft, the site requires the following design elements:

- Raise the overall site grade by up to 2 ft (from minimum ground elevation of 710 ft to the 100-year flood elevation of 712-ft), or construct a berm (approximately 4 ft tall to have a minimum of 2 ft freeboard above the 100-year flood elevation) on the perimeter of the AWPF site.
- Excavate additional flood water storage volume off-site in the Sepulveda Flood Control Basin to compensate for the storage volume lost when raising the site grade or building a berm around Site 5 Contractor Lay Down Area.

In addition, it is assumed that new fence and parking would be provided since Site 5 Contractor Lay Down Area is located outside of the existing DCTWRP property line. However, since Site 5 Contractor Lay Down Area is located close to DCTWRP, it is assumed that the existing administration building would be shared between DCTWRP and the AWPF.

Site Layout

The preliminary site layout for Site 5 Contractor Lay Down Area is shown in Figure 5-15.

5.5.3 Pipelines and Pumping for Base Condition

The four sites at or adjacent to DCTWRP (Site 1 DCT SE, Site 2 DCT SW, Site 4 Cricket Fields, and Site 5 Contractor Lay Down Area) have similar pipeline and pumping needs for the Base Condition, which are shown in Figure 5-4, and described in Section 5.1.3.

For Site 5 Contractor Lay Down Area, the estimated length of the 27-inch AWPF backwash and concentrate pipeline is 500 feet, rather than 450 feet.

5.5.4 Pipelines and Pumping for Scenario 1

The four sites at or adjacent to DCTWRP (Site 1 DCT SE, Site 2 DCT SW, Site 4 Cricket Fields, and Site 5 Contractor Lay Down Area) have similar pipeline and pumping needs for Scenario 1, which are shown in Figure 5-5, and described in Section 5.1.4.

For Site 5 Contractor Lay Down Area, the estimated length of the 27-inch AWPF backwash and concentrate pipeline is 500 feet, rather than 450 feet.

5.5.5 Summary

The unique features of Site 5 Contractor Lay Down Area, including unique site features and pipeline and pumping requirements are summarized in Table 5-10 for the Base Condition and Scenario 1.

Table 5-10: Unique Features of Site 5 Contractor Lay Down Area for Base Condition and Scenario 1

Base Condition	Scenario 1
Use area north of Cricket Fields	
Raise site elevation or construct berm for 100-year flood	
Compensate for flood water storage volume off-site	
Share existing DCTWRP facilities: security, administration building	
Install new fence and parking	
AWPF backwash and concentrate discharge to AVORS on-site	
Expand existing Balboa Pump Station for purified recycled water pumping (GWR only)	Expand existing Balboa Pump Station for purified recycled water pumping (GWR & NPR)
New Title 22 pump station and pipeline for Title 22 recycled water pumping (NPR)	--

5.5.6 Advantages and Disadvantages

The advantages and disadvantages of Site 5 Contractor Lay Down Area are summarized in Table 5-11. The advantages and disadvantages are summarized in terms of general advantages and disadvantages of the site, as well as the advantages and disadvantages associated with the Base Condition and Scenario 1.

Table 5-11: Advantages and Disadvantages for Site 5 Contractor Lay Down Area

Condition	Advantages	Disadvantages
General	• Share existing facilities with DCTWRP: parking and administration building • Discharge flexibility if the AWPF produces off-specification water • Discharge AWPF backwash and concentrate to nearby AVORS sewer • Protects space at DCTWRP for future wastewater expansions • Provides space for future AWPF expansions	• Requires negotiating lease agreement with USACE • Requires new security and fence • Requires raising site to 100-year flood elevation and compensating for flood storage volume off site • Adjacent to DCTWRP's Septage Receiving Facility (Potential intermittent odor issues)
Base Condition	• Only treat GWR water at AWPF (Lower AWPF O&M costs)	• Requires new parallel pipeline and pump station to distribute Title 22 water to customers
Scenario 1	• Use existing 54-inch pipeline and Balboa Pump Station to distribute purified recycled water to Title 22 customers and for GWR (New parallel Title 22 pipeline and pump station not needed)	• Treat Title 22 water to higher quality than required (Higher AWPF O&M costs and possible public perception issues for other Title 22 customers within City)

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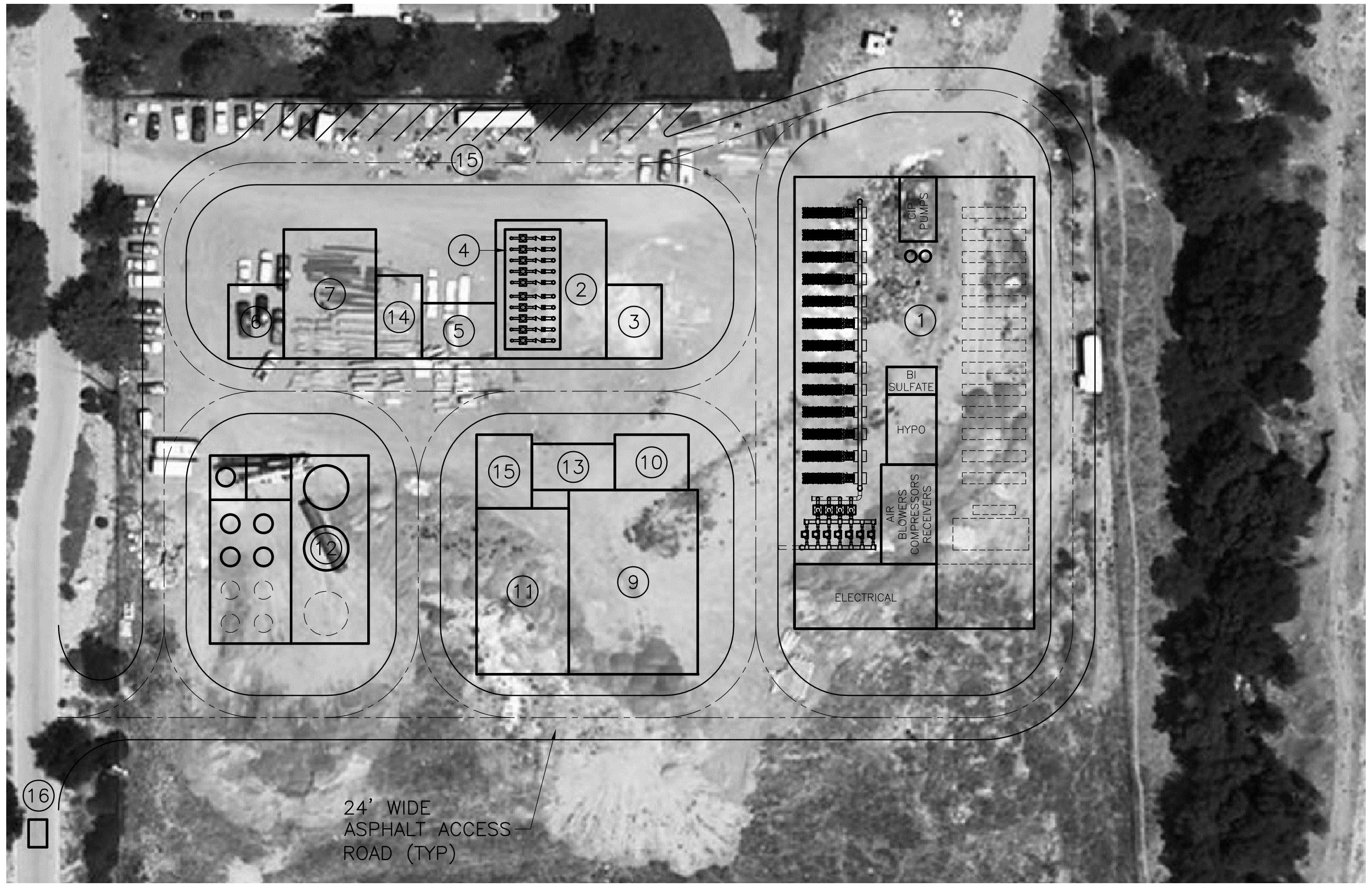
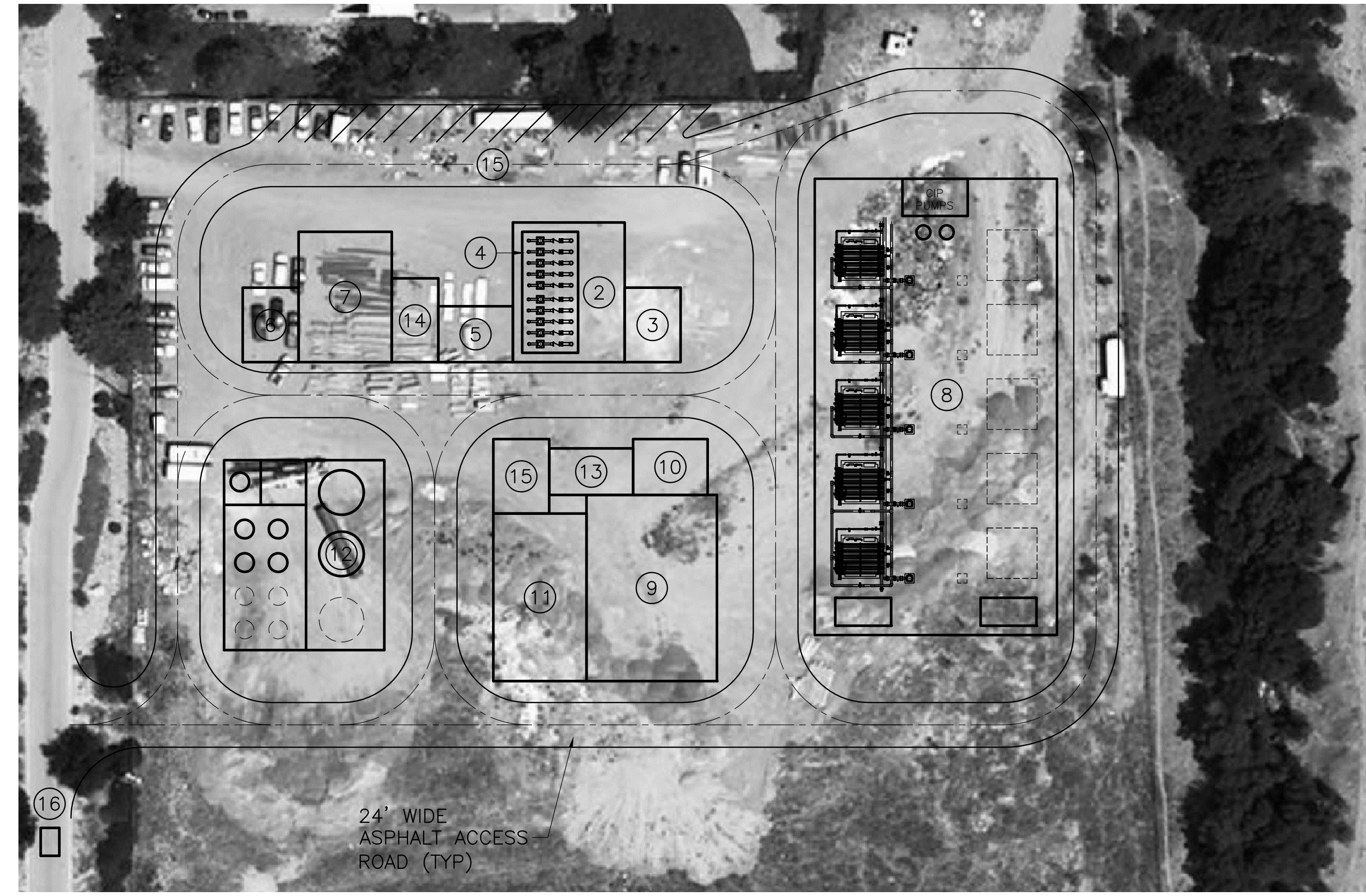


MF LEVEL

BOTTOM PLAN



RO LEVEL

TOP PLAN

LEGEND

1. MF SYSTEM (130'x245')
2. MF/RO BREAK TANK (130'x135')
3. AMMONIA (30'x40')
4. RO TRANSFER PUMPS (35'x65')
5. CARTRIDGE FILTERS (30'x40')
6. ANTI-SCALANT (30'x40')
7. SULFURIC ACID (50'x70')
8. RO SYSTEM (130'x245')
9. UV BUILDING (70'x100')
10. HYDROGEN PEROXIDE (30'x40')
11. DECARBONATORS AND RO FLUSH TANKS (50'x90')
12. LIME (85'x105')
13. CAUSTIC SODA FOR PH CONTROL AND RO CIP (25'x45')
14. CITRIC ACID (25'x45')
15. PARKING (16 SPACES)
16. GUARD SHACK (10'x15')

——— PHASE I AWTP

- - - - - PHASE II AWTP

NOTES:

1. ASSUMES 20 MGD PRODUCT WATER CAPACITY FOR PHASE I AND ADDITIONAL 20 MGD CAPACITY FOR PHASE II. FOR PRELIMINARY SITE LAYOUT REFERENCE SECTION 2.3.
2. WHERE PHASE II IS NOT SPECIFICALLY SHOWN, FACILITY IS SIZED FOR PHASE I AND PHASE II.

N

1" = 50'

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VERIFY SCALES
BAR IS ONE INCH LONG ON FULL SIZE DRAWING. IF NOT ONE INCH LONG ON THIS DRAWING, ADJUST SCALES ACCORDINGLY

RMC in association with CDM

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CHECKED

SUBMITTED: RMC PROJ ENGR C____
APPROVED: RMC ENGR C____

CITY OF LOS ANGELES - RECYCLED WATER MASTER PLAN

FIGURE 5-15
SITE 5 - CONTRACTOR LAY DOWN AREA
PRELIMINARY SITE LAYOUT

DWG NO
SHEET NO OF .
PROJ NO 0000-000
DATE JANUARY 2010

FILENAME: FIGURE 5-15- LAYDOWN AREA 1-11-12 02:49pm Bilderbackce || XREFS: X-LADWP-TBLK | RO_MF Bldg (DCT Opt1) |<<--

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6. Detailed Site Evaluation

This section describes the performance measure scores for each objective and evaluation criteria identified and weighted in Section 3. The performance measure scores are determined based on planning-level analysis, and modified based on the input from the City.

The planning-level analysis is performed for both the Base Condition and Scenario 1, described in Section 2.1, and includes: AWPF site layout design, pipeline and pumping requirements evaluation, capital cost and O&M cost estimates, wastewater system benefits, operational flexibility, habitat impacts, GHG emissions, institutional partnership, permitting process complexity, ability to expedite implementation, economic benefits, environmental justice, job creation, geotechnical review, expansion capability, and opportunities to maximize reuse.

The performance measure scores, summarized in Section 6.7, are used as inputs for decision modeling, the results of which are discussed in Section 7.

6.1 Objective 1 – Promote Cost Efficiency

Objective 1 Promote Cost Efficiency is measured in terms of capital cost and O&M cost, as described in Section 3.2.2. The capital cost is discussed for each site in Section 6.1.1 and O&M cost is discussed for each site in Section 6.1.2. The details of the capital cost estimates are included in Appendix B.1, and the O&M cost estimates in Appendix B.2.

6.1.1 Capital Cost

The AWPF capital cost assumptions are described in Section 2.1.4. The capital cost estimate for each site includes the base cost for the AWPF, and incremental costs for process facilities, ancillary facilities, and site features unique to each site. The cost for conveyance pipelines and pumping requirements for Title 22 recycled water, AWPF influent water, purified recycled water, and AWPF backwash and concentrate are also included as incremental costs. The descriptions of the unique features of each site are described in Section 5.

AWPF Base Cost

The base cost for the AWPF is derived from the capital cost estimate presented in the "Tillman Advanced Treatment System Basis of Design Criteria and Cost Estimate TM", dated June 27, 2006, and prepared by CH:CDM Smith as part of the Phase II Integrated Resources Plan for the Wastewater Program. In the Tillman Advanced Treatment System Basis of Design Criteria and Cost Estimate TM, the capital cost of a 15.6 mgd production capacity AWPF was estimated to be $92.6 million, including 30 percent contingency, in December 2005 costs. This capital cost estimate is escalated to January 2011 cost using Engineering News Record (ENR) construction cost index (CCI) for Los Angeles, CA, and then scaled to a 30.6 mgd product capacity AWPF for the DCT sites for the Base Condition and the VGS site for the Base Condition and Scenario 1, and scaled to 32.4 mgd for the DCT sites for Scenario 1. The ENR CCI for Los Angeles, CA, is 8567.42 for December 2005 and 10000.3 for January 2011. The base cost for a 30.6 mgd production capacity AWPF is $212 million, including 30 percent contingency only, and $276 million, including 30 percent contingency and 30 percent implementation, in January 2011 costs.

The base cost for a 32.4 mgd production capacity AWPF is $225 million, including 30 percent contingency only, and $292 million, including 30 percent contingency and 30 percent implementation, in January 2011 costs.

Incremental Costs Common for Base Condition and Scenario 1

Incremental costs for the unique features of each site, described in detail in Section 5, are estimated and used to differentiate the five sites. The incremental costs common for the Base Condition and Scenario 1 include:

- Site 1 DCT SE (Reference Section 5.1.2)
    - Additional cost required to construct a two-story MF/RO building in lieu of two single-story buildings (i.e., Cost of a two-story building minus the cost of two single-story buildings) is added. It is assumed that the cost of two single-story buildings for MF and RO systems is included in the AWPF base cost.
    - Additional cost required to modify the eastern half of the Phase II CCB to use as the MF/RO break tank and to build process facilities on top (i.e., cost of CCB modifications minus the cost of MF/RO break tank) is added. It is assumed that the cost of MF/RO break tank is included in the AWPF base cost.
- Site 2 DCT SW (Reference Section 5.2.2)
    - Additional cost required to construct a two-story MF/RO building in lieu of two single-story buildings (i.e., Cost of a two-story building minus the cost of two single-story buildings).
    - Cost to demolish existing maintenance and warehouse buildings to provide space for the AWPF.
    - Cost to construct new maintenance and warehouse buildings at the northern end of DCTWRP.
- Site 3 VGS (Reference Section 5.3.2)
    - Cost to add new fence, security gate, parking, and administration buildings.
    - Additional cost required to construct a larger UV system for higher NDMA reduction (i.e., cost of UV system sized for 1.7-log reduction of NDMA minus the cost of the UV system sized for 1.2-log reduction of NDMA) is added. It is assumed that the cost of the UV system sized for 1.2-log reduction is included in AWPF base cost.
- Site 4 Cricket Fields (Reference Section 5.4.2)
    - Cost to add new parking, fence and site security.
    - Cost to purchase new land within the City to relocate existing two cricket fields (11.5 acres). Assumed approximate land purchase price of $3 million per acre, based on recent sales record of vacant properties in the San Fernando Valley (www.loopnet.com).
    - Cost to raise overall site grade to the 100-year flood elevation of 712 ft. Assumed raising the site grade by 8 ft (from average ground elevation of 704 ft to the 100-year flood elevation of 712 ft) for approximately 313,000 sf area.

  - Cost to excavate additional flood water storage volume off-site in the Sepulveda Flood Control Basin to compensate for the storage volume lost when raising the site. Assumed excavation volume of approximately 93,000 cubic yards (cy).
- Site 5 Contractor Lay Down Area (Reference Section 5.5.2)
  - Cost to add new parking, fence and site security.
  - Cost to raise overall site grade to the 100-year flood elevation of 712 ft. Assumed raising the site grade by up to 2 ft (from average ground elevation of 704 ft to the 100-year flood elevation of 712 ft).
  - Cost to excavate additional flood water storage volume off-site in the Sepulveda Flood Control Basin to compensate for the storage volume lost when raising the site. Assumed excavation volume of approximately 8,900 cy, equivalent to the storage volume lost when half of the site (120,000 sf) is raised by 2 ft.

Incremental Costs for Conveyance Pipelines and Pumping Requirements for Base Condition

The cost for conveyance pipelines and pumping requirements for Title 22 recycled water, AWPF influent water, purified recycled water, and AWPF backwash and concentrate are also included as incremental costs. The conveyance pipelines and pumping requirements for the Base Condition include:

- Sites at or adjacent to DCTWRP (Site 1 DCT SE, Site 2 DCT SW, Site 4 Cricket Fields, and Site 5 Contractor Lay Down Area) (Reference Section 5.1.3)
  - Cost to expand Balboa Pump Station by adding one 800 hp pump for purified recycled water pumping to HSG. The expanded Balboa Pump Station would have a total of four pumps (three duty and one standby), with the total pumping capacity of 30.6 mgd.
  - Cost to add a new Title 22 Recycled Water Pump Station for Title 22 recycled water pumping for NPR. Assumed three 400 hp pumps (two duty and one standby) for the total pumping capacity of 8 mgd.
  - Cost to construct 10.3 miles of 18-inch forcemain, parallel to existing 54-inch recycled water pipeline to convey Title 22 recycled water from DCTWRP to the Hansen Tank. Cost includes two freeway crossings and one railroad crossing.
  - Cost to construct a 27-inch PVC gravity pipe to discharge AWPF backwash and concentrate to AVORS was added. Cost estimate is based on 450 ft of pipe length for Site 1 DCT SE, Site 2 DCT SW, and Site 4 Cricket Fields, and 500 ft of pipe length for Site 5 Contractor Lay Down Area.
- Site 3 VGS (Reference Section 5.3.3) – The cost for conveyance pipelines and pumping requirements for Site 3 VGS is same for both the Base Condition and Scenario 1.
  - Cost to expand existing Balboa Pump Station by adding two 800 hp pumps for Title 22 recycled water pumping for NPR and AWPF influent water. The expanded Balboa Pump Station would have a total of five pumps (four duty and one standby), with the total pumping capacity of 41 mgd.

  - o Cost to add a new Pump Station to pumping purified recycled water from VGS to HSG. Assumed four 60 hp pumps (three duty and one standby) for the total pumping capacity of 30.6 mgd.
  - o Cost to construct 7.4 miles of 18-inch PVC forcemain and a new pump station with two 200-hp pumps (one duty and one standby) to discharge AWPF backwash and concentrate to VORS was added. Assumed three freeway crossings and one railroad crossing.

Incremental Costs for Conveyance Pipelines and Pumping Requirements for Scenario 1

The cost for conveyance pipelines and pumping requirements for Title 22 recycled water, AWPF influent water, purified recycled water, and AWPF backwash and concentrate are also included as incremental costs. The conveyance pipelines and pumping requirements for the Scenario 1 include:

- Sites at or adjacent to DCTWRP (Site 1 DCT SE, Site 2 DCT SW, Site 4 Cricket Fields, and Site 5 Contractor Lay Down Area) (Reference Section 5.1.4)
  - o Cost to expand Balboa Pump Station by adding one 800 hp pump for purified recycled water pumping to HSG. The expanded Balboa Pump Station would have a total of four pumps (three duty and one standby), with the total pumping capacity of 32.4 mgd.
  - o Cost to construct a 27-inch PVC gravity pipe to discharge AWPF backwash and concentrate to AVORS was added. Cost estimate is based on 450 ft of pipe length for Site 1 DCT SE, Site 2 DCT SW, and Site 4 Cricket Fields, and 500 ft of pipe length for Site 5 Contractor Lay Down Area.
- Site 3 VGS (Reference Section 5.3.3) – The cost for conveyance pipelines and pumping requirements for Site 3 VGS is same for both the Base Condition and Scenario 1.

Capital Cost Estimate Summary

Table 6-1 summarizes the capital cost estimate for each site for the Base Condition and Scenario 1. See Appendix B.1 for the breakdown of the capital cost estimate.

Table 6-1: Capital Cost Estimate for Base Condition and Scenario 1

	Cost Item	Site 1 DCT SE	Site 2 DCT SW	Site 3 VGS [a]	Site 4 Cricket Fields	Site 5 Contractor Lay Down Area
Base Condition	AWPF Base Cost	$276M	$276M	$276M	$276M	$276M
	Incremental Cost Items	$90M	$116M	$66M	$141M	$94M
	Total	**$366M**	**$392M**	**$342M**	**$417M**	**$370M**
Scenario 1	AWPF Base Cost	$292M	$292M	$276M	$292M	$292M
	Incremental Cost Items	$20M	$46M	$66M	$71M	$24M
	Total	**$312M**	**$338M**	**$342M**	**$363M**	**$316M**

Footnotes:

a. The capital cost estimate is same for both the Base Condition and Scenario 1 for Site 3 VGS.
b. See Appendix B.1 for the breakdown of capital cost estimates.
c. The costs are in January 2011 dollars, and include 30% contingency and 30% implementation costs.

For sites at or adjacent to DCTWRP (Site 1 DCT SE, Site 2 DCT SW, Site 4 Cricket Fields, and Site 5 Contractor Lay Down Area), the capital cost for Scenario 1 is lower than the capital cost for the Base Condition, as shown in Table 6-1. This cost savings is from eliminating the need for the new pump station and conveyance pipe for the Title 22 recycled water.

6.1.2 O&M Cost

As described in Section 2.14, the AWPF O&M cost is estimated using the annual average production. For sites at or adjacent to DCTWRP (Site 1 DCT SE, Site 2 DCT SW, Site 4 Cricket Fields, and Site 5 Contractor Lay Down Area), the annual AWPF production is 26.9 mgd for the Base Condition and 31.3 mgd for Scenario 1. For Site 3 VGS, the annual AWPF production capacity is 26.9 mgd for both the Base Condition and Scenario 1.

As described in Section 3.2.2, the 50-year total O&M cost in present value is estimated. The O&M cost estimates include energy, chemical, equipment maintenance and replacement of consumables, and labor cost.

O&M Cost for Base Condition

The estimated O&M cost for Site 1 DCT SE, Site 2 DCT SW, Site 4 Cricket Fields, and Site 5 Contractor Lay Down for Scenario 1 is $669 million. Site 3 VGS had a higher O&M cost of $741 million. Several components created the increase. VGS requires the construction of a new administration building, which will contribute to power usage, while the other four sites will rely on the DCTWRP administration building. Also, VGS requires a larger UV system, due to the formation of NDMA during the transmission of the tertiary water from DCTWRP to VGS. Finally, VGS requires additional pumps to transport the Title 22 water from DCTWRP to AWPF at VGS as well as to supply NPR demands.

O&M Cost for Scenario 1

As seen in Table 6-2, the O&M cost is higher for the sites within or adjacent to DCTWRP (Sites 1, 2, 4, and 5) for Scenario 1 when compared to the Base Condition, yet remains constant for Site 3 VGS because the conditions are the same for Base Condition and Scenario 1 for VGS. For Scenario 1 for Sites 1, 2, 4, and 5, the AWPF would produce a an average of 31.3 mgd of purified recycled water for supplying both NPR and GWR, while in the Base Condition only 26.9 mgd of purified recycled water would be produced for GWR with the balance of Title 22 water served to NPR users. See Section 2.2.1 for additional information of flow and production differences between the Base Condition and Scenario 1. Production of a greater quantity of purified recycled water requires more labor, chemicals, and power usage, resulting in higher O&M costs.

O&M Cost Estimate Summary

Table 6-2 summarizes the O&M cost estimate for each site for the Base Condition and Scenario 1. See Appendix B.2 for the breakdown of the O&M cost estimate.

Table 6-2: O&M Cost Estimate for Base Condition and Scenario 1

	Cost Item	Site 1 DCT SE	Site 2 DCT SW	Site 3 VGS [a]	Site 4 Cricket Fields	Site 5 Contractor Lay Down Area
Base Condition	AWPF Base Cost	$14.0M	$14.0M	$14.0M	$14.0M	$14.0M
	Incremental Cost Items	$2.7M	$2.7M	$4.5M	$2.7M	$2.7M
	Total Annual O&M Cost	**$16.7M**	**$16.7M**	**$18.5M**	**$16.7M**	**$16.7M**
	50-year O&M Cost in Present Value	**$669M**	**$669M**	**$741M**	**$669M**	**$669M**
Scenario 1	AWPF Base Cost	$16.3M	$16.3M	$14.0M	$16.3M	$16.3M
	Incremental Cost Items	$2.9M	$2.9M	$4.5M	$2.9M	$2.9M
	Total Annual O&M Cost	**$19.2M**	**$19.2M**	**$18.5M**	**$19.2M**	**$19.2M**
	50-year O&M Cost in Present Value	**$769M**	**$769M**	**$741M**	**$769M**	**$769M**

Footnotes:

a. The O&M cost estimate is same for both the Base Condition and Scenario 1 for Site 3 VGS.
b. See Appendix B.2 for the breakdown of O&M cost estimates.

6.1.3 Summary of Performance Measure Scores for Objective 1 Promote Cost Efficiency

For Objective 1 Promote Cost Efficiency, the capital cost and O&M cost estimate scores for the five candidate sites are summarized in Tables 6-3 and 6-4 for the Base Condition and Scenario 1, respectively.

Table 6-3: Performance Measure Scores for Objective 1 Promote Cost Efficiency for Base Condition

Evaluation Criteria	Performance Measure	Site 1 DCT SE	Site 2 DCT SW	Site 3 VGS	Site 4 Cricket Fields	Site 5 Contractor Lay Down Area
Capital Cost [a]	Capital Cost ($)	$366M	$392M	$342M	$417M	$370M
O&M Cost [b]	50-Year O&M in Present Value ($)	$669M	$669M	$741M	$669M	$669M

Footnotes:

a. See Appendix B.1 Capital Cost Estimate for Base Condition for more details

b. See Appendix B.2 O&M Cost Estimate for Base Condition for more details

Table 6-4: Performance Measure Scores for Objective 1 Promote Cost Efficiency for Scenario 1

Evaluation Criteria	Performance Measure	Site 1 DCT SE	Site 2 DCT SW	Site 3 VGS	Site 4 Cricket Fields	Site 5 Contractor Lay Down Area
Capital Cost [a]	Capital Cost ($)	$312M	$338M	$342M	$363M	$316M
O&M Cost [b]	50-Year O&M in Present Value ($)	$769M	$769M	$741M	$769M	$769M

Footnotes:

a. See Appendix B.1 Capital Cost Estimate for Scenario 1 for more details

b. See Appendix B.2 O&M Cost Estimate for Scenario 1 for more details

6.2 Objective 2 – Achieve Supply and Operational Goals

As described in Section 3.2.2, Objective 2 Achieve Supply and Operational Goals is evaluated based on the following three evaluation criteria: 1) Achieve 15,000 AFY for Phase 1 and 30,000 AFY for Phase 2; 2) Wastewater system benefits; and 3) Operational flexibility. The performance measure scores for these evaluation criteria are discussed below.

6.2.1 Achieve Water Supply Goals

This evaluation criterion is a non-discriminator, since all five candidate sites can accommodate the Phase 1 and Phase 2 AWPF. On a scale of 1 to 5, with 1 being the worst and 5 being the best, all sites are given the same score of 5.

6.2.2 Wastewater System Benefits

For wastewater system benefits evaluation criterion, each site is scored on a scale of 1 to 5, with 1 being the worst and 5 being the best, based on whether or not the site occupies land that could be used for future wastewater system projects.

Site 1 DCT SE is scored a 1, because it is is located in the space designated for future expansion of DCTWRP Phase III wastewater processes.

Site 2 DCT SW is scored a 4, higher than DCT SE, because the area is not defined as for a future location for DCTWRP expansion.

Site 3 VGS is rated a 5 because it is not located at or adjacent to a wastewater treatment plant, and therefore there is no possibility of this space being used for future wastewater system expansion.

Site 4 Cricket Fields and Site 5 Contractor Lay Down Area are both rated a 4 because they are located outside of the berm and east of the DCTWRP Phase III expansion area. Site 4 Cricket Fields and Site 5 Contractor Lay Down Area have been shown as potential areas for DCTWRP Phases IV and V expansions, but based on flow projections for the DCTWRP tributary area, it is unlikely that these expansions would be needed.

6.2.3 Operational Flexibility

For operational flexibility evaluation criterion, each site is scored on a scale of 1 to 5 (1 being the worst and 5 being the best) based on how well the AWPF could respond to a disruption to normal operation at each site (e.g., how easily off-specification purified recycled water could be handled through storage or discharge, the problem corrected, and the AWPF returned to normal operation).

Site 1 DCT SE, Site 2 DCT SW, Site 4 Cricket Fields, and Site 5 Contractor Lay Down Area are scored a 5, because off-specification purified recycled water could easily be discharged to the AVORS sewer, and the AWPF could continue to operate while the problems are corrected.

Site 3 VGS is scored a 2 because there is not an adequate discharge pipeline to handle the capacity of the AWPF, nor is there a storage area for off-specification purified recycled water. If the AWPF was to malfunction, the plant would need to be shut down and the off-specification water would need to be bled into the backwash and concentrate pipeline to discharge to sewer. This would delay returning the AWPF to normal plant operations.

6.2.4 Summary of Performance Measure Scores for Objective 2 Achieve Supply and Operational Goals

For Objective 2 Achieve Supply and Operational Goals, the performance measures scores are summarized in Table 6-5.

Table 6-5: Performance Measure Scores for Objective 2 Achieve Supply and Operational Goals for Base Condition and Scenario 1

Evaluation Criteria	Performance Measure	Site 1 DCT SE	Site 2 DCT SW	Site 3 VGS	Site 4 Cricket Fields	Site 5 Contractor Lay Down Area
Achieve 15,000 AFY for Phase 1 and 30,000 AFY for Phase 2	Non-discriminator	5	5	5	5	5
Wastewater System Benefits	Available Space for Future DCTWRP Wastewater Expansions (1 to 5 score)	1	4	5	4	4
Operational Flexibility	Discharge Flexibility (1 to 5 score)	5	5	2	5	5

Footnotes:

a. For performance measures scored on a scale of 1 to 5, 5 = better and 1 = worse.

6.3 Objective 3 – Protect Environment

As described in Section 3.2.2, Objective 3 Protect Environment is measured by the following two evaluation criteria: 1) Habitat impacts; and 2) GHG emissions. The performance measure scores for these evaluation criteria are discussed below.

6.3.1 Habitat Impacts

For habitat impacts evaluation criterion, each site is scored on a scale of 1 to 5, with a rating of 1 reflecting a high potential for ecological impacts that would present difficulty in permitting, and a rating of 5 reflecting a low potential for ecological impacts and therefore no anticipated permitting issues in this regard.

The methodology used to evaluate the habitat impacts associated with each site is divided into several steps and are described below.

Step 1. Significant Ecological Areas

The first step entailed review of the Los Angeles County General Plan's SEA designation for each potential site, if applicable. SEAs are defined as "ecologically important or fragile land and water areas, valuable as plant and animal communities" and classified as one or more of the following: 1) habitats for rare and endangered species of plants and animals; 2) restricted natural communities - ecological areas which are scarce on a regional basis; 3) habitat restricted in distribution in the county; 4) breeding or nesting grounds; 5) unusual biotic communities; 6) sites with critical wildlife and fish value; and 7) relatively undisturbed habitat.

While development within a SEA is not prohibited, the General Plan does require development to be limited and controlled in order to avoid impacting valuable biological resources. Public and semi-public uses essential to the maintenance of public health, safety and welfare would be permitted within an SEA only "where no alternative site or alignment is feasible" (County of Los Angeles, 1993). Further, an extensive analysis of biological impacts would be required for projects located within an SEA.

SEAs have been identified for both the City and County of Los Angeles, and both types of SEA are shown as map layers on the City of Los Angeles Department of Public Works Bureau of Engineering website: http://navigatela.lacity.org. According to the Navigate L.A. database, none of the sites are located within County SEAs. None of the sites located within or adjacent to DCTWRP are located within a City SEA; however, Site 3 VGS is located within a City SEA (Navigate L.A., 2009). However, since VGS is already a highly industrial site used for generating electricity, the addition of an AWPF within the site boundaries would have no negative effects on the environment.

Step 2. California Natural Diversity Database

Next, the California Department of Fish and Game's California Natural Diversity Database (CNDDB) and Biogeographic Information and Observation System (BIOS) were consulted (CNDDB, 2009). The CNDDB provides biological field data, including the locations of observations of rare and endangered plant and wildlife species and habitat conditions. Both federally listed (U.S. Fish and Wildlife Service) and state listed (California Department of Fish and Game) species are included in the CNDDB. The CNDDB also identifies any sensitive natural community present on the site. BIOS is an information management tool for using the CNDDB to gain information on sites throughout California.

The CNDDB/BIOS search indicates that DCTWRP is located near a population of least Bell's vireo, a federally-endangered bird known to inhabit the nearby Sepulveda Basin Wildlife Reserve. Site 1 DCT SE is within the existing boundaries of DCTWRP, so the addition of an AWPF would have no effect on least Bell's vireo. Site 2 DCT SW would also involve the addition of an AWPF within the existing site which would not impact the wildlife. Site 4 Cricket Fields and Site 5 Contractor Lay Down Area have the most potential of the DCTWRP sites for affecting the least Bell's vireo, a species of bird found in the area, because it is outside the boundaries of DCTWRP.

According to CNDDB/BIOS, VGS is located near a population of Davidson's bush mallow, a plant considered by the California Native Plant Society as rare, threatened or endangered in California. However, since this site is highly disturbed and does not provide riparian habitat required by this species, this plant is very unlikely to occur at VGS.

Step 3. Geographic Proximity to Open Space and/or Habitat

Next, the sites were evaluated based on their geographic proximity to areas of high quality habitat. The closer the site is to high quality habitat, the more likely for wildlife species to occur and utilize the site, however limited the on-site habitat may be, for foraging, roosting, or migrating through. DCTWRP is located adjacent to the 225-acre Sepulveda Basin Wildlife Reserve, which supports a variety of high quality habitat including riparian and wetland areas, sage scrub, and oak savannah (City of Los Angeles, 2009). Based on their proximity to the Sepulveda Basin Wildlife Reserve and the fact that they are located outside the boundaries of DCTWRP, Site 4 Cricket Fields and Site 5 Contractor Lay Down Area would be considered to have some ecological significance and a lower rating is warranted due to the potential for ecological impacts. Site 1 DCT SE and Site 2 DCT SW are within the DCTWRP boundaries and would not have habitat impacts.

Step 4. On-site Ecological Resources

Finally, an aerial map of each site was evaluated visually using the Google Maps website for the presence of wildlife habitat on the site itself (Google, 2009). Each of the sites is located within an urban area and has been highly altered from its original condition.

Based on a review of aerial maps, the area surrounding DCTWRP appears to provide the most habitat, consisting of trees and other vegetation. Following the same reasoning as mention above concerning building the AWPF within the DCTWRP boundaries, Site 1 DCT SE and Site 2 DCT SW would be rated the highest, and Site 4 Cricket Fields and Site 5 Contractor Lay Down Area would be rated the lowest.

Sites outside of the DCTWRP boundaries may contain some trees and/or vegetation that, if native species, would be protected under the City of Los Angeles's Native Tree Protection Ordinance. The Native Tree Protection Ordinance (Ordinance No. 177,404) protects several native tree species of a certain size. Protected tree removal requires a removal permit by the Board of Public Works. The tree removal permit may require replanting of native trees within the project area or at another location within the City of Los Angeles to mitigate for the removal of these trees. In addition, any act that may cause the failure or death of a protected tree requires inspection by the City's Urban Forestry Division. Although the law does not require a permit for the pruning of protected trees, the City recommends consultation with a certified arborist to ensure that the pruning of protected trees is performed carefully. Both Van Nuys and Sun Valley are within the City of Los Angeles. As such, all sites would be subject to the Native Tree Protection Ordinance.

Habitat Impacts Summary

Based on the evaluation above, Site 1 DCT SE, Site 2 DCT SW, and Site 5 VGS are rated a 5, and Site 4 Cricket Fields and Site 5 VGS are rated a 3.

6.3.2 Greenhouse Gas Emissions

For GHG emissions evaluation criterion, a GHG emissions inventory was completed for each alternative, to include emissions from purchased electricity for conveyance pumping, UV system, and new administrative buildings, which are three main differentiators between the five candidate sites.

GHG emissions for Base Condition

The GHG emissions inventory for the Base Condition include:

- Sites at or adjacent to DCTWRP (Site 1 DCT SE, Site 2 DCT SW, Site 4 Cricket Fields, and Site 5 Contractor Lay Down Area)
    - Purchased electricity for conveyance pumping. To pump 26.9 mgd of AWPF purified recycled water from DCTWRP to HSG, assumed operating three pumps at 630 break horsepower. To pump 4.5 mgd of Title 22 recycled water from DCTWRP to NPR users, assumed operating one pump at 270 break horsepower.
    - Purchased electricity for UV. Assumed a 1,160 kW for 26.9 mgd UV system sized for 1.2 log reduction of NDMA.
- Site 3 VGS – Same for both Base Condition and Scenario 1
    - Purchased electricity for conveyance pumping. To pump 41 mgd of Title 22 recycled water pumping from DCTWRP to VGS and NPR users, assumed operating four pumps at 790 break horsepower. To pump 26.9 mgd of AWPF purified recycled water from VGS to HSG, assumed operating three pumps at 60 break horsepower.
    - Purchased electricity for UV. Assumed a 1,740 kW for 26.9 mgd UV system sized for 1.7 log reduction of NDMA.
    - Purchased electrical for new administration building. Assumed 9.5 watts/sf for a typical office/administration building. Assumed 9,000 sf area for the new administration building.

GHG emissions from purchased electricity for the Base Condition are summarized in Table 6-6.

Table 6-6: Summary of Emissions from Purchased Electricity for Base Condition

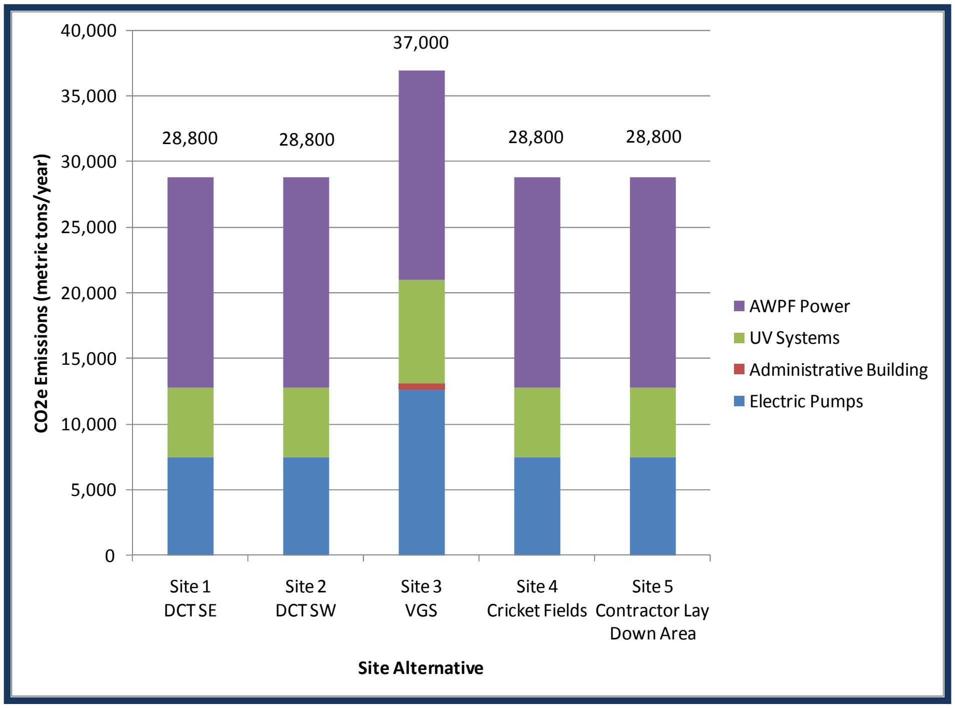
Location	GHG Emissions (metric tons/year)			CO_2e Emissions (metric tons/year)			
	CO_2	CH_4	N_2O	CO_2	CH_4	N_2O	Total
Site 1: DCT SE	28,665	0.68	0.26	28,665	14	80	28,758
Site 2: DCT SW	28,665	0.68	0.26	28,665	14	80	28,758
Site 3: VGS	36,843	0.87	0.33	36,843	18	102	36,964
Site 4: Cricket Fields	28,665	0.68	0.26	28,665	14	80	28,758
Site 5: Contractor Lay Down Area	28,665	0.68	0.26	28,665	14	80	28,758

Footnotes:

a. Abbreviations: GHG = greenhouse gas; CO_2 = carbon dioxide; GWP = global warming potential; CH_4 = methane; N_2O = nitrous oxide
b. Notes: GWP for CH_4 = 21; GWP for N_2O = 310
c. Source: CDM Smith, 2009.

A summary of the GHG emissions by location and source type for Base Condition is provided in Figure 6-1.

Figure 6-1: GHG Emissions for Base Condition



GHG emissions for Scenario 1

The GHG emissions inventory for Scenario 1 include:

- Sites at or adjacent to DCTWRP (Site 1 DCT SE, Site 2 DCT SW, Site 4 Cricket Fields, and Site 5 Contractor Lay Down Area)
  - Purchased electricity for conveyance pumping. To pump 31.3 mgd of AWPF purified recycled water from DCTWRP to HSG and NPR users, assumed operating three pumps at 755 break horsepower.
  - Purchased electricity for UV. Assumed a 1,280 kW for 32.4 mgd UV system sized for 1.2 log reduction of NDMA.
- Site 3 VGS – Same for both Base Condition and Scenario 1

Table 6-7 summarizes the Habitat Impacts and Greenhouse Gas Emissions scores for Scenario 1.

Table 6-7: Summary of Emissions from Purchased Electricity for Scenario 1

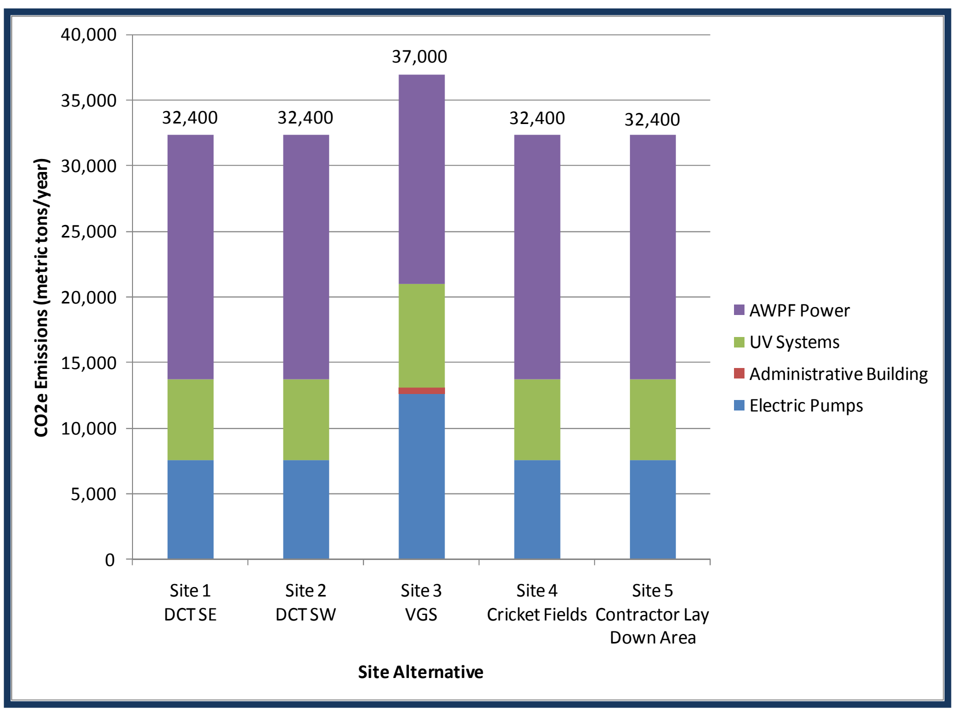
Location	GHG Emissions (metric tons/year)			CO_2e Emissions (metric tons/year)			
	CO_2	CH_4	N_2O	CO_2	CH_4	N_2O	Total
Site 1: DCT SE	32,268	0.76	0.29	32,268	16	90	32,374
Site 2: DCT SW	32,268	0.76	0.29	32,268	16	90	32,374
Site 3: VGS	36,843	0.87	0.33	36,843	18	102	36,964
Site 4: Cricket Fields	32,268	0.76	0.29	32,268	16	90	32,374
Site 5: Contractor Lay Down Area	32,268	0.76	0.29	32,268	16	90	32,374

Footnotes:

a. Abbreviations: GHG = greenhouse gas; CO_2 = carbon dioxide; GWP = global warming potential; CH_4 = methane; N_2O = nitrous oxide
b. Notes: GWP for CH_4 = 21; GWP for N_2O = 310
c. Source: CDM Smith, 2009.

A summary of the GHG emissions by location and source type for Scenario 1 is provided in Figure 6-2. As seen in the figure, the higher GHG emissions estimates for Sites 1, 2, 4, and 5 are due to the larger contribution from UV systems. Since Scenario 1 involves 31.3 mgd of AWPF purified recycled water for both GWR and NPR, while the Base Condition had only 26.9 mgd for just GWR, the UV systems needed to be upsized for the greater flow, resulting in more power usage and higher GHG emissions.

Figure 6-2: GHG Emissions for Scenario 1



6.3.3 Summary of Performance Measures for Objective 3 Protect Environment

For Objective 3 Protect Environment, the performance measure scores for Habitat Impacts and Greenhouse Gas Emissions evaluation criteria are summarized in Tables 6-8 and 6-9 for the Base Condition and Scenario 1, respectively.

Table 6-8: Performance Measure Scores for Objective 3 Protect Environment for Base Condition

Evaluation Criteria	Performance Measure	Site 1 DCT SE	Site 2 DCT SW	Site 3 VGS	Site 4 Cricket Fields	Site 5 Contractor Lay Down Area
Habitat Impacts	Habitat Impacts Score (1 to 5 score) [a]	5	5	5	3	3
Greenhouse Gas Emissions	Incremental GHG Emissions (metric tons CO_2 equivalents) [b]	28,800	28,800	37,000	28,800	28,800

Footnotes:

a. For performance measures scored on a scale of 1 to 5, 5 = better and 1 = worse.
b. Lower GHG emissions is better and higher GHG emissions is worse.

Table 6-9: Performance Measure Scores for Objective 3 Protect Environment for Scenario 1

Evaluation Criteria	Performance Measure	Site 1 DCT SE	Site 2 DCT SW	Site 3 VGS	Site 4 Cricket Fields	Site 5 Contractor Lay Down Area
Habitat Impacts	Habitat Impacts Score (1 to 5 score)	5	5	5	3	3
Greenhouse Gas Emissions	Incremental GHG Emissions (metric tons CO_2 equivalents)	32,400	32,400	37,000	32,400	32,400

Footnotes:

a. For performance measures scored on a scale of 1 to 5, 5 = better and 1 = worse.
b. Lower GHG emissions is better and higher GHG emissions is worse.

6.4 Objective 4 – Maximize Implementation

As described in Section 3.2.2, Objective 4 Maximize Implementation is evaluated based on the following five evaluation criteria: 1) Public perception; 2) Institutional partnership; 3) Permitting; and 4) Ability to expedite implementation. The performance measure scores for these evaluation criteria are discussed below.

6.4.1 Public Perception

For public perception evaluation criterion, each site is scored on a scale of 1 to 5, with 1 being the worst and 5 being the best, based on the degree of separation from the wastewater treatment plant. It is assumed that if the AWPF is physically separated from the wastewater treatment plant, then the public is less likely to associate the AWPF (or their drinking water) with wastewater.

Site 1 DCT SE is scored a 2 because the new AWPF would be built within the current DCTWRP fence line and directly adjacent to the current wastewater treatment processes. Also, some of the AWPF components would be built on top of the existing wastewater treatment processes. Therefore, it is more likely for the public to associate the AWPF with a wastewater treatment plant.

Site 2 DCT SW is scored a 3 because this site is located in the southwest corner of DCTWRP. This site is rated higher than Site 1 DCT SE, because it is located near the Japanese Garden and administration building, away from the wastewater processes.

Site 3 VGS is scored a 5 because the AWPF would be located more than 10 miles away from DCTWRP and therefore the public would not easily identify it as a sewage treatment plant. There is concern that the public would be wary of having a water treatment facility adjacent to a power generating facility, however, these perceptions could be offset by constructing a separate entrance for the AWPF on San Fernando Road.

Site 4 Cricket Fields is scored a 4 because the AWPF would be a distinct facility with its own parking, fence and separate entrance, even though this site is located close to DCTWRP. Also, it would not be located on current DCTWRP land property.

Site 5 Contractor Lay Down Area is scored a 3 because it is currently a part of DCTWRP leased from the USACE. This site is also directly adjacent to the current septage intake area, which is likely to have intermittent odor release in low levels during truck unloading process.

6.4.2 Institutional Partnership

For the institutional partnership evaluation criterion, each site is scored on a scale of 1 to 5, with 1 being the worst and 5 being the best, based on the City agency partnerships what will be formed through the project.

If the AWPF is located at or adjacent to DCTWRP (Site 1 DCT SE, Site 2 DCT SW, Site 4 Cricket Fields, or Site 5 Contractor Lay Down Area), it will be operated by the City's Department of Public Works, specifically BOS. BOS would be responsible for day-to-day operations at the facility and LADWP would be responsible for the transport and spreading of the advanced-treated water. This relationship would be similar to the Terminal Island Water Reclamation Plant (TIWRP) model, which has worked successfully.

If the AWPF is located at Site 3 VGS, it will be operated by LADWP. In this scenario, BOS would be responsible for providing tertiary effluent from DCTWRP and LADWP would be responsible for transferring that water to the AWPF, treating it with MF, RO, and AOP, and spreading the advance-treated water at the HSG. This model is similar to the West Basin Water Recycling Plant (WBWRP) model and assumes that LADWP will hire wastewater operators for the AWPF.

Since City agency partnerships would be fostered between LADWP and BOS if the AWPF is located at or adjacent to DCTWRP, Sites 1, 2, 4, and 5 are scored a 5. Since BOS would have minimal involvement if the site is located at VGS, Site 3 is scored a 1.

6.4.3 Permitting

For permitting evaluation criterion, each site is scored on a scale of 1 to 5, with 1 being the worst and 5 being the best, based on the ease of obtaining USACE approval. This score is different for each site in question depending on the location of the site relevant to the flood protection berm.

Site 4 Cricket Fields and Site 5 Contractor Lay Down are located outside of the flood protection berm and is on USACE land. The USACE approval process is expected to be most extensive for these site; therefore, both sites received a score of 1 for permitting.

Site 1 DCT SE and Site 2 DCT SW are located on USACE land within the flood protection berm. These sites will require USACE approval and scored a 4 since the approval process is expected to be less complex than that required for Sites 4 and 5.

Site 3 VGS is not located on USACE and, therefore, will not require USACE approval. Site 3 VGS received a score of 5 for permitting.

6.4.4 Ability to Expedite Implementation

For ability to expedite implementation evaluation criterion, each site is scored on a scale of 1 to 5, with 1 being the worst and 5 being the best, based on anticipated work related to the construction of the AWPF that may add time to the overall project schedule.

Site 1 DCT SE and Site 2 DCT SW are each scored a 5 because there is little preliminary work that would need to be completed prior to construction. For Site 2 DCT SW, the existing maintenance and warehouse buildings would need to be demolished and reconstructed; however, this work is not expected to prolong the project.

Site 3 VGS is scored a 4 because the existing training towers, shown in Figure 6-5, would need to be demolished and removed prior to construction. This demolition will require coordinating with the power division of LADWP.

Figure 6-5: Training Towers Area at VGS

Site 4 Cricket Fields is scored a 1 because a substantial amount of preliminary work would need to be done to compensate for the flood water storage volume lost when the site grade is raised or a berm is built around the site for the 100-year flood conditions. This work involves construction off-site, and therefore could potentially prolong the project.

Site 5 Contractor Lay Down Area is scored a 2 because, although flood water storage volume would need to be compensated off-site, similar to the Site 4 Cricket Fields option, the volume of work would be most smaller in scale.

6.4.5 Summary of Performance Measure Scores for Objective 4 Maximize Implementation

For Objective 4 Maximize Implementation, the performance measure scores for Public Perception, Institutional Partnership, Permitting, and Ability to Expedite Implementation evaluation criteria are summarized in Table 6-10.

Table 6-10: Performance Measure Scores for Objective 4 Maximize Implementation for Base Condition and Scenario 1

Evaluation Criteria	Performance Measure	Site 1 DCT SE	Site 2 DCT SW	Site 3 VGS	Site 4 Cricket Fields	Site 5 Contractor Lay Down Area
Public Perception	Separation from WW Treatment (1 to 5 score)	2	3	5	4	3
Institutional Partnership	Institutional Partnership Score (1 to 5 score)	5	5	1	5	5
Permitting	Permitting Score (1 to 5 score)	4	4	5	1	1
Ability to Expedite Implementation	Implementation Score (1 to 5 score)	5	5	4	1	2

Footnotes:

a. For performance measures scored on a scale of 1 to 5, 5 = better and 1 = worse.

6.5 Objective 5 – Promote Economic and Social Benefits

As described in Section 3.2.2, Objective 5 Promote Economic and Social Benefits is evaluated based on the following three evaluation criteria: 1) Economic Benefits; 2) Environmental Justice; and 3) Job Creation. The performance measure scores for these evaluation criteria are discussed below.

6.5.1 Economic Benefits

The Economic Benefits evaluation criterion is scored as a quantitative estimate of the number of temporary jobs created for the design and construction of the AWPF. The temporary jobs created are estimated based on the total capital cost of the project. The factor used is 7.2 temporary jobs created per $1 million in capital cost. See Section 3.2.2 for details.

6.5.2 Environmental Justice

The Environmental Justice evaluation criterion is scored on a Yes/No basis about whether or not a site is located within an Environmental Justice Improvement Area.

The only site that is within the Sun Valley Environmental Justice Improvement Area is Site 3 VGS. Therefore, Site 3 VGS is a "Yes" and the other are assigned a "No".

6.5.3 Job Creation

The Job Creation evaluation criterion is scored on a rating scale of 1 to 5, with 1 signifying the least number of permanent jobs created and 5 signifying the greatest number of permanent jobs created.

Site 1 DCT SE, Site 2 DCT SW, Site 4 Cricket Fields and Site 5 Contractor Lay Down Area are each rated a 4, because it is anticipated that some of the current maintenance staff and wastewater plant operators at DCTWRP would be able to assist with the maintenance of the new AWPF. As a result, fewer employees would need to be hired for these options.

Site 3 VGS is scored a 5 because it is anticipated that the AWPF at this site would require an entirely new team of operators and maintenance staff.

6.5.4 Summary of Performance Measure Scores for Objective 5 Promote Economic and Social Benefits

For Objective 5 Promote Economic and Social Benefits, the performance measure scores for Economic Benefits, Environmental Justice, Job Creation evaluation criteria are summarized in Tables 6-11 and 6-12 for the Base Condition and Scenario 1, respectively.

Table 6-11: Performance Measure Scores for Objective 5 Promote Economic and Social Benefits for Base Condition

Evaluation Criteria	Performance Measure	Site 1 DCT SE	Site 2 DCT SW	Site 3 VGS	Site 4 Cricket Fields	Site 5 Contractor Lay Down Area
Economic Benefits	Temporary Job Creation Score[a] (Number of Jobs)	2,000	2,200	1,900	2,100 [b]	2,000
Environmental Justice	Environmental Justice Improvement Area [c] (Yes or No)	No	No	Yes	No	No
Job Creation	Permanent Job Creation (1 to 5 score)	4	4	5	4	4

Footnotes:

a. Higher number of jobs is better and lower number of jobs is worse. Based on total construction cost, without 30% implementation cost.
b. The land purchase cost for cricket fields replacement is excluded in the capital cost used to estimate temporary job creation.
c. Yes = worse, No = better
d. For performance measures scored on a scale of 1 to 5, 5 = better and 1 = worse.

Table 6-12: Performance Measure Scores for Objective 5 Promote Economic and Social Benefits for Scenario 1

Evaluation Criteria	Performance Measure	Site 1 DCT SE	Site 2 DCT SW	Site 3 VGS	Site 4 Cricket Fields	Site 5 Contractor Lay Down Area
Economic Benefits	Temporary Job Creation Score[a] (Number of Jobs)	1,700	1,900	1,900	1,800 [b]	1,800
Environmental Justice	Environmental Justice Improvement Area [c] (Yes or No)	No	No	Yes	No	No
Job Creation	Permanent Job Creation (1 to 5 score)	4	4	5	4	4

Footnotes:

a. Higher number of jobs is better and lower number of jobs is worse. Based on total construction cost, without 30% implementation cost.
b. The land purchase cost for cricket fields replacement is excluded in the capital cost used to estimate temporary job creation.
c. Yes = worse, No = better
d. For performance measures scored on a scale of 1 to 5, 5 = better and 1 = worse.

6.6 Objective 6 – Maximize Adaptability and Reduce Risk

As described in Section 3.2.2, Objective 6 Maximize Adaptability and Reduce Risk is evaluated based on the following three evaluation criteria: 1) Geotechnical; 2) Expansion capability; and 3) Maximize reuse. The performance measure scores for these evaluation criteria are discussed below.

6.6.1 Geotechnical

For geotechnical evaluation criterion, each site is scored on a scale of 1 to 5, with 1 being the worst and 5 being the best, based on the geotechnical risks associated with each site.

The DCTWRP area does not include any of the geologic hazards. For geologic materials, the site analysis found Holocene alluvial gravel, sand, and clay. The Northridge (East Oak Ridge) Fault is less than 1.25 miles from the DCTWRP site. The depth to high groundwater is only 20 feet. The ground motion PGA is 0.56 g. As a result, Site 1 DCT SE, Site 2 DCT SW, Site 4Cricket Fields, and Site 5 Contractor Lay Down Area are each be scored a 5.

The VGS site only included one of the geologic hazards: earthquake induced landslides. For geologic materials, the site analysis found Holocene alluvial deposits of gravel, sand, and clay; cobbles and boulders; and possible unclassified fill for the top 5 feet. The Verdugo Fault is about 0.6 mile away. The Sierra Madre-San Fernando Fault and Oak Ridge Fault are located 3 miles from the site. The depth to high groundwater is 180-200 feet. The ground motion PGA is 0.9 g. As a result of the potential for landslides, Site 3 VGS will be scored a 4.

6.6.2 Expansion Capability

For expansion capability criterion, each site is scored on a scale of 1 to 5, with 1 being the worst and 5 being the best, based the availability of additional space for future AWPF expansion beyond Phase 2 or 30,000 AFY.

Site 1 DCT SE is scored a 1 because there would be no available space adjacent to the new facility for expansion.

Site 2 DCT SW is scored a 3 because there is some space, north of the site in the existing parking lot, available for expansion with special design considerations.

Site 3 VGS is scored a 4 because the existing fuel storage tanks area is available for expansion, but this space may be used for additional NPR distribution system storage.

Site 4 Cricket Fields and Site 5 Contractor Lay Down Area are both scored a 5 because the remaining cricket fields area between the two sites may be used for future expansion beyond Phase 2.

6.6.3 Maximize Reuse

Each AWPF site would be designed to take full advantage of the available wastewater flows to DCTWRP, while balancing other DCTWRP effluent uses. The evaluation criteria of Maximize Reuse attempts to rate the ability of each site to expand beyond the DCTWRP and incorporate other sources of wastewater. In the future, maximizing reuse will be achieved by incorporating flows from Burbank WRP and the Los Angeles-Glendale Water Reclamation Plant (LAGWRP). Burbank WRP is significantly closer to the site alternatives than LAGWRP and would be the first choice as a source of additional flows. Therefore, the distance between the site alternatives and Burbank WRP was used as the score for this evaluation criterion. Distance would be directly correlated to the cost of the pipeline that would need to be constructed. Shorter pipelines signify lower costs and are therefore, more desirable. Higher costs affect the feasibility of incorporating these additional flows. VGS is closer to Burbank WRP than the sites within and adjacent to DCTWRP.

6.6.4 Summary of Performance Measure Scores for Objective 6 Maximize Adaptability and Reduce Risk

Table 6-13 summarizes the scores for the following evaluation criteria: Geotechnical, Expansion Capability, and Maximize Reuse. The first two evaluation criteria are scored on a rating scale of 1 to 5 with the 1 being the worst and 5 being the best. The third evaluation criterion is a quantitative measure of distance between the site and Burbank WRP.

Table 6-13: Performance Measure Scores for Objective 6 Maximize Adaptability and Reduce Risk for Base Condition and Scenario 1

Evaluation Criteria	Performance Measure	Site 1 DCT SE	Site 2 DCT SW	Site 3 VGS	Site 4 Cricket Fields	Site 5 Contractor Lay Down Area
Geotechnical	Geotechnical Risk Score (1 to 5 score)	5	5	4	5	5
Expansion Capability	Space to Expand Beyond 30,000 AFY (1 to 5 score)	1	3	4	5	5
Maximize Reuse	Distance from Burbank WRP [b] (Miles)	9.1	9.1	6.1	9.1	9.1

Footnotes:

a. For performance measures scored on a scale of 1 to 5, 5 = better and 1 = worse.
b. Shorter distances are better and longer distances are worse.

6.7 Performance Measure Summary

Table 6-14 summarizes the performance measure scores for each site for the Base Condition. Table 6-15 summarizes the performance measure scores for Scenario 1 that differ from the Base Condition. As described in Section 2.1, Scenario 1 represents an alternate scenario where the purified recycled water for both GWR and NPR. The existing 54-inch recycled water pipeline would be used to transport all of the purified recycled water, and separate Title 22 recycled water pump station and pipelines would not be required. Since Scenario 1 involves changes to the infrastructure (AWPF sizing, pipelines, pumps, etc.), the performance measure scores that change are capital cost, O&M cost, which are directly related with infrastructure and construction, GHG emissions, and economic benefits, which are estimated based on the capital cost.

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Table 6-14: Objectives, Evaluation Criteria, Weightings, and Scores for CDP Model for Base Condition

Objectives		Evaluation Criteria			AWPF Site Alternatives				
Name	Weighting	Name	Sub-Weighting	Performance Measures	Site 1 DCT SE	Site 2 DCT SW	Site 3 VGS	Site 4 Cricket Fields	Site 5 Contractor Lay Down Area
Meet All Water Quality Regulations and Health & Safety Requirements, and Use Proven Technologies Provide Effective Communication and Education on Recycled Water Program		All alternatives meet these critical, threshold objectives.							
Promote Cost Efficiency	25%	Capital Cost	50%	Capital Cost ($)	$366M	$392M	$342M	$417M	$370M
		O&M Cost	50%	50-year O&M in Present Value ($)	$669M	$669M	$741M	$669M	$669M
Achieve Supply & Operational Goals	10%	Achieve 15,000 AFY for Phase 1 and 30,000 AFY for Phase 2		Non-Discriminator. All sites can accommodate 30,000 AFY AWPF.	5	5	5	5	5
		Wastewater system benefits	60%	Available Space for Future DCTWRP Wastewater Expansions (1 to 5 score)	1	4	5	4	4
		Operational flexibility	40%	Discharge Flexibility (1 to 5 score)	5	5	2	5	5
Protect Environment	10%	Habitat impacts	50%	Habitat Impacts Score (1 to 5 score)	5	5	5	3	3
		Greenhouse gas emissions	50%	Incremental GHG Emissions (metric tons CO_2 equivalents)	28,800	28,800	37,000	28,800	28,800
Maximize Implementation	30%	Public perception	25%	Separation from Wastewater Treatment (1 to 5 score)	2	3	5	4	3
		Institutional partnership	25%	Co-located with Existing BOS Facility (1 to 5 score)	5	5	1	5	5
		Permitting	25%	Permitting Score (1 to 5 score)	4	4	5	1	1
		Ability to expedite implementation	25%	Implementation Score (1 to 5 score)	5	5	4	1	2
Promote Economic & Social Benefits	5%	Economic benefits	30%	Temporary Job Creation Score (Number of Jobs)	2,000	2,200	1,900	2,100	2,000
		Environmental justice	35%	Environmental Justice Improvement Area (Yes or No)	No	No	Yes	No	No
		Job creation	35%	Permanent Job Creation (1 to 5 score)	4	4	5	4	4
Maximize Adaptability & Reduce Risk	20%	Geotechnical	30%	Geotechnical Risk Score (1 to 5 score)	5	5	4	5	5
		Expansion capability	50%	Space to AWPF Expand Beyond 30,000 AFY (1 to 5 score)	1	3	4	5	5
		Maximize reuse	20%	Distance from Burbank WRP (miles)	9.1	9.1	6.1	9.1	9.1

Footnotes:
a. For performance measures scored on a scale of 1 to 5, 5 = better and 1 = worse.
b. For quantitative measures, higher score are better and lower score worse, or vice versa, depending on the performance measure.

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Table 6-15: Changes to Selected Scores for CDP Model for Scenario 1

Objectives		Evaluation Criteria			AWPF Site Alternatives				
Name	Weighting	Name	Sub-Weighting	Performance Measures	Site 1 DCT SE	Site 2 DCT SW	Site 3 VGS	Site 4 Cricket Fields	Site 5 Contractor Lay Down Area
Promote Cost Efficiency	25%	Capital Cost	50%	Capital Cost ($)	$312M	$338M	$342M	$363M	$316M
		O&M Cost	50%	50-year O&M in Present Value ($)	$769M	$769M	$741M	$769M	$769M
Protect Environment	10%	Greenhouse gas emissions	50%	Incremental GHG Emissions (metric tons CO_2 equivalents)	32,400	32,400	37,000	32,400	32,400
Promote Economic & Social Benefits	5%	Economic benefits	30%	Temporary Job Creation Score (Number of Jobs)	1,700	1,900	1,900	1,800	1,800

Footnotes:

a. For quantitative measures, higher score are better and lower score worse, or vice versa, depending on the performance measure.

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7. Decision Modeling Results

This section summarizes the results of the decision modeling for the Base Condition, Scenario 1, and the sensitivity evaluation. As discussed in Section 6, each site alternative was characterized in terms of the evaluation criteria and performance measures established for the AWPF site assessment. Table 6-1 summarizes the performance measures for the Base Condition and Table 6-2 summarizes the performance measures that change for Scenario 1. The following results are presented in this section:

- Base Condition results – summarizes the ranking of the site alternatives for the Base Condition based on the objectives weighting established for the AWPF site assessment (see Section 2).
- Scenario 1 results - summarizes the ranking of the site alternatives for Scenario 1 based on the objectives weighting established for the AWPF site assessment (see Section 2).
- Sensitivity Analysis results – presents the results of a series of sensitivity runs that vary the objectives weightings, the method of scaling the scores themselves within the CDP model, performance measures scores, or evaluation criteria weightings to determine if the rankings of the site alternatives is consistent or varies with different focus.

As discussed in Section 3, the decision model was built using the commercial software Criterium Decision Plus (CDP) to rank the sites. CDP is decision analysis software that performs multi-attribute rating techniques to determine a preferred alternative given a set of weighted decision criteria. The software is simple to use and it produces visual output useful to understanding the results. The inputs to the decision model are the performance measures for each site alternative and the weightings for both the objectives and the evaluation criteria within each objective. The software then normalizes the scores given to each performance measure and multiplies them by the criteria weights and provides an overall decision score. Refer to Section 3.2.3 for more information on normalization of scores.

Score Interpretation

In the figures presented in this section, the overall length of the horizontal bars represents the total decision score for the alternative. The overall score indicates how well each site performed in meeting the overall *set* of criteria. The colored segments within each bar represent the contribution of each of the *individual* criteria to the total decision score. Two factors determine the size of each color segment for a given bar, or site: 1) the raw performance or score of the site for that objective; and 2) the weight of the objective. In general, the results should be interpreted as follows:

- If the color segment is larger, then that site scores better than the other sites for that performance measure when considered along with its weight of importance.
- If the color segment is smaller, then that site does not score as well for that performance measure, or the performance measure has a lower weight of importance, or both.

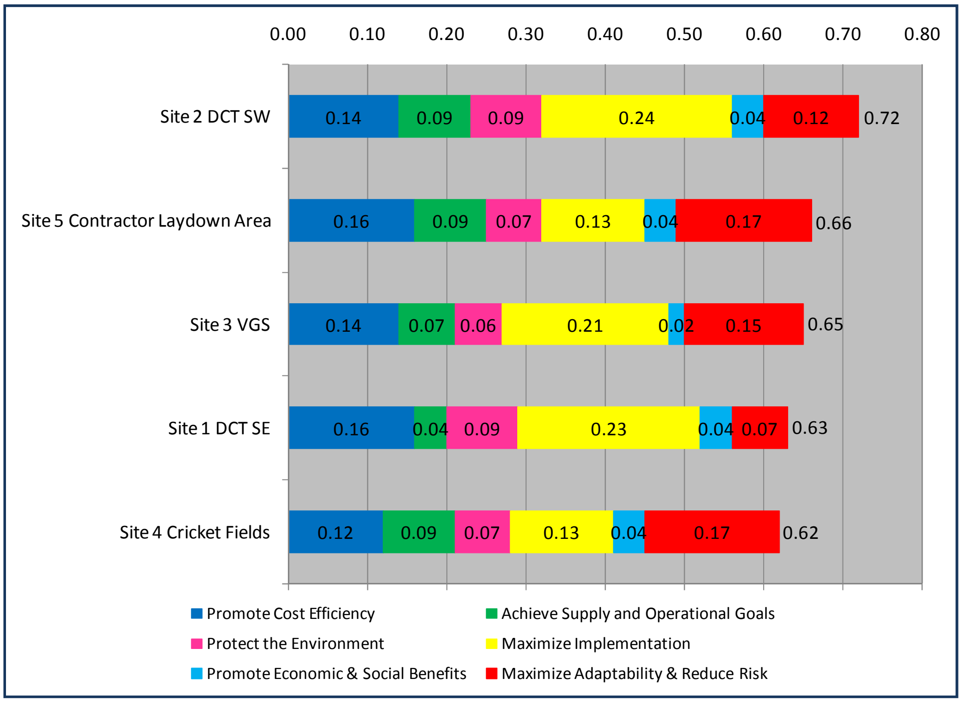
The scores for the individual objectives and the overall score for each site alternative are shown on each graph.

7.1 Base Condition Results

Figure 7-1 shows graphical results from the CDP model analysis for the Base Condition using the objectives weightings established for the AWPF site assessment (see Section 3, Figure 3-2). Following are observations of the results:

- Site 2 DCT SW is the highest ranked site. This site had the highest score among the alternatives in the following objectives: Maximize Implementation (due to co-locating with an existing BOS facility, less extensive USACE permitting requirements, and ease of implementation), Achieve Supply & Operational Goals (due to not taking space for future DCTWRP expansions), and Protect the Environment (due to no habitat impacts). Site 2 DCT SW did not receive the highest scores for the Promote Cost Efficiency objective (second highest score) and Maximize Adaptability & Reduce Risk objective (third highest score).
- Site 5 Contractor Lay Down Area is the second ranked alternative. While the overall score of Site 5 Contractor Lay Down Area is lower than that of Site 2 DCT SW primarily due to its lower performance for Achieve Supply & Operational Goals, Site 5 Contractor Lay Down Area scored marginally higher for Promote Cost Efficiency and Maximize Adaptability & Reduce Risk. The two sites scored the same for Protect the Environment and Achieve Supply & Operational Goals.
- Site 3 VGS is the third ranked alternative. This alternative scored higher than Site 5 Contractor Lay Down Area in the Maximize Implementation objective, but lower in all other objective ratings.
- Site 1 DCT SE is the fourth ranked site alternative. Although this alternative also scored high in the Maximize Implementation objective, and well in the other objective categories, it scored much lower than the other alternatives in the Maximize Adaptability & Reduce Risk objective due to its lack of potential expansion space.
- Site 4 Cricket Fields was the lowest ranked alternative. While Site 4 Cricket Fields scored highly in Maximize Adaptability & Reduce Risk, Promote Economic & Social Benefits, and Protect the Environment, its overall score was greatly reduced by a low score in Maximize Implementation.

Figure 7-1: Base Condition Results



7.2 Scenario 1 Results

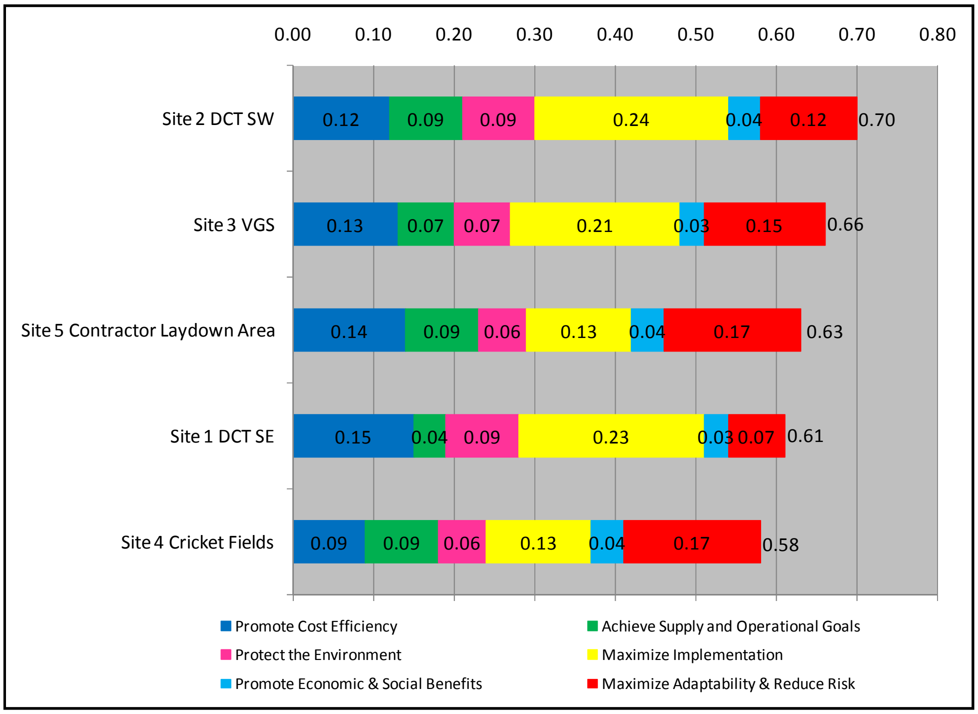
Figure 7-2 presents the graphical results from the CDP model analysis for Scenario 1 using the objectives weightings established for the AWPF site assessment (see Section 3, Figure 3-2). Following are observations of the results:

- As with the Base Condition, Site 2 DCT SW was the highest ranked alternative and received the highest scores for the following objectives: Maximize Implementation (due to co-locating with an existing BOS facility, less extensive USACE permitting requirements, and ease of implementation), Achieve Supply & Operational Goals (due to preserving space for future DCTWRP expansions), and Protect the Environment (due to minimal habitat impacts). Site 2 DCT SW did not receive the highest scores for the Promote Cost Efficiency objective (fourth highest score) and Maximize Adaptability & Reduce Risk objectives (third highest score). The scoring is very similar to the Base Condition score except with a lower score for Promote Cost Efficiency since the Site 2 DCT SW costs are higher for Scenario 1.
- Site 3 VGS is the second highest ranked alternative and scored lower than Site 2 DCT SW, primarily due to its performance for Maximize Implementation. But, Site 3 VGS scored higher than Site 2 DCT SW on Promote Cost Efficiency and Maximize Adaptability & Reduce Risk, but scored lower than Site 2 DCT SW on the other objectives, which caused its lower overall score.
- Site 5 Contractor Lay Down Area is the third ranked site. It scored higher than both Site 2 DCT SW and Site 3 VGS on Promote Cost Efficiency and Maximize Adaptability & Reduce Risk, and scored the same as Site 2 DCT SW for Achieve Supply & Operational Goals and

Promote Economic & Social Benefits. It scored the lowest on Maximize Implementation, which caused its overall lower score.

- Site 1 DCT SE is the fourth ranked site. It scored better than Site 2 DCT SW on Promote Cost Efficiency and the same on Protect the Environment. It scored lower on Maximize Implementation, Achieve Supply & Operational Goals, and Maximize Adaptability & Reduce Risk.
- Site 4 Cricket Fields was the lowest scoring alternative for Scenario 1, primarily due to its performance for Promote Cost Efficiency, Protect the Environment, and Maximize Implementation. Despite having the lowest overall score, Site 4 Cricket Fields received the highest scores in Achieve Supply & Operational Goals, Promote Economic & Social Benefits, and Maximize Adaptability & Reduce Risk.

Figure 7-2: Scenario 1 Results



7.3 Sensitivity Analysis

A series of sensitivity runs were conducted using the decision model for both the Base Condition and Scenario 1. These sensitivity runs involved altering the objectives weightings or the method of scaling the scores themselves within the CDP model to determine how robust the alternatives rankings are for the Base Condition and Scenario 1. If the alternatives rankings change with the sensitivity runs, then this means that the site selection for the Base Condition or Scenario 1 was sensitive to that particular element that was emphasized in the sensitivity run.

A total of six sensitivity runs were conducted for both the Base Condition and Scenario 1. The sensitivity runs were developed based on input from the City's Recycled Water Advisory Group (RWAG), conditions developed to increase the importance of a single objective, as well as input from the City regarding performance measures scoring and evaluation criteria weighting within a specific objective. The six sensitivity runs are summarized below.

Sensitivity Runs 1 through 5: Modified Objectives Weighting

Sensitivity Runs 1 through 3 were developed based on input from the City's RWAG. The RWAG is a group of Los Angeles residents, who represent specific community groups and their interests. They provide feedback about the RWMP throughout the planning process. At the first RWAG workshop on December 9, 2009, the members completed a survey about the weightings in the CDP model and how they should reflect their interests. Based on the input from the RWAG, the following sensitivity runs were developed by the RWMP team:

7. *Average Weights:* an average of all the RWAG inputs on weightings.
8. *Environmental Emphasis:* weightings based on the inputs of RWAG members who felt the environment was their primary concern.
9. *Social Emphasis*: weightings based on the inputs of RWAG members who felt that social issues were their chief concern.

Sensitivity Runs 4 and 5 were developed by the RWMP team to test the alternatives rankings:

10. *Cost Emphasis:* weighting cost substantially higher than the other objectives.
11. *Equal weights:* equal weighting for all objectives to see if the results change if none of the objectives are weighted higher than the others.

The modified objectives weightings for Sensitivity Runs 1 through 5 are summarized in Table 7-1.

Table 7-1: Summary of Sensitivity Runs 1 through 5 Modified Objectives Weightings

Sensitivity Run Number	1	2	3	4	5
Objectives	**RWAG Average Weights**	**RWAG Environmental Emphasis**	**RWAG Social Emphasis**	**Cost Emphasis**	**Equal Weights**
Promote Cost Efficiency	20%	0%	12%	50%	16.7%
Achieve Supply & Operational Goals	23%	50%	14%	10%	16.7%
Protect the Environment	18%	50%	24%	10%	16.7%
Maximize Implementation	15%	0%	12%	10%	16.7%
Promote Economic & Social Benefits	11%	0 %	29%	10%	16.7%
Maximize Adaptability & Reduce Risk	12%	0%	10%	10%	16.7%
Total	100%	100%	100%	100%	100%

Sensitivity Run 6: Modified Cost Scale

As described in Section 3, the scales within the decision model are usually set to range from 0.9 of the lowest score to 1.1 of the highest score. The capital costs used in the analysis are based on preliminary assumptions and generally thought to be within an accuracy range of +50 percent to -30 percent of the actual project costs. Even though variation is shown between the capital costs for the alternatives, due to the accuracy range the alternatives are typically considered to be similar in cost with the higher cost alternatives understood to likely be the highest capital cost alternatives and the lower cost alternatives understood to likely be the lowest capital cost alternatives. Setting the scale in the typical fashion might be overstating the cost differences between the alternatives. Therefore, this sensitivity run modifies the cost scale from zero dollars on the low end to 1.1 of the highest cost.

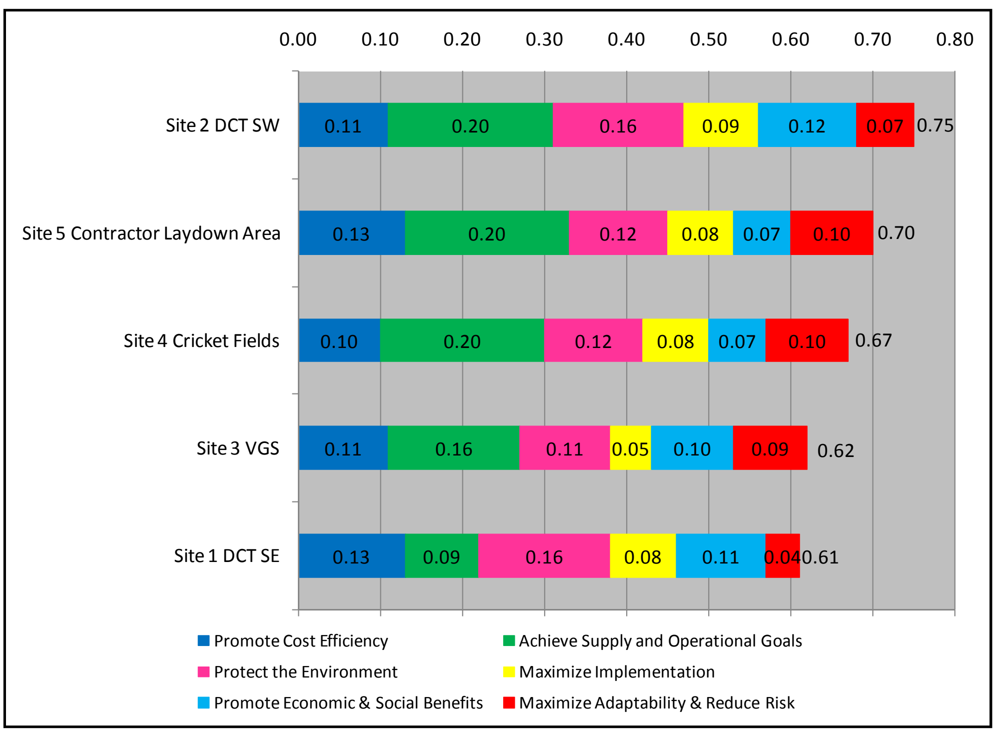
The results of the six sensitivity runs are presented individually in the following sections for the Base Condition and Scenario 1. The results of the Base Condition, Scenario 1, and all sensitivity runs are summarized in Table 7-2 at the end of Section 7.

7.3.1 Base Condition Sensitivity Results

Base Condition Sensitivity Run 1 – Average Weights

The results of Sensitivity Run 1 Average Weights are presented in Figure 7-3. Site 2 DCT SW remained the highest ranked site alternative with Site 5 Contractor Lay Down Area as the second ranked site. When compared to Figure 7-1, Site 2 DCT SW scored even higher overall than it did in the Base Scenario, where it was also the highest ranked site alternative. With Site 2 DCT SW scoring highest in the sensitivity runs, it reinforces the results of the Base Condition base run.

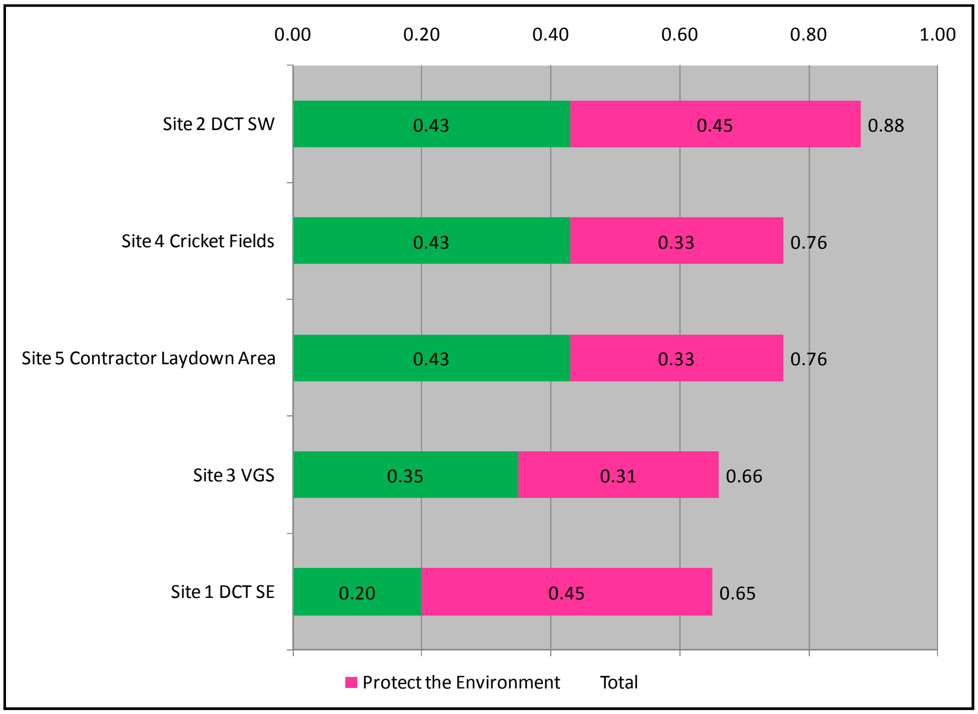
Figure 7-3: Base Condition Sensitivity Run 1 – Average Weights



Base Condition Sensitivity Run 2 – Environmental Emphasis

The results of the Sensitivity Run 2 Environment Emphasis are presented in Figure 7-4. With this sensitivity run, Site 2 DCT SW is the highest ranked site and is consistent with the Base Condition and Scenario 1 runs. Site 4 Cricket Fields and Site 5 Contractor Lay Down are tied as the second ranked alternatives. Site 3 VGS is the fourth ranked alternative, and Site 1 DCT SE drops to the lowest rank. The three highest ranking sites scored the same for Protect the Environment.

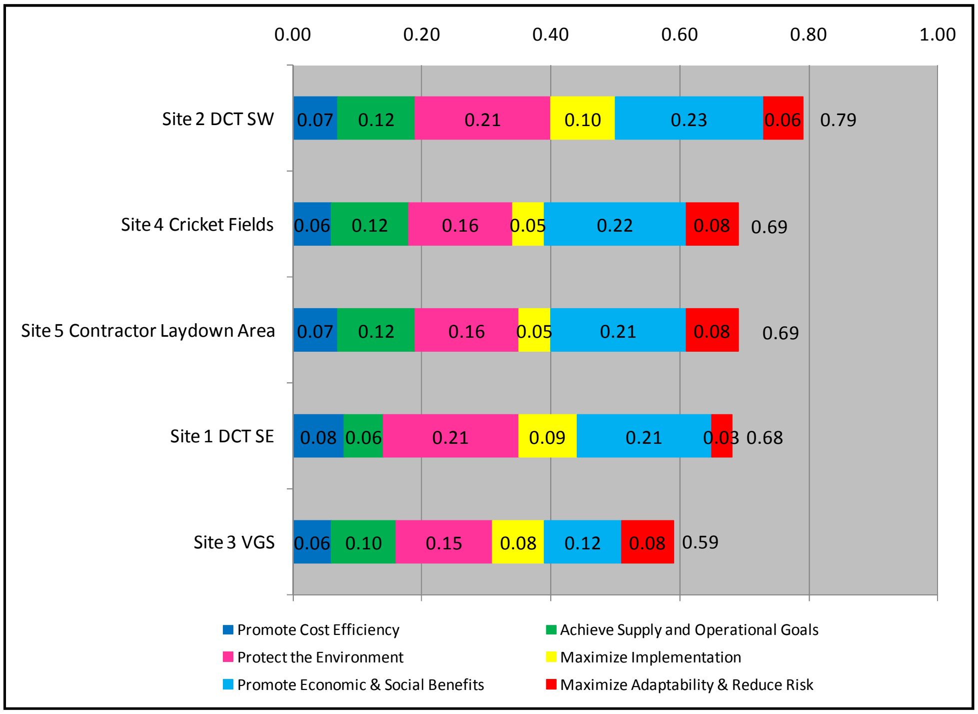
Figure 7-4: Base Condition Sensitivity Run 2 – Environmental Emphasis



Base Condition Sensitivity Run 3 – Social Emphasis

The results of Sensitivity Run 3 Social Emphasis are presented in Figure 7-5. In this sensitivity run, Protect the Environment and Promote Economic & Social Benefits were given greater weighting than the other objectives. Site 2 DCT SW remains the highest ranked alternative, consistent with the Base Condition, Scenario 1, and other Base Condition sensitivity runs. The second, third, and fourth ranked sites (Site 4 Cricket Fields, Site 5 Contractor Lay Down Area, and Site 1 DCT SE, respectively) essentially have the same scores.

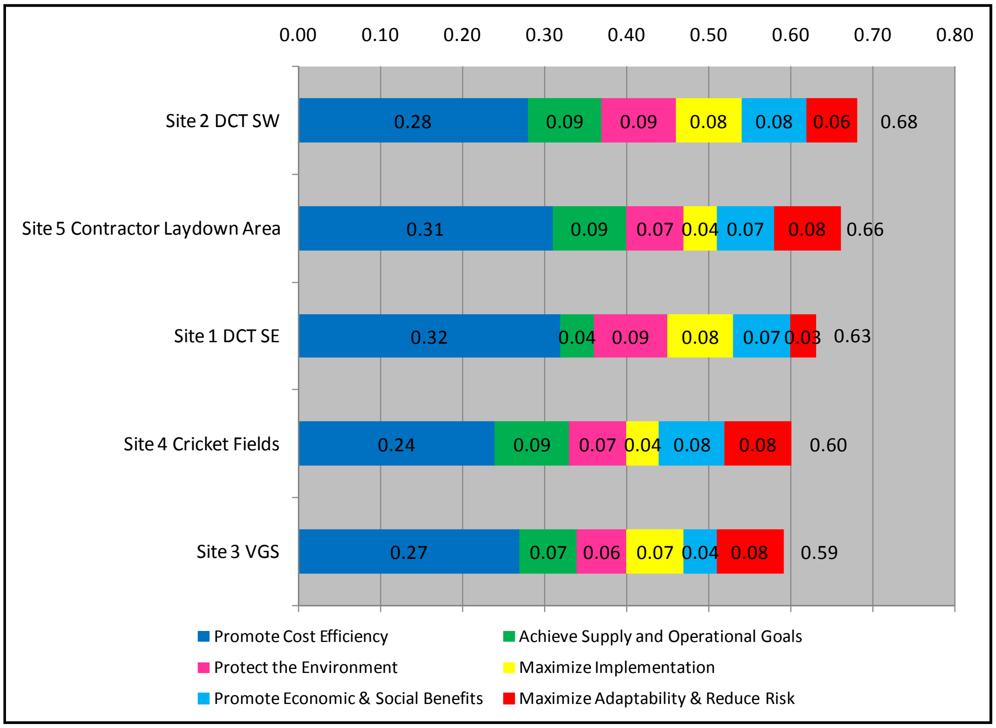
Figure 7-5: Base Condition Sensitivity Run 3 – Social Emphasis



Base Condition Sensitivity Run 4 – Cost Emphasis

The results of Sensitivity Run 4 Cost Emphasis are presented in Figure 7-6. Site 2 DCT SW has the highest ranking, with Site 5 Contractor Lay Down Area ranked second. This sensitivity run demonstrates that even with additional emphasis on costs, Site 2 DCT SW is favorable due to the other five objectives.

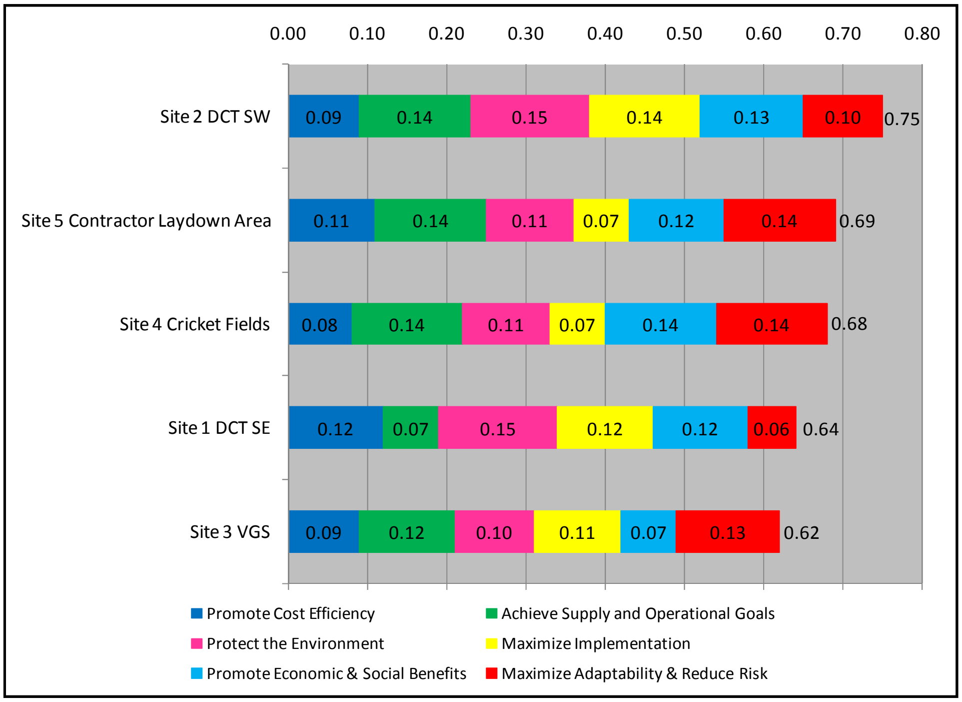
Figure 7-6: Base Condition Sensitivity Run 4 – Cost Emphasis



Base Condition Sensitivity Run 5 – Equal Weights

The results of the Sensitivity Run 5 Equal Weights are presented in Figure 7-7. Site 2 DCT SW remains the highest ranked site alternative with Site 5 Contractor Lay Down Area as the second ranked alternative. Both Site 2 DCT SW and Site 5 Contractor Lay Down Area scored even higher than in the Base Condition. Site 2 DCT SW scores the highest due to high scores on Protect the Environment and Maximize Implementation.

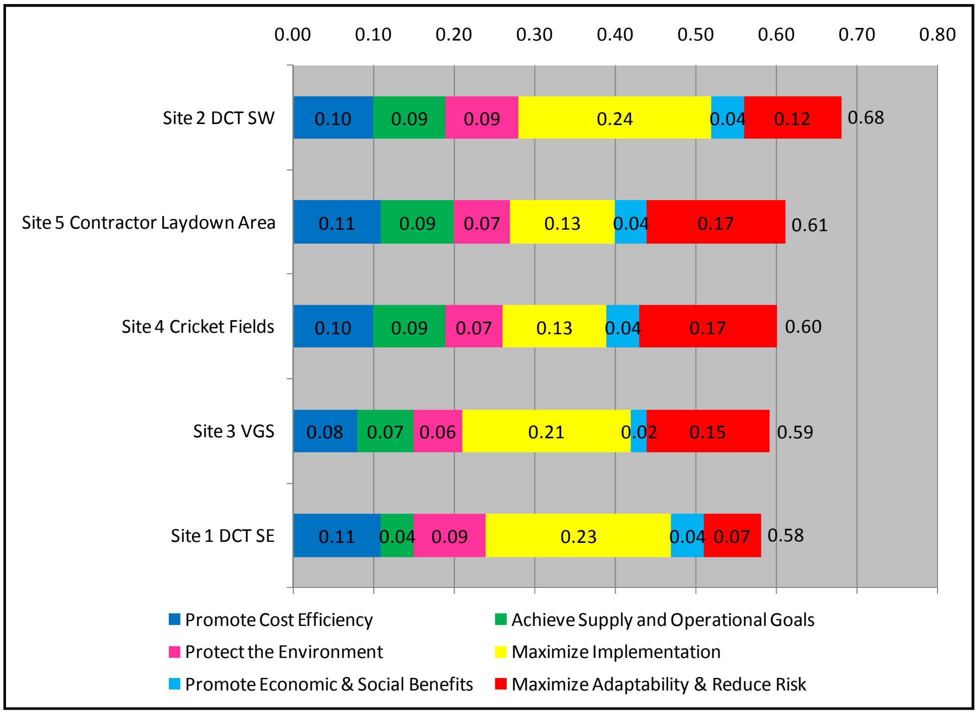
Figure 7-7: Base Condition Sensitivity Run 5 – Equal Weights



Base Condition Sensitivity Run 6 – Modified Cost Scale

The results of the Sensitivity Run 6 Modified Cost Scale are presented in Figure 7-8. For all alternatives, the cost scores are lower and there is a smaller differential between the Promote Cost Efficiency scores than the base run due to the modified cost scale. Site 2 DCT SW remains the highest ranked site alternative due to scoring high on Maximize Implementation. The second, third, fourth, and fifth ranked sites (Site 5 Contractor Lay Down Area, Site 4 Cricket Fields, Site 3 VGS, and Site 1 DCT SE, respectively) have essentially equal scores.

Figure 7-8: Base Sensitivity 6 – Modified Cost Scale Results

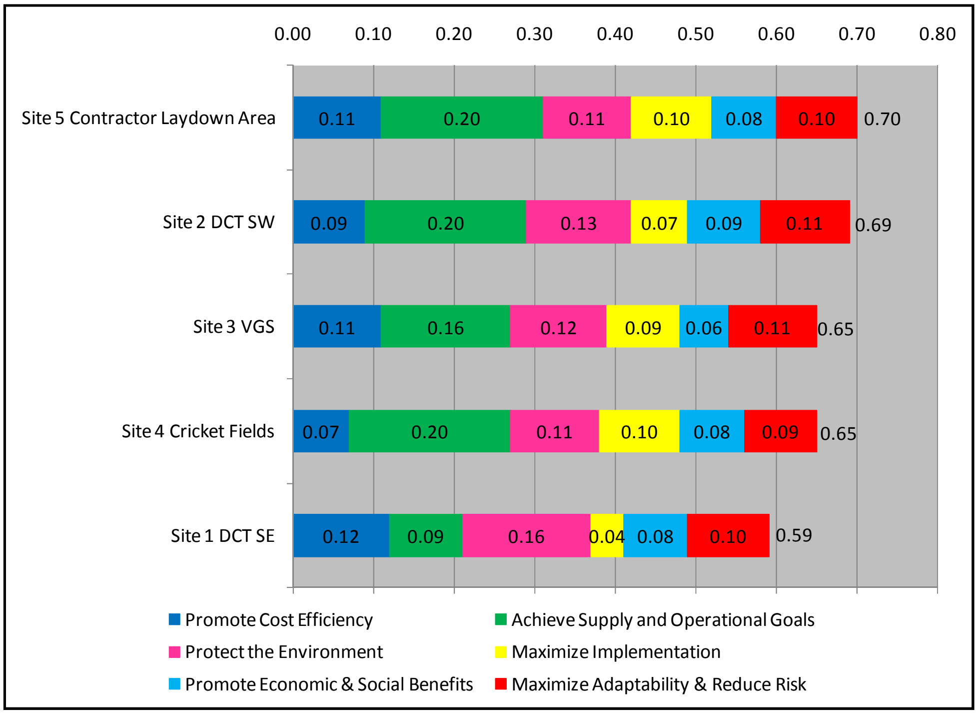


7.3.2 Scenario 1 Sensitivity Results

Scenario 1 Sensitivity Run 1 – Average Weights

The results of Sensitivity Run 1 Average Weights are presented in Figure 7-9. Site 5 Contractor Lay Down Area is the highest ranked site alternative. Site 2 DCT SW is ranked second, but is essentially equal to Site 5 Contractor Lay Down Area. Site 3 VGS is ranked third and is tied with Site 4 Cricket Fields in this run. Site 2 is ranked second in this analysis, down from the highest ranking in most other runs. Site 1 DCT SE is the lowest ranked alternative, down from the fourth ranked alternative in the Scenario 1 base run.

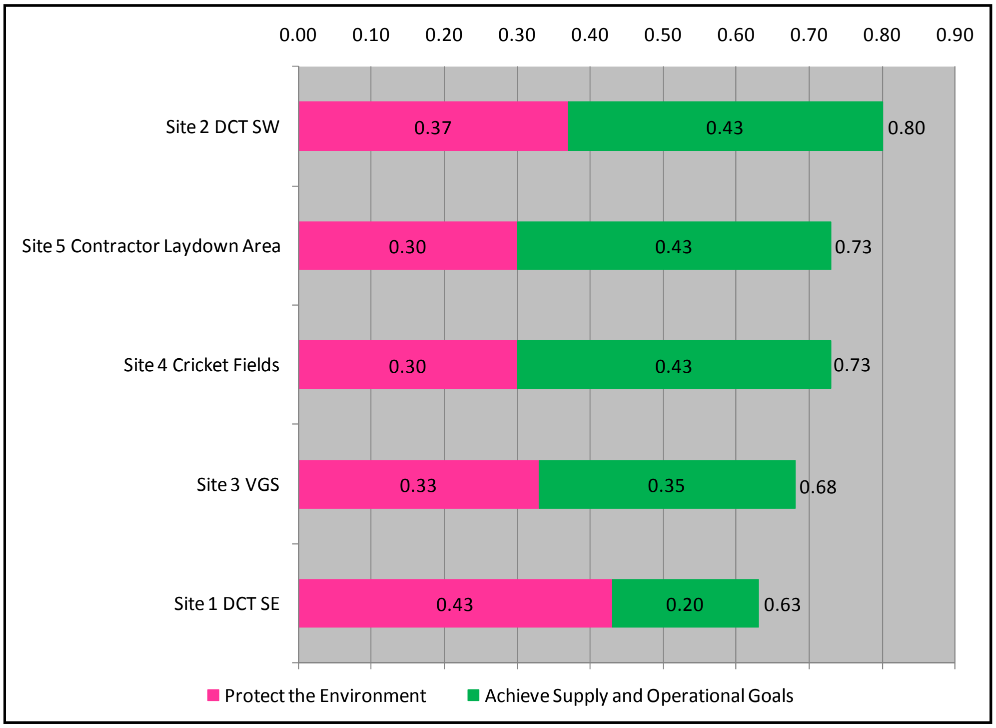
Figure 7-9: Scenario 1 Sensitivity Run 1 – Average Weights



Scenario 1 Sensitivity Run 2 – Environmental Emphasis

The results of Sensitivity Run 2 Environmental Emphasis are presented in Figure 7-10. Site 2 DCT SW is the highest ranked site. Site 2 DCT SW is ranked higher than Site 5 Contractor Lay Down Area due to a higher score for Protect the Environment. Site 5 Contractor Lay Down Area and Site 4 Cricket Fields are tied for second. Site 3 VGS and Site 1 DCT SE are the fourth and fifth ranked sites, respectively, due to lower scores on Achieve Supply & Operational Goals.

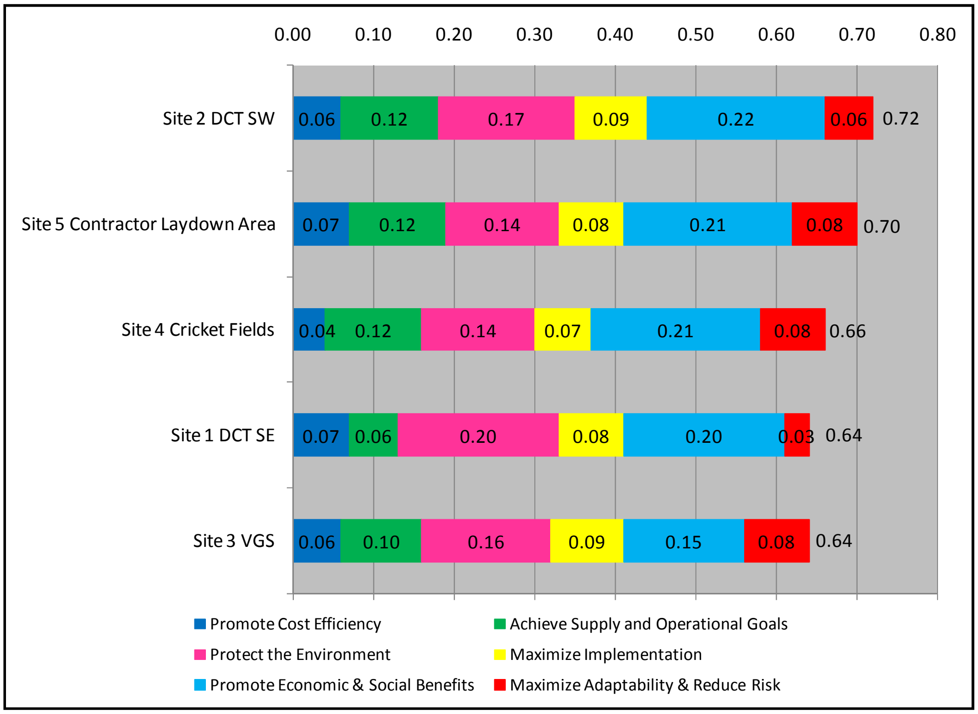
Figure 7-10: Scenario 1 Sensitivity Run 2 – Environmental Emphasis



Scenario 1 Sensitivity Run 3 – Social Emphasis

The results of Sensitivity Run 3 Social Emphasis are presented in Figure 7-11. Site 2 DCT SW is the highest ranked site alternative, due to somewhat higher scores in Achieve Supply & Operational Goals, Protect the Environment, and Promote Economic & Social Benefits. Site 5 Contractor Lay Down Area is the second ranked site. Site 1 DCT SE and Site 3 VGS are the two lowest ranked sites and are scored equally.

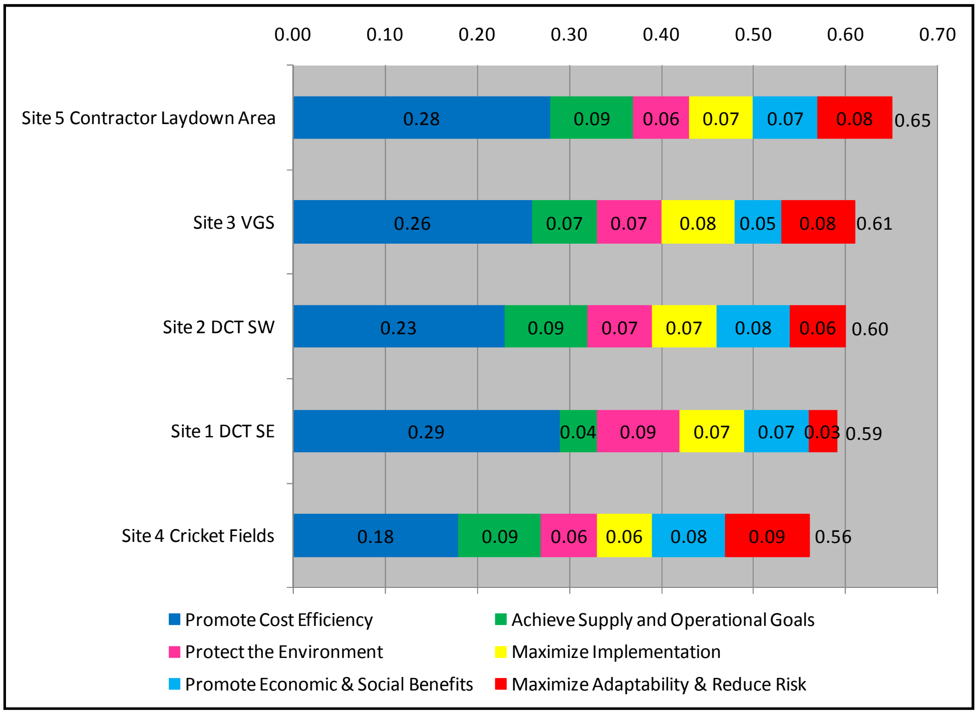
Figure 7-11: Scenario 1 Sensitivity Run 3 – Social Emphasis



Scenario 1 Sensitivity Run 4 – Cost Emphasis

The results of Sensitivity Run 4 Cost Emphasis are presented in Figure 7-12. The overall scores are more impacted by the score on Promote Cost Efficiency. Site 5 Contractor Lay Down Area is the highest ranked site alternative. Site 3 VGS and Site 2 DCT SW are the second and third ranked alternatives, respectively, and since their scores are within 0.01 of each other, they are essentially equal.

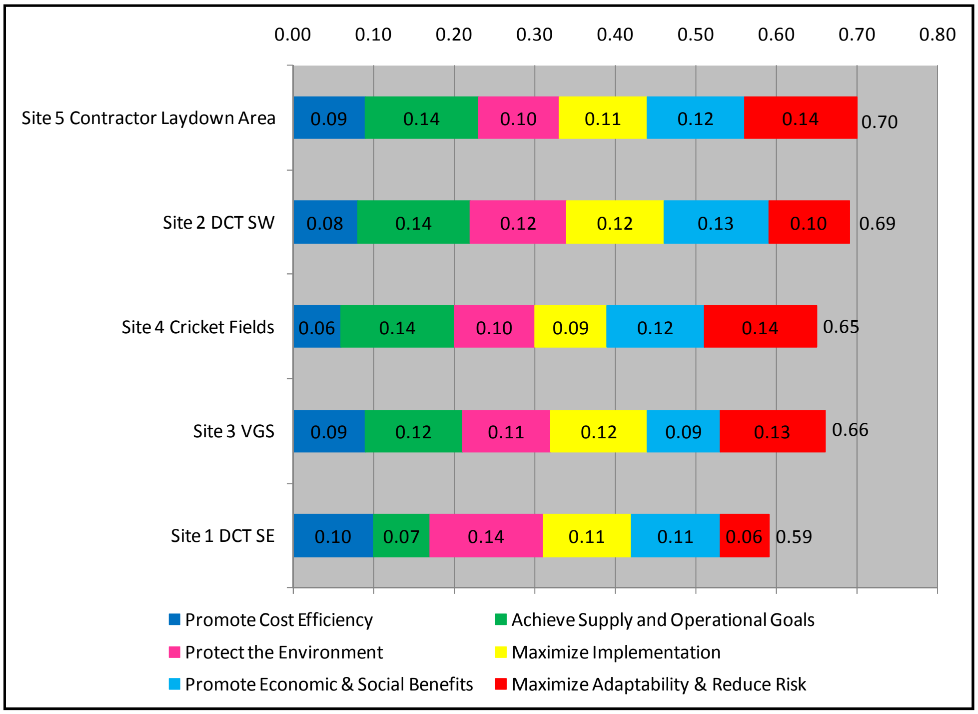
Figure 7-12: Scenario 1 Sensitivity Run 4 – Cost Emphasis



Scenario 1 Sensitivity Run 5 – Equal Weights

The results of Sensitivity Run 5 Equal Weights are presented in Figure 7-13. Site 5 Contractor Lay Down Area is the highest ranked alternative and Site 2 DCT SW is the second ranked alternative. The scores for these two sites are so close they are essentially equal.

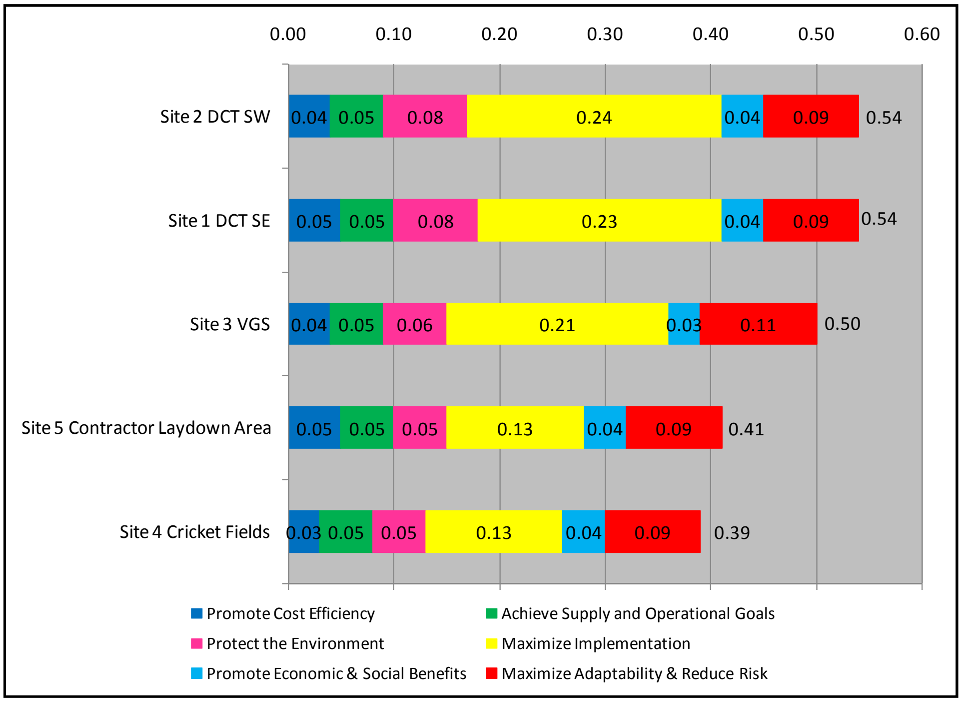
Figure 7-13: Scenario 1 Sensitivity Run 5 – Equal Weights



Scenario 1 Sensitivity Run 6 – Modified Cost Scale

The results of Sensitivity Run 6 Modified Cost Scale are presented in Figure 7-14. For all alternatives, the cost scores are lower and there is a smaller differential between the Promote Cost Efficiency scores than the base run due to the modified cost scale. Site 2 DCT SW and Site 1 DCT SE are tied as the highest ranked site alternatives. The Modified Cost Scale Sensitivity run resulted in Site 3 VGS scoring third. Site 5 Contractor Lay Down Area dropped to the fourth ranked site and is tied with Site 4 Cricket Fields.

Figure 7-14: Scenario 1 Sensitivity Run 6 – Modified Cost Scale



7.4 Summary

Table 7-2 summarizes the number of times that each site alternative was ranked the highest, where dark green reflects a No. 1 (best) ranking, light green a No. 2 ranking, yellow a No. 3 ranking, orange a No. 4 ranking, and red a No. 5 (last) ranking. The ideal situation would be that the sensitivity runs had no effect on the highest ranked site, signifying that the choice of the site was not sensitive to differing viewpoints expressed in the varying weightings.

Based on the results of all 14 decision model runs, Site 2 DCT SW is generally the highest ranked site and Site 5 Contractor Lay Down Area is generally the second ranked site, as described below:

- Site 2 DCT SW was the highest ranked site alternative for 11of the 14 decision model runs. For the Base Condition, Site 2 DCT SW was the highest ranked alternative for all seven decision model runs; for Scenario 1, it was the highest ranked alternative for four of the seven decision model runs. Furthermore, the site was ranked second for Scenario 1 Sensitivity Run 1 RWAG Average Weights and Sensitivity Run 5 Equal Weights, but is essentially equal to the first ranked site, Site 5 Contractor Lay Down Area, on both runs. Taking these two runs into consideration, Site 2 DCT SW is the highest ranked site alternative for 13 of the 14 decision model runs.
- Site 5 Contractor Lay Down Area was the highest ranked site alternative for three of the 14 decision model runs; and as noted above, two of Site 5's highest rankings were essentially equal to Site 2 DCT SW . The site was ranked second for seven of the model runs, more than Site 1 DCT SE, Site 3 VGS, and Site 4 Cricket Fields.

Since the only variation in the Site 2 DCT SW ranking occurs on the Scenario 1 decision model results, they are inspected for strengths and weaknesses of the site. The sensitivity run results indicate that a strength of Site 2 DCT SW is Protect the Environment as it scored first on Scenario 1 Sensitivity Runs 2 and 3. A weakness of this site would be costs as it scored average (third ranking) on Scenario 1 Sensitivity Run 4, which focuses on costs.

Table 7-2: Summary of CDP Results

Condition		Run Description	Site 1 DCT SE	Site 2 DCT SW	Site 3 VGS	Site 4 Cricket Fields	Site 5 Contractor Lay Down Area	Figure Number
Base Condition		Base Condition	4	1	3	5	2	7-1
	1	RWAG Average Weights	5	1	4	3	2	7-3
	2	RWAG Environment Emphasis	5	1	4	2	2	7-4
	3	RWAG Social Emphasis	3	1	5	2	4	7-5
	4	Cost Emphasis	3	1	5	4	2	7-6
	5	Equal Weights	4	1	5	3	2	7-7
	6	Modified Cost Scale	5	1	4	3	2	7-8
Scenario 1		Scenario 1	4	1	2	5	3	7-2
	1	RWAG Average Weights	5	2	3	4	1	7-9
	2	RWAG Environment Emphasis	5	1	4	2	2	7-10
	3	RWAG Social Emphasis	4	1	4	3	2	7-11
	4	Cost Emphasis	4	3	2	5	1	7-12
	5	Equal Weights	5	2	4	3	1	7-13
	6	Modified Cost Scale	1	1	3	5	4	7-14
Number of Times Ranked First			1	11	0	0	3	

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8. Key Findings and Recommendations

This section presents the conclusions and recommendations of the AWPF site assessment based on the detailed evaluation of sites and the key findings from the decision modeling.

8.1 Key Findings of the AWPF Site Assessment Detailed Evaluation

This section summarizes the key findings of the AWPF site assessment detailed evaluation. The findings include an analysis of the results of the decision modeling, as well as a summary of the advantages and disadvantages of the five AWPF sites.

8.1.1 Interpreting the Decision Model Results

As discussed in Section 7, a decision model was employed to compare the five site alternatives using objectives specifically established for the RWMP and tailored for the AWPF site assessment. The detailed decision modeling results are presented in Section 7 for the Base Condition and Scenario 1, as well as for the series of sensitivity runs for both of these conditions. The ranking results from all of the decision model runs are summarized in Table 8-1, where dark green reflects a No. 1 (best) ranking, light green a No. 2 ranking, yellow a No. 3 ranking, orange a No. 4 ranking, and red a No. 5 (last) ranking.

Table 8-1: Summary of Decision Model Runs

Condition		Run Description	Site 1 DCT SE	Site 2 DCT SW	Site 3 VGS	Site 4 Cricket Fields	Site 5 Contractor Lay Down Area	Figure Number
Base Condition		Base Condition	4	1	3	5	2	7-1
	1	RWAG Average Weights	5	1	4	3	2	7-3
	2	RWAG Environment Emphasis	5	1	4	2	2	7-4
	3	RWAG Social Emphasis	3	1	5	2	4	7-5
	4	Cost Emphasis	3	1	5	4	2	7-6
	5	Equal Weights	4	1	5	3	2	7-7
	6	Modified Cost Scale	5	1	4	3	2	7-8
Scenario 1		Scenario 1	4	1	2	5	3	7-2
	1	RWAG Average Weights	5	2	3	4	1	7-9
	2	RWAG Environment Emphasis	5	1	4	2	2	7-10
	3	RWAG Social Emphasis	4	1	4	3	2	7-11
	4	Cost Emphasis	4	3	2	5	1	7-12
	5	Equal Weights	5	2	4	3	1	7-13
	6	Modified Cost Scale	1	1	3	5	4	7-14
Number of Times Ranked First			1	11	0	0	3	

The following key findings are drawn from the results of the decision modeling, and summarized in Table 8-2:

- ***Site 2 DCT SW is the highest (best) ranked alternative*** for both the Base Condition and Scenario 1, and the highest ranked alternative overall. This site was ranked highest on 11 of the 14 decision model runs, ranked second on two of the remaining three runs (and essentially equal to the first ranked site), and ranked third on one runs (where Site 5 Contractor Lay Down Area was ranked highest). On the runs where Site 2 DCT SW scored second (Scenario 1 Sensitivity Run 1 RWAG Average Weights and Sensitivity Run 5 Equal

Weights), its score is only 0.0.1 lower than the highest ranked site (Site 5 Contractor Lay Down Area) so the two sites are assumed to be scored essentially equal on both runs. Taking this into account, Site 2 DCT SW ranked highest on 13 of the 14 decision model runs. Contributing to this high ranking is Site 2's consistently high scores on Achieve Supply & Operational Goals (due to leaving space for future DCTWRP expansions), Protect the Environment (due to minimal habitat impacts), and Maximize Implementation (due to co-locating with an existing BOS facility, less extensive USACE permitting requirements, and ease of implementation). When tested for sensitivity under the Cost Emphasis (Scenario 1 Sensitivity Run 4), Site 2 DCT SW is reduced to the third-place ranking. This is due to Site 5 Contractor Lay Down Area and Site 3 VGS performing better on Promote Cost Efficiency because they have overall lower costs than Site 2 DCT SW.

- ***Site 5 Contractor Lay Down Area is the second highest ranked alternative*** for both the Base Condition and Scenario 1, and the second highest ranked alternative overall. Contributing to this second highest ranking is a lower score in Maximize Implementation, due to the need for a USAGE permit. During the sensitivity runs, this site's ranking improved to highest when tested for sensitivity under the cost emphasis (Scenario 1 Sensitivity Run 4). The higher ranking was due to this site's lower overall cost and higher ranking for expansion capability. Site 5 Contractor Lay Down Area also scored highest under the RWAG Average Weights (Scenario 1 Sensitivity Run 1) and Equal Weights (Scenario 1 Sensitivity Run 5), but is essentially equal to Site 2 DCT SW on both runs.
- ***Site 4 Cricket Fields is the third ranked alternative*** overall when considering the Base Condition, Scenario 1, and the sensitivity runs. Contributing to this middle ranking is the balance of its high capital costs (due to the need to relocate the existing recreational cricket field) and need for a USACE permit with its higher operational flexibility ranking in terms of available space for future wastewater expansions as well as for future AWPF expansions. When tested under the RWAG environmental condition (Base Condition and Scenario 1 Sensitivity Run 2), Site 4 Cricket Fields improved from third to second, since costs and maximizing adaptability were not factored into the run. Conversely, Site 4 Cricket fields decreased from third to fourth/fifth when tested for sensitivity to costs (Sensitivity Run 4).
- ***Site 1 DCT SE is the fourth/fifth ranked alternative*** for both the Base Condition and Scenario 1, and the lowest ranked alternative overall. Contributing to this ranking is that Site 1 DCT SE takes space that could be available for future DCTWRP expansions and similarly has less adjacent space available for future AWPF expansions. Also, it is located within the DCTWRP near existing wastewater processes, which could affect public perception of the source of the AWPF. During the sensitivity test runs, Site 1 DCT SE improved rankings only when tested for the RWAG social emphasis condition (Base Condition Sensitivity Run 3), and cost emphasis condition (Base Condition Sensitivity Run 4). Similarly, it improved to a second ranking when tested against the modified cost scale (Scenario 1 Sensitivity Run 6) when there was very little difference between the costs of the comparison sites.
- ***Site 3 VGS is the fourth/fifth ranked alternative*** overall when considering the Base Condition, Scenario 1, and the sensitivity runs. The VGS scores ranged from second to fifth, and was never ranked first. Contributing to VGS' ranking is its high capital and O&M costs, its reduced discharge flexibility if the AWPF produces off-specification water, its higher greenhouse gas emissions due to the larger UV size to address NDMA and higher pumping

requirements, and its location within an Environmental Justice Improvement Area. When tested for sensitivity against the cost scale (Sensitivity Run 6), VGS's ranking improved from fourth to third (Scenario 1) because the cost differentials between the five sites were reduced with the expanded cost scale, meaning that there was very little difference between the sites. So, while VGS has the second highest estimated capital costs (Scenario 1), the fourth highest estimated capital costs (Base Condition), and the highest O&M costs, these did not detract against its score when tested for sensitivity against a modified cost scale. VGS' ranking reduced to last when tested for sensitivity under the RWAG social emphasis condition, cost emphasis condition, and equal weights (Base Condition Sensitivity Runs 3, 4, and 5, respectively).

In addition, the rankings of the sites do not substantially differ between the Base Condition and Scenario 1, with the exception of more variation in the ranking for the highest ranked site, Site 2 DCT SW, under Scenario 1. The Base Condition assumes separate non-potable reuse and GWR distribution systems, and Scenario 1 assumes a combined NPR and GWR system where tertiary effluent is treated through the AWPF and Title 22 customers are served with AWPF purified recycled water instead of Title 22 recycled water. Meaning, the decision modeling analysis for the both the Base Condition and Scenario 1 results in the following:

- Site 2 DCT SW is the highest ranked site.
- Site 5 Contractor Lay Down Area is the second highest.
- Site 3 VGS is the third highest.
- Site 4 Cricket Fields is tied for the fourth/fifth highest.
- Site 1 DCT SE is tied for the fourth/fifth highest.

Therefore, the selection of a preferred site is not dependent on whether or not to assume separate systems or combined distribution systems. Instead, this technical decision will be made as part of the detailed facilities planning for the preferred site and will likely be combination of the Base Condition and Scenario 1 (i.e., some Title 22 distribution to customers near DCT and purified recycled water to customers served along the existing 54-inch pipeline). The overall decision model rankings are summarized in Table 8-2.

8.1.2 Summary of Advantages and Disadvantages

The advantages and disadvantages, and other site-specific advantages and disadvantages of the five sites, are summarized in Table 8-3.

Table 8-2: Summary of Overall Ranking Based on Decision Model Results

Overall Ranking [a]	Site	Contributors to Rank	Observed Conditions of Sensitivity
1	Site 2 DCT SW	• Operational flexibility in terms of available space for future wastewater expansions and discharge flexibility if the AWPF produces off-specification water • Ability to expedite implementation, since it does not require a new lease agreement with USACE	• Site 2 was <u>consistently ranked highest</u> on 11 of 14 decision model runs • Essentially tied for the highest rank with Site 5 under RWAG average weights and equal weights, resulting in Site 2 <u>improved</u> to ranking highest 13 of 14 decision model runs
2	Site 5 Contractor Lay Down Area	• Operational flexibility in terms of available space for future wastewater expansions and discharge flexibility if the AWPF produces off-specification water • Available space for future AWPF expansions	• Under the RWAG environmental condition, Site 5 <u>reduced</u> to second highest ranking because its location could be relatively less beneficial for habitat than Site 2 • Under the RWAG social emphasis condition, Site 5 <u>reduced</u> to second highest ranking because it provided less economic benefits in terms of temporary jobs than Site 2[b]
3	Site 4 Cricket Fields	• The tradeoff of its high capital costs ($417M) (due to the need to relocate the existing cricket fields) is added operational flexibility in terms of available space for future wastewater expansions as well as for future AWPF expansions	• Under the RWAG environmental condition, Site 4 <u>improved</u> from third to second since costs were not a factor, nor maximizing adaptability
4	Site 1 DCT SE	• Lowest overall capital costs ($336M) • Uses space that could be available for future DCTWRP expansions, and similarly has less adjacent space available for future AWPF expansions. • It is located within the DCTWRP near existing wastewater processes, which could affect public perception of the source of the AWPF	• Under the RWAG social emphasis condition, Site 1 only moderately <u>improved</u> from fourth to third.
5	Site 3 VGS	• Highest O&M costs ($741M) • Reduced discharge flexibility if the AWPF produces off-specification water • Highest relative greenhouse gas emissions due to the larger UV size to address NDMA and higher pumping requirements • Location within an Environmental Justice Improvement Area	• Under the RWAG social emphasis condition, the Site 3 ranking <u>reduced</u> to last, because of its location within an Environmental Justice Improvement Area • Under the cost emphasis condition, the Site 3 ranking <u>reduced</u> to last, because of its high O&M costs (Base Condition)

Footnotes:
a. Based on decision model runs for the Base Condition, Scenario 1, and sensitivity evaluation (see Table 8-1).
b. The temporary jobs estimate is dependent on estimated capital cost. Since Site 1 has the lowest estimated capital cost, it also has the least number of temporary jobs created.

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Table 8-3: Overall Summary of Site Alternative Advantages & Disadvantages

Site	Estimated Costs[a]	Advantages	Disadvantages	Decision Model Ranking
Site 1 DCT SE	Capital: $336M O&M: $669M	Share existing facilities with DCTWRP: security, fence, parking, administration building Discharge flexibility if the AWPF produces off-specification water Discharge AWPF backwash and concentrate to nearby AVORS sewer Located within flood control berm (no additional flood control measures necessary) Minimal habitat impacts since within existing DCTWRP boundary Ability to expedite implementation, since it does not require a new lease agreement with USACE	Usable space is approximately half of space available at other four sites, so would need two-story MF/RO building, and would need to modify existing Phase II CCB to build treatment processes on top Uses space that could be available for future DCTWRP wastewater expansions Provides the least amount of adjacent space for future AWPF expansions It is located within the DCTWRP near existing wastewater processes, which could affect public perception of the source of the AWPF Requires new parallel pipeline and pump station to distribute Title 22 water to NPR customers (Base Condition only)[b]	4/5 (last)
Site 2 DCT SW	Capital: $392M O&M: $669M	Share existing administration building with DCTWRP Discharge flexibility if the AWPF produces off-specification water Discharge AWPF backwash and concentrate to nearby AVORS sewer Located within flood control berm (No additional flood control measures necessary) Minimal habitat impacts since within existing DCTWRP boundary Ability to expedite implementation, since it does not require a new lease agreement with USACE Protects space at DCTWRP for future wastewater expansions	Requires demolition of existing maintenance building and warehouse and reconstruction near existing blower building Provides moderate adjacent space for future AWPF expansions Requires new parallel pipeline and pump station to distribute Title 22 water to NPR customers (Base Condition only)[b]	1 (first)
Site 3 VGS	Capital: $342M O&M: $741M	Close proximity to HSG Uses existing 54-inch pipeline and Balboa Pump Station for Title 22 recycled water pumping (for AWPF influent and non-potable reuse distribution) Protects space at DCTWRP for future wastewater expansions Provides space for future AWPF expansions Physically separated from DCTWRP (Public perception) Minimal habitat impacts since within existing VGS (industrial) boundary	Need security, fence, parking, administration building Requires demolition of existing training towers Requires larger UV system due to higher NDMA formation (results in higher capital and highest O&M cost) Reduced discharge flexibility if the AWPF produces off-specification water Highest relative greenhouse gas emissions due to the larger UV size Located in an Environmental Justice Improvement Area Requires 7.4-mile AWPF backwash and concentrate pipeline	3

Footnotes:

a. Assumes Base Condition. See Section 6 for detailed assumptions.
b. Under Scenario 1, the new parallel pipeline and pump station would not be required for Sites 1, 2, 4, and 5. Instead, would use existing 54-inch pipeline and Balboa Pump Station for AWPF purified recycled water pumping (for both GWR and NPR distribution).

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Table 8-3: Overall Summary of Site Alternative Advantages & Disadvantages (Continued)

Site	Estimated Costs (1)	Advantages	Disadvantages	Decision Model Ranking
Site 4 Cricket Fields	Capital: $417M O&M: $669M	Share existing administration building with DCTWRP Discharge flexibility if the AWPF produces off-specification water Discharge AWPF backwash and concentrate to nearby AVORS sewer Protects space at DCTWRP for future wastewater expansions Provides space for future AWPF expansions	Highest capital costs Requires negotiating lease agreement from USACE Requires purchasing land for and building new Cricket Fields Requires raising site to 100-year flood elevation and compensation for flood storage volume off site Requires new fence and parking Requires new parallel pipeline and pump station to distribute Title 22 water to NPR customers (Base Condition only)[b]	4/5 (last)
Site 5 Contractor Lay Down Area	Capital: $370M O&M: $669M	Lowest capital costs Share existing facilities with DCTWRP: parking and administration building Discharge flexibility if the AWPF produces off-specification water Discharge AWPF backwash and concentrate to nearby AVORS sewer Protects space at DCTWRP for future wastewater expansions Provides space for future AWPF expansions	Requires negotiating lease agreement from USACE Requires raising site to 100-year flood elevation and compensation for flood storage volume off site Requires new fence and parking Requires new parallel pipeline and pump station to distribute Title 22 water to NPR customers (Base Condition only)[b]	2

Footnotes:

a. Assumes Base Condition. See Section 6 for detailed assumptions.

b. Under Scenario 1, the new parallel pipeline and pump station would not be required for Sites 1, 2, 4, and 5. Instead, would use existing 54-inch pipeline and Balboa Pump Station for AWPF purified recycled water pumping (for both GWR and NPR distribution).

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8.2 Recommendations

Determining the potential location of the AWPF is a key planning consideration for the City's recycled water program. This TM outlines the multi-criteria decision making process that was used to evaluate the potential sites in the San Fernando Valley for the AWPF. Fifty-nine sites were identified as part of the site identification process, which was reduced to five sites after the threshold screening. A detailed evaluation was completed for these five sites for the purpose of selecting the staff preferred site to use as the basis for master planning. The detailed evaluation included multi-criteria decision modeling to evaluate and compare the five sites on six objectives. The results of the decision modeling, including sensitivity runs, are summarized in Section 7. Based on these results, Site 2 DCT SW scored the highest of the five alternatives.

The short-list of five sites was also evaluated using three, specific critical criteria that were identified by LADWP and BOS management. These criteria include:

- BOS already has related facilities and staffing at the site to support the operation of the AWPF for GWR. Although new facilities will be built for GWR, there are benefits and economies of operation having new facilities alongside existing operational facilities and staff. This criterion is important since BOS will be leading the operations for the AWPF.
- The site is within the boundaries of the existing berm or outside of the Sepulveda Flood Control Basin to minimize the USACE permitting needs, which are anticipated to be extensive.
- The site is not in an area of potential future expansion to the existing treatment processes for producing tertiary treated effluent at DCTWRP.

In addition, cost is an important and logistical parameter to be considered in selecting a staff-preferred site for the AWPF.

Table 8-4 summarizes the capital costs, O&M costs, and compliance with the three criteria presented above. As shown in the table, only Site 2 DCT SW meets each of the three criteria.

Table 8-4: Critical Criteria for Evaluation of Five Candidate Sites

Critical Criteria	Site 1 DCT SE	Site 2 DCT SW	Site 3 VGS	Site 4 Cricket Fields	Site 5 Contractor Lay Down Area
Bureau of Sanitation (BOS) already has related facilities and staffing at the site to support the operation of the AWPF for GWR. Although new facilities will be built for GWR, there are benefits and economies of operation having new facilities alongside existing operational facilities and staff.	✓	✓		✓	✓
Site is within the boundaries of the existing berm or outside of the Sepulveda Flood Control Basin.	✓	✓	✓		
Site is not in an area of potential future expansion to the existing treatment processes for producing tertiary treated effluent at DCTWRP.		✓	✓		

Note:
✓ = Site meets criterion.

Therefore, based on the multi-criteria decision evaluation and the three critical criteria, the City selected Site 2 DCT SW as the staff-preferred location for the proposed project. Therefore, for the GWR Master Planning Report, the RWMP team assumed that the AWPF would be located at DCTWRP, within the flood control berm and in the southwest location.

All sites will be evaluated equally for environmental impacts as part of the environmental documentation. The AWPF site will be selected as part of the environmental documentation process.

Appendix A

Threshold Screening Criteria Evaluation

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Appendix A: Threshold Screening Criteria Evaluation

Site No.	Address	Description	Zoning[a]	Adjacent to Residential[b]	Area (sq ft)	Available Size[c]	Developable[d]	Geotechnical[e]	Candidate Sites[f]
1	7140 Louise Ave Reseda 91406	Louise Park	X	X	290,320	X	O		N
2	16400 Victory Bl Van Nuys 91406	Van Nuys Golf Course	O	X	2,452,593	O	X		N
3	15110 Erwin St Van Nuys 91411	Delano Park	O	X	264,189	X	O		N
4	14101 Husto St Van Nuys 91423	Sherman Oaks Rec & Parks Service	O	X	2,855,483	O	O		N
5	11430 Chandler Blvd N Hollywood 91601	North Hollywood Park	O	X	2,443,621	O	O		N
6	11117 Vicotry Bl N Hollywood 91606	Victory/Vineland Park	O	X	282,342	X	O		N
7a	7100 Whitsett Ave Sun Valley 91605	Valley Plaza Park-open space	O	O	208,770	X	O	O	N
7b	7100 Whitsett Ave Sun Valley 91605	Valley Plaza Park-recreation space	O	O	3,084,550	O	X	O	N
8	13101 Erwin St Van Nuys 91401	Erwin Park	O	X	223,718	X	O		N
9	14301 Vanowen Ave Van Nuys 91405	Van Nuys Recreation Center	X	X	169,900	X	O		N
10	14345 Arminta St Panorama City 91402	Fire Station #81	O	X	200,785	X	X		N
11	16400 Roscoe Bl LA 91406	Sod Farm	O	O	2,444,812	O	X	O	N
12	17141 Nordhoff St Northridge 91325	Dearborn Park	O	X	397,149	O	O		N
13	16730 Chatsworth St Granada Hills 91344	Granada Hills Park & Rec Center	O	X	798,822	O	O		N
14	11121 N Sepulveda Bl Mission Hills 91345	North Valley Police Station	O	X	149,862	X	X		N
15	14841 Brand Bl Los Angeles 91345	Brand Park	X	O	805,460	O	O		N
16	10940 Sepulveda Bl Mission Hills 91345	Andres Pico Adobe Park	O	X	95,781	X	X		N
17	13925 Paxton St Pacoima 91331	Paxton Park & Recreation Center	O	O	1,232,914	O	X		N
18	10230 Woodman Av Mission Hills 91345	Devonwood Park	O	O	210,699	X	X	X	N
19	8798 Parthenia Pl Los Angeles 91343	Landscape Median Island	O	O	157,727	X	O		N
20	8737 Kester Ave Van Nuys 91402	Sepulveda Recreation Center	O	X	464,267	O	O		N
21	8600 Hazeltine Ave Panorama City 91402	Panorama Recreation Center	O	X	261,415	X	O		N
22	13306 Branford Pk Arletta 91331	Branford Park	O	X	591,807	O	O		N
23	8787 Sharp Ave Sun Valley 91352	Sheldon-Arleta Landfill	O	O	1,950,000	O	X		N
24	8851 Laurel Canyon Sun Valley 91352	Fernangeles Rec Center	O	X	403,468	O	O		N
25	12541 Blythe St Sun Valley 91605	Strathern Park	O	X	918,541	O	O		N
26	8122 Fair Ave Sun Valley 91352	Sun Valley Park & Rec Center	O	X	751,872	O	O		N
27	8360 San Fernando Rd Los Angeles 91352	Parking Lot Sun Valley Metrolink	O	X	108,405	X	O		N
28	9121 Cabrini Dr Sun Valley 91504	Verdugo Mountain Park	O	X	23,462,994	O	O		N
29	9224 Sunland Bl Sun Valley 91352	New Fire Station #77	O	X	67,678	X	X		N
30	11225 Wicks St Sun Valley 91352	Stonehurst Park	O	X	597,163	O	O		N
31	12453 Osborne St Sun Valley 91352	Roger Jessup Park	O	O	627,886	O	X	O	N
32	11798 Foothill Bl Sun Valley 91342	Hansen Dam Golf Course/Park	O	O	104,934	X	O		N
33	11502 Foothill Bl Sun Valley 91342	Hansen Dam Golf Course/Park	X	O	221,007	X	X		N
34	Wheatland Ave Los Angeles 91342	Big Tujunga Mitigation Bank	O	O	1,014,098	O	X	X	N
35	Water and Power Rd Los Angeles 91342	Green Verdugo Reservoir	X	O	4,574,968	O	O		N
36	16244 Nordhoff St North Hills 91343	Nordhoff Rec Center/Youth Center	O	X	306,678	O	X		N
37	14832 Raymer St Van Nuys 91405	Raymer St Car Shelter	O	O	270,330	X	X		N
38	14401 Saticoy St Van Nuys 91405	LADWP Valley Service/Metrolink Parking	O	O	1,560,005	O	X		N
39	12730 Saticoy St N Hollywood 91605	LADWP East Valley Yard	O	O	317,275	O	X		N
40	12544 Saticoy St N Hollywood 91605	Parking Enforcement Valley Area	O	O	156,346	X	X		N
41	11761 Roscoe Bl Sun Valley 91352	LADWP Sun Valley Water Yard	O	O	360,758	O	X		N
42	6240 Sylmar Ave Van Nuys 91401	City Hall, Court House, Police Station	O	O	457,719	O	X		N
43	14651 Oxnard St Van Nuys 91411	LADOT/BOS and St. Services	O	O	123,431	X	O		N
44	14400 Oxnard St Van Nuys 91411	Metro Buildings and Parking	O	O	258,516	X	X		N
45	11000 Pendleton St Sun Valley 91352	Pendleton Gravel Pit	O	O	653,038	O	X		N

Appendix A: Threshold Screening Criteria Evaluation

Site No.	Address	Description	Zoning[a]	Adjacent to Residential[b]	Area (sq ft)	Available Size[c]	Developable[d]	Geotechnical[e]	Candidate Sites[f]
46	12760 Osborne St Pacoima 91331	Foothill Police Station	O	X	92,278	X	X		N
47	16461 Sherman Way Van Nuys 91406	Van Nuys Airport	O	O	25,150,665	O	X		N
48	6100 Woodley Ave Van Nuys 91406	DCT	O	O	3,011,180	O	O		Y
49	11801 Sheldon St Sun Valley 91352	VGS	O	O	6,621,240	O	O		Y
50	6100 Woodley Ave Van Nuys 91406	Sepulveda Basin Cricket Fields	O	O	637,796	O	O		Y
N1	12746 Burbank Bl Los Angeles 91607	3-50,000 Watt Radio Towers	X	X	830,289	O	X		N
N2	7004 Vineland Ave Burbank 91605	Runway Protection Zone for Burbank Airport	O	O	1,297,757	O	X		N
N3	17106 Victory Bl Los Angeles 91406	Open Space near Military Recruitment Center	O	O	3,298,082	O	O		N
N4	17490 Oxford St Los Angeles 91406	Agricultural Plot near Encino Velodrome	O	O	1,554,828	O	O		N
N5	16454 Burbank Bl Los Angeles 91316	Agricultural Plot near Sevulveda Dam	O	O	2,133,843	O	X		N
N6	13466 Paxton St Los Angeles 91331	Lowes Hardware Building	O	O	1,187,948	O	X		N
N7	14800 Lassen St Los Angeles 91345	4-30,000 Watt Radio Towers	X	X	326,914	O	X		N
N8	12234 Osborne St Lake View Terraces 91342	Open Space near Hansen Dam Park	O	O	981,061	O	O		N
N9	7500 Tyrone Ave Van Nuys 91405	Time Warner Cable Building	O	O	352,056	O	X		N

Footnotes

a--X: Parcel is zoned as Residential. O: Parcel is zoned as Agricultural, Commercial, Industrial, Open Space, Parking, or Public Facilities.

b--X: Parcel is adjacent to Residential area on two or more sides. O: Parcel is adjacent to Residential area on less than two sides.

c--X: Parcel size is less than 300,000 sf. O: Parcel size is larger than 300,000 sf.

d--X: Parcel is not developable due to obvious critical failures, which are noted on the last column. O: Parcel is developable.

e--X: Parcel has possible hazard of future rupture, liquefaction, landslide/rockfall, debris flows, floods or methane contamination, O: Parcel does not have any apparent hazards

f--N: Parcel will not be considered further. Y: Parcel will be added to the short-list to be evaluated further

Appendix B

Cost Estimates

B-1 Capital Cost

B-2 O&M Cost

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B-м /l-Ljλűl-f Cost

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Site No.	1			2			3			4			5		
Site Name	DCT SE			DCT SW			VGS			Cricket Fields			Contractor Laydown Area		
	Item	Notes	Cost	Item	Notes	Cost	Item	Notes	Cost	Item	Notes	Cost	Item	Notes	Cost
	AWPF Capacity		30.6	AWPF Capacity		30.6	AWPF Capacity		30.6	AWPF Capacity		30.6	AWPF Capacity		30.6
	Capacity Cost of Structures	a	$58,800,000	Capacity Cost of Structures	a	$58,800,000	Capacity Cost of Structures	a	$58,800,000	Capacity Cost of Structures	a	$58,800,000	Capacity Cost of Structures	a	$58,800,000
	Capacity Cost of Equipment	a	$104,300,000	Capacity Cost of Equipment	a	$104,300,000	Capacity Cost of Equipment	a	$104,300,000	Capacity Cost of Equipment	a	$104,300,000	Capacity Cost of Equipment	a	$104,300,000
	Two-story MF/RO Building (Incremental cost)	b	$515,000	Two-story MF/RO Building	b	$515,000			$0			$0			$0
			$0	New parking and fence	c	$65,000	New fence, security gate, parking, and administration building	d	$5,740,000	New parking, fence and site security	e	$248,000	New parking, fence and site security	e	$248,000
	Modification of Phase II CCB for MF/RO Break Tank (Incremental cost)	f	$765,000			$0			$0			$0			$0
			$0			$0	Additional UV Capacity (Incremental cost)	g	$1,390,000			$0			$0
			$0	Demo existing maintenance and warehouse bldgs	h	$219,000			$0			$0			$0
			$0	Add new maintenance and warehouse bldgs	i	$14,000,000			$0			$0			$0
			$0			$0			$0	Purchase new land to relocate Cricket Fields	j	$27,200,000			$0
			$0			$0			$0	Raise site grade to 100-yr flood	k	$3,080,000	Raise site grade to 100-yr flood	l	$184,000
			$0			$0			$0	Compensate for flood water storage volume off-site	m	$803,000	Compensate for flood water storage volume off-site	n	$318,000
	Add new pumps at existing Balboa PS for AWPF product water pumping	o	$762,000	Add new pumps at existing Balboa PS for AWPF product water pumping	o	$762,000	Add new pumps at existing Balboa PS for AWPF influent water and Title 22 NPR water pumping	p	$1,520,000	Add new pumps at existing Balboa PS for AWPF product water pumping	o	$762,000	Add new pumps at existing Balboa PS for AWPF product water pumping	o	$762,000
	Add new Title 22 Pump Station at DCT	q	$1,300,000	Add new Title 22 Pump Station at DCT	q	$1,300,000			$0	Add new Title 22 Pump Station at DCT	q	$1,300,000	Add new Title 22 Pump Station at DCT	q	$1,300,000
Base Condition			$0			$0	Add new AWPF Product Water Pump Station at VGS	r	$627,000			$0			$0
	New 18" (10.3 miles) RW pipeline for Title 22 NPR	s	$40,300,000	New 18" (10.3 miles) RW pipeline for Title 22 NPR	s	$40,300,000			$0	New 18" (10.3 miles) RW pipeline for Title 22 NPR	s	$40,300,000	New 18" (10.3 miles) RW pipeline for Title 22 NPR	s	$40,300,000
			$0	New 48" (500 ft) pipeline to convey Secondary/Tertiary effluent from DCT to AWPF influent	t	$397,000			$0			$0	New 48" (2050 ft) pipeline to convey Secondary/Tertiary effluent from DCT to AWPF influent	u	$1,630,000
			$0	New 42" (1500 ft) pipeline to convey AWPF product water to Balboa Pump Station	v	$1,040,000	New 42" (500 ft) AWPF Product Water pipeline	w	$792,000			$0	New 42" (1450 ft) pipeline to convey AWPF product water to Balboa Pump Station	x	$1,010,000
	New 27" PVC (450 ft) AWPF backwash and concentrate pipeline	y	$459,000	New 27" PVC (450 ft) AWPF backwash and concentrate pipeline	y	$459,000	New 18" PVC (7.4 miles) AWPF backwash and concentrate pipeline	z	$18,600,000	New 27" PVC (450 ft) AWPF backwash and concentrate pipeline	y	$459,000	New 27" PVC (500 ft) AWPF backwash and concentrate pipeline	aa	$511,000
			$0			$0	Add new AWPF Backwash and Concentrate Pump Station at VGS	ab	$542,000			$0			$0
			$0			$0	New Wet Well upstream of AWPF backwash and concentrate pump station	ac	$295,000			$0			$0
	New Phase 4 Equalization Basin	ad	$9,538,000	New Phase 4 Equalization Basin	ad	$9,538,000	New Phase 4 Equalization Basin	ad	$9,538,000	New Phase 4 Equalization Basin	ad	$9,538,000	New Phase 4 Equalization Basin	ad	$9,538,000
	Subtotal		**$216,700,000**	**Subtotal**		**$231,700,000**	**Subtotal**		**$202,100,000**	**Subtotal**		**$246,800,000**	**Subtotal**		**$218,900,000**
	Contingency (30%)		***$65,000,000***	***Contingency (30%)***		***$69,500,000***	***Contingency (30%)***		***$60,600,000***	***Contingency (30%)***		***$74,000,000***	***Contingency (30%)***		***$65,700,000***
	Construction Total		**$281,700,000**	**Construction Total**		**$301,200,000**	**Construction Total**		**$262,700,000**	**Construction Total**		**$320,800,000**	**Construction Total**		**$284,600,000**
	Implementation Costs (30%)		***$84,500,000***	***Implementation Costs (30%)***		***$90,400,000***	***Implementation Costs (30%)***		***$78,800,000***	***Implementation Costs (30%)***		***$96,200,000***	***Implementation Costs (30%)***		***$85,400,000***
	TOTAL CAPITAL COST		**$366,000,000**	**TOTAL CAPITAL COST**		**$392,000,000**	**TOTAL CAPITAL COST**		**$342,000,000**	**TOTAL CAPITAL COST**		**$417,000,000**	**TOTAL CAPITAL COST**		**$370,000,000**

General Notes:
1. All costs are in January 2011 dollars. ENR construction cost index for January 2011 for Los Angeles, CA is 10000.30
2. Capital costs are escalated from the June 2006 O&M costs presented in Phase II Integrated Resources Plan for the Wastewater Program Technical Memorandum Tillman Advanced Treatment System Basis of Design Criteria and Cost Estimate, dated June 27, 2006, and prepared by CH:CDM.

Footnotes:
a. AWPF is sized for 30.6 mgd product water capacity (See Section 2.1.4) for all sites.

b. Incremental Cost = Cost to construct one two-story MF/RO building - Cost to construct two single-story buildings.
c. Relocate parking to west of property line and add new fence. See Section 5.2.2.
d. Install new parking, fence, site security and administration building. See Section 5.3.2.
e. Install new parking and fence. See Sections 5.4.2 and 5.5.2.
f. Incremental Cost = Cost to modify eastern half of Phase II CCB to use as MF/RO Break Tank - Cost to install a new MF/RO Break Tank. Assumed that that MF/RO Break Tank would be sized for 1 MG storage capacity. See Section 5.1.2.
g. Incremental Cost = Cost to install a UV system sized for 1.2 log reduction of NDMA - Cost to install a UV system sized for 1.7 log reduction of NDMA. The cost of UV system is based on the information provided by Calgon Carbon. See Section 5.3.2.

h. Demolish existing maintenance building and warehouse west of Phase I CCB. Assumed existing maintenance building and warehouse has combined footprint of 23,200 sf. See Section 5.2.2.
i. Construct new maintenance building and warehouse adjacent to existing blower building at DCT. Assumed maintenance building and warehouse has combined footprint of 23,200 sf. See Section 5.2.2.
j. Purchase new land equivalent to the area of two existing cricket fields (11.5 acres). Assumed land purchase cost of $3 million/acre, based on recent commercial sales record in the San Fernando Valley. See Section 5.4.2.
k. Raise approximately 313,000 sf of site area by 8 ft to 100-yr flood elevation of 712 ft. See Section 5.4.2.
l. Earthwork on 240,000 sf of site area to raise the site by up to 2 ft to 100-yr flood elevation of 712 ft. See Section 5.5.2.
m. Excavate off-site within the Sepulveda Flood Control Basin to compensate for the storage volume lost when site is elevated or a flood control berm is constructed around the site. Includes excavation volume of 93,000 cubic yard (assumed equivalent to flood water storage volume lost when approximately 313,000 sf of site is raised by 8 ft). See Section 5.4.2.
n. Excavate off-site within the Sepulveda Flood Control Basin to compensate for the storage volume lost when site is elevated or a flood control berm is constructed around the site. Includes excavation volume of 8,900 cubic yard (assumed equivalent to flood water storage volume lost when half of the site (120,000 sf) is raised by 2 ft). See Section 5.5.2.
o. Expand existing Balboa Pump Station by adding one 800 hp capacity pump. The expanded Balboa Pump Station would have a total of four pumps, three duty and one standby, with the total pumping capacity of 31 mgd. See Section 5.1.3
p. Expand existing Balboa Pump Station by adding two 800 hp capacity pumps. The expanded Balboa Pump Station would have a total of five pumps, four duty and one standby, with the total pumping capacity of 39 mgd. See Section 5.3.3.

q. New Title 22 Recycled Water Pump Station with three 400 hp capacity pumps (two duty and one standby). Total capacity of new Title 22 Recycled Water Pump Station is 8 mgd. See Section 5.1.3.
r. New AWPF Product Water Pump Station with five 60 hp capacity pumps (four duty and one standby). Total capacity of new AWPF Product Water Pump Station is 31 mgd. See Section 5.3.3.
s. 10.3 miles of 18-inch steel forcemain, constructed parallel to existing 54-inch RW pipeline to convey Title 22 recycled water from DCT to the 7 MG Hansen Tank at VGS, which would be tied to the Title 22 NPR distribution system to serve existing and Tier 1 NPR users. Includes construction costs for two-freeway crossing and one railroad crossing. See Section 5.1.3.
t. 500 ft of 48-inch steel forcemain to convey DCT tertiary (or secondary) effluent to the AWPF influent located at Site 2 DCT SW. Measured from a point south of the tertiary filters between Phase I and Phase II CCBs to the MF feed pumps shown on Figure 5-7.

u. 2050 ft of 48-inch steel forcemain to convey DCT tertiary (or secondary) effluent to the AWPF influent located at Site 5 Contractor Lay Down Area. Measured from a point south of the tertiary filters between Phase I and Phase II CCBs to the MF feed pumps shown on Figure 5-15.

v. 1500 ft of 42-inch steel forcemain to convey AWPF product water from Site 2 DCT SW to the Balboa Pump Station. Assumed pipe may need to be routed to the south side of the berm to avoid existing piping within the south access road.
w. 500 ft of 42-inch steel forcemain to convey AWPF product water from VGS to the Hansen Spreading Grounds. Includes construction cost for Tujunga Wash crossing. See Section 5.3.3.
x. 1450 ft of 42-inch steel forcemain to convey AWPF product water from Site 5 Contractor Lay Down Area to the Balboa Pump Station.
y. 450 ft of 27-inch PVC gravity pipe to discharge AWPF backwash and concentrate to AVORS on-site.
z. 7.4 miles of 18-inch PVC forcemain pipe to discharge AWPF backwash and concentrate to VORS. Includes construction cost for three freeway crossings and one railroad crossing.
aa. 500 ft of 27-inch PVC gravity pipe to discharge AWPF backwash and concentrate to AVORS on-site.
ab. New AWPF backwash and concentrate Pump Station with two 200 hp capacity pumps (one duty and one standby). The pump station is needed for system reliability after Phase II construction build-out.
ac. Assumed 10 ft x 10 ft x 10 ft wetwell for operational flexibility. The wetwell is not intended to provide AWPF backwash and concentrate storage.
ad. Cost to construct nine new equalization basins for a total capacity of 3.24 MG. This is derived from the cost estimate presented in the DCT Dry Weather Flow Equalization Evaluation Technical Memorandum, dated January 21, 2010, and prepared by RMC:CDM, and escalated to January 2011 costs.

Site No.	1			2			3			4			5		
Site Name	DCT SE			DCT SW			VGS			Cricket Fields			Contractor Laydown Area		
	Item	Notes	Cost	Item	Notes	Cost	Item	Notes	Cost	Item	Notes	Cost	Item	Notes	Cost
Scenario 1	AWPF Capacity		32.4	AWPF Capacity		32.4	AWPF Capacity		30.6	AWPF Capacity		32.4	AWPF Capacity		32.4
	Capacity Cost of Structures	a	$62,300,000	Capacity Cost of Structures	a	$62,300,000	Capacity Cost of Structures	a	$58,800,000	Capacity Cost of Structures	a	$62,300,000	Capacity Cost of Structures	a	$62,300,000
	Capacity Cost of Equipment	a	$110,400,000	Capacity Cost of Equipment	a	$110,400,000	Capacity Cost of Equipment	a	$104,300,000	Capacity Cost of Equipment	a	$110,400,000	Capacity Cost of Equipment	a	$110,400,000
	Two-story MF/RO Building (Incremental Cost)	b	$515,000	Two-story MF/RO Building	b	$515,000			$0			$0			$0
			$0	New parking and fence	c	$65,000	New fence, security gate, parking, and administration building	d	$5,740,000	New parking, fence and site security	e	$248,000	New parking, fence and site security	e	$248,000
	Use eastern half of Phase II CCB for MF/RO Break Tank and UV Building (Incremental Cost)	f	$765,000			$0			$0			$0			$0
			$0			$0	Additional UV Capacity (Incremental Cost)	g	$1,390,000			$0			$0
			$0	Demo existing maintenance and warehouse bldgs and relocate to north	h	$219,000			$0			$0			$0
			$0	Add new maintenance and warehouse bldgs	i	$14,000,000			$0			$0			$0
			$0			$0			$0	Purchase new land to relocate Cricket Fields	j	$27,200,000			$0
			$0			$0			$0	Raise site grade or build berm around site for 100-yr flood	k	$3,080,000	Raise site grade or build berm around site for 100-yr flood	l	$184,000
			$0			$0			$0	Compensate for flood water storage volume off-site	m	$803,000	Compensate for flood water storage volume off-site	n	$318,000
	Add new pumps at existing Balboa PS for AWPF product water pumping	o	$762,000	Add new pumps at existing Balboa PS for AWPF product water pumping	o	$762,000	Add new pumps at existing Balboa PS for AWPF influent water pumping	p	$1,520,000	Add new pumps at existing Balboa PS for AWPF product water pumping	o	$762,000	Add new pumps at existing Balboa PS for AWPF product water pumping	o	$762,000
			$0			$0	Add new AWPF Product Water Pump Station at VGS	q	$627,000			$0			$0
			$0	New 48" (500 ft) pipeline to convey Secondary/Tertiary effluent from DCT to AWPF influent	r	$397,000			$0			$0	New 48" (2050 ft) pipeline to convey Secondary/Tertiary effluent from DCT to AWPF influent	s	$1,630,000
			$0	New 42" (1500 ft) pipeline to convey AWPF product water to Balboa Pump Station	t	$1,040,000	New 42" (500 ft) AWPF Product Water pipeline	u	$792,000			$0	New 42" (1450 ft) pipeline to convey AWPF product water to Balboa Pump Station	v	$1,010,000
	New 27" PVC (450 ft) AWPF backwash and concentrate pipeline	w	$459,000	New 27" PVC (450 ft) AWPF backwash and concentrate pipeline	w	$459,000	New 18" PVC (7.4 miles) AWPF backwash and concentrate pipeline	x	$18,600,000	New 27" PVC (450 ft) AWPF backwash and concentrate pipeline	w	$459,000	New 27" PVC (500 ft) AWPF backwash and concentrate pipeline	y	$511,000
			$0			$0	Add new AWPF Backwash and Concentrate Pump Station at VGS	z	$542,000			$0			$0
			$0			$0	New Wet Well upstream of AWPF backwash and concentrate pump station	aa	$295,000			$0			$0
	New Phase 4 Equalization Basin	ab	$9,540,000	New Phase 4 Equalization Basin	ab	$9,540,000	New Phase 4 Equalization Basin	ab	$9,540,000	New Phase 4 Equalization Basin	ab	$9,540,000	New Phase 4 Equalization Basin	ab	$9,540,000
	Subtotal		**$184,700,000**	**Subtotal**		**$199,700,000**	**Subtotal**		**$202,100,000**	**Subtotal**		**$214,800,000**	**Subtotal**		**$186,900,000**
	Contingency (30%)		***$55,400,000***	***Contingency (30%)***		***$59,900,000***	***Contingency (30%)***		***$60,600,000***	***Contingency (30%)***		***$64,400,000***	***Contingency (30%)***		***$56,100,000***
	Construction Total		**$240,100,000**	**Construction Total**		**$259,600,000**	**Construction Total**		**$262,700,000**	**Construction Total**		**$279,200,000**	**Construction Total**		**$243,000,000**
	Implementation Costs (30%)		***$72,000,000***	***Implementation Costs (30%)***		***$77,900,000***	***Implementation Costs (30%)***		***$78,800,000***	***Implementation Costs (30%)***		***$83,800,000***	***Implementation Costs (30%)***		***$72,900,000***
	TOTAL CAPITAL COST		**$312,000,000**	**TOTAL CAPITAL COST**		**$338,000,000**	**TOTAL CAPITAL COST**		**$342,000,000**	**TOTAL CAPITAL COST**		**$363,000,000**	**TOTAL CAPITAL COST**		**$316,000,000**

General Notes:
1. All costs are in January 2011 dollars. ENR construction cost index for January 2011 for Los Angeles, CA is 10000.30
2. Capital costs are escalated from the June 2006 O&M costs presented in Phase II Integrated Resources Plan for the Wastewater Program Technical Memorandum Tillman Advanced Treatment System Basis of Design Criteria and Cost Estimate, dated June 27, 2006, and prepared by CH:CDM.

Footnotes:
a. AWPF is sized for 32.4 mgd product water capacity (See Section 2.1.4) for all DCT sites, and 30.6 mgd product water capacity for VGS site.

b. Incremental Cost = Cost to construct one two-story MF/RO building - Cost to construct two single-story buildings.
c. Relocate parking to west of property line and add new fence. See Section 5.2.2.
d. Install new parking, fence, site security and administration building. See Section 5.3.2.
e. Install new parking and fence. See Sections 5.4.2 and 5.5.2.
f. Incremental Cost = Cost to modify eastern half of Phase II CCB to use as MF/RO Break Tank - Cost to install a new MF/RO Break Tank. Assumed that that MF/RO Break Tank would be sized for 1 MG storage capacity. See Section 5.1.2.
g. Incremental Cost = Cost to install a UV system sized for 1.2 log reduction of NDMA - Cost to install a UV system sized for 1.7 log reduction of NDMA. The cost of UV system is based on the information provided by Calgon Carbon. See Section 5.3.2.

h. Demolish existing maintenance building and warehouse west of Phase I CCB. Assumed existing maintenance building and warehouse has combined footprint of 23,200 sf. See Section 5.2.2.
i. Construct new maintenance building and warehouse adjacent to existing blower building at DCT. Assumed maintenance building and warehouse has combined footprint of 23,200 sf. See Section 5.2.2.
j. Purchase new land equivalent to the area of two existing cricket fields (11.5 acres). Assumed land purchase cost of $3 million/acre, based on recent commercial sales record in the San Fernando Valley. See Section 5.4.2.
k. Raise approximately 313,000 sf of site area by 8 ft to 100-yr flood elevation of 712 ft. See Section 5.4.2.
l. Earthwork on 240,000 sf of site area to raise the site by up to 2 ft to 100-yr flood elevation of 712 ft. See Section 5.5.2.
m. Excavate off-site within the Sepulveda Flood Control Basin to compensate for the storage volume lost when site is elevated or a flood control berm is constructed around the site. Includes excavation volume of 93,000 cubic yard (assumed equivalent to flood water storage volume lost when approximately 313,000 sf of site is raised by 8 ft). See Section 5.4.2.
n. Excavate off-site within the Sepulveda Flood Control Basin to compensate for the storage volume lost when site is elevated or a flood control berm is constructed around the site. Includes excavation volume of 8,900 cubic yard (assumed equivalent to flood water storage volume lost when half of the site (120,000 sf) is raised by 2 ft). See Section 5.5.2.
o. Expand existing Balboa Pump Station by adding one 800 hp capacity pump. The expanded Balboa Pump Station would have a total of four pumps, three duty and one standby, with the total pumping capacity of 32 mgd. See Section 5.1.4.

p. Expand existing Balboa Pump Station by adding two 800 hp capacity pumps. The expanded Balboa Pump Station would have a total of five pumps, four duty and one standby, with the total pumping capacity of 39 mgd. See Section 5.3.3.

q. New AWPF Product Water Pump Station with four 60 hp capacity pumps (three duty and one standby). Total capacity of new AWPF Product Water Pump Station is 31 mgd. See Section 5.3.3.
r. 500 ft of 48-inch steel forcemain to convey DCT tertiary (or secondary) effluent to the AWPF influent located at Site 2 DCT SW. Measured from a point south of the tertiary filters between Phase I and Phase II CCBs to the MF feed pumps shown on Figure 5-7.

s. 2050 ft of 48-inch steel forcemain to convey DCT tertiary (or secondary) effluent to the AWPF influent located at Site 5 Contractor Lay Down Area. Measured from a point south of the tertiary filters between Phase I and Phase II CCBs to the MF feed pumps shown on Figure 5-15.

t. 1500 ft of 42-inch steel forcemain to convey AWPF product water from Site 2 DCT SW to the Balboa Pump Station. Assumed pipe may need to be routed to the south side of the berm to avoid existing piping within the south access road.
u. 500 ft of 42-inch steel forcemain to convey AWPF product water from VGS to the Hansen Spreading Grounds. Includes construction cost for Tujunga Wash crossing. See Section 5.3.3.
v. 1450 ft of 42-inch steel forcemain to convey AWPF product water from Site 5 Contractor Lay Down Area to the Balboa Pump Station.
w. 450 ft of 27-inch PVC gravity pipe to discharge AWPF backwash and concentrate to AVORS on-site.
x. 7.4 miles of 18-inch PVC forcemain pipe to discharge AWPF backwash and concentrate to VORS. Includes construction cost for three freeway crossings and one railroad crossing.
y. 500 ft of 27-inch PVC gravity pipe to discharge AWPF backwash and concentrate to AVORS on-site.
z. New AWPF backwash and concentrate Pump Station with two 200 hp capacity pumps (one duty and one standby). The pump station is needed for system reliability after Phase 2 construction build-out.
aa. Assumed 10 ft x 10 ft x 10 ft wetwell for operational flexibility. The wetwell is not intended to provide AWPF backwash and concentrate storage.
ab. Cost to construct nine new equalization basins for a total capacity of 3.24 MG. This is derived from the cost estimate presented in the DCT Dry Weather Flow Equalization Evaluation Technical Memorandum, dated January 21, 2010, and prepared by RMC:CDM, and escalated to January 2011 costs.

B-2 O&M Cost

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Site No.	1		
Site Name	DCT SE		
	Item	Notes	Cost
Base Condition	Total Labor, Chemical, Equipment Replacement	a	$10,544,000
	Power Cost for AWPF excl. UV	b	$3,439,000
	Power Cost for UV	c	$1,129,000
	Power Cost for Balboa PS	d	$1,380,000
	Power Cost for Title 22 Water PS		$228,000
	Power Cost for Product Water PS		$0
	Power Cost for Brine PS		$0
	Power Cost for Admin Bldgs		$0
	O&M Cost:		**$16,700,000**
	50-Year NPV:		**$669,000,000**
Scenario 1	Total Labor, Chemical, Equipment Replacement	l	$12,280,000
	Power Cost for AWPF excl. UV	m	$4,005,000
	Power Cost for UV	n	$1,315,000
	Power Cost for Balboa PS	o	$1,632,000
	Power Cost for Product Water PS		$0
	Power Cost for Brine PS		$0
	Power Cost for Admin Bldgs		$0
	O&M Cost:		**$19,200,000**
	50-Year NPV:		**$769,000,000**

Site No.	2		
Site Name	DCT SW		
	Item	Notes	Cost
Base Condition	Total Labor, Chemical, Equipment Replacement	a	$10,544,000
	Power Cost for AWPF excl. UV	b	$3,439,000
	Power Cost for UV	c	$1,129,000
	Power Cost for Balboa PS	d	$1,380,000
	Power Cost for Title 22 Water PS		$228,000
	Power Cost for Product Water PS		$0
	Power Cost for Brine PS		$0
	Power Cost for Admin Bldgs		$0
	O&M Cost:		**$16,700,000**
	50-Year NPV:		**$669,000,000**
Scenario 1	Total Labor, Chemical, Equipment Replacement	l	$12,280,000
	Power Cost for AWPF excl. UV	m	$4,005,000
	Power Cost for UV	n	$1,315,000
	Power Cost for Balboa PS	o	$1,632,000
	Power Cost for Product Water PS		$0
	Power Cost for Brine PS		$0
	Power Cost for Admin Bldgs		$0
	O&M Cost:		**$19,200,000**
	50-Year NPV:		**$769,000,000**

Site No.	3		
Site Name	VGS		
	Item	Notes	Cost
Base Condition	Total Labor, Chemical, Equipment Replacement	e	$10,544,000
	Power Cost for AWPF excl. UV	f	$3,439,000
	Power Cost for UV	g	$1,694,000
	Power Cost for Balboa PS	h	$2,484,000
	Power Cost for Title 22 Water PS		$0
	Power Cost for Product Water PS	i	$124,000
	Power Cost for Brine PS	j	$108,000
	Power Cost for Admin Bldgs	k	$90,000
	O&M Cost:		**$18,500,000**
	50-Year NPV:		**$741,000,000**
Scenario 1	Total Labor, Chemical, Equipment Replacement	p	$10,544,000
	Power Cost for AWPF excl. UV	q	$3,439,000
	Power Cost for UV	r	$1,694,000
	Power Cost for Balboa PS	s	$2,484,000
	Power Cost for Product Water PS	t	$124,000
	Power Cost for Brine PS	u	$108,000
	Power Cost for Admin Bldgs	v	$90,000
	O&M Cost:		**$18,500,000**
	50-Year NPV:		**$741,000,000**

Site No.	4		
Site Name	Cricket Fields		
	Item	Notes	Cost
Base Condition	Total Labor, Chemical, Equipment Replacement	a	$10,544,000
	Power Cost for AWPF excl. UV	b	$3,439,000
	Power Cost for UV	c	$1,129,000
	Power Cost for Balboa PS	d	$1,380,000
	Power Cost for Title 22 Water PS		$228,000
	Power Cost for Product Water PS		$0
	Power Cost for Brine PS		$0
	Power Cost for Admin Bldgs		$0
	O&M Cost:		**$16,700,000**
	50-Year NPV:		**$669,000,000**
Scenario 1	Total Labor, Chemical, Equipment Replacement	l	$12,280,000
	Power Cost for AWPF excl. UV	m	$4,005,000
	Power Cost for UV	n	$1,315,000
	Power Cost for Balboa PS	o	$1,632,000
	Power Cost for Product Water PS		$0
	Power Cost for Brine PS		$0
	Power Cost for Admin Bldgs		$0
	O&M Cost:		**$19,200,000**
	50-Year NPV:		**$769,000,000**

Site No.	5		
Site Name	Contractor Lay Down Area		
	Item	Notes	Cost
Base Condition	Total Labor, Chemical, Equipment Replacement	a	$10,544,000
	Power Cost for AWPF excl. UV	b	$3,439,000
	Power Cost for UV	c	$1,129,000
	Power Cost for Balboa PS	d	$1,380,000
	Power Cost for Title 22 Water PS		$228,000
	Power Cost for Product Water PS		$0
	Power Cost for Brine PS		$0
	Power Cost for Admin Bldgs		$0
	O&M Cost:		**$16,700,000**
	50-Year NPV:		**$669,000,000**
Scenario 1	Total Labor, Chemical, Equipment Replacement	l	$12,280,000
	Power Cost for AWPF excl. UV	m	$4,005,000
	Power Cost for UV	n	$1,315,000
	Power Cost for Balboa PS	o	$1,632,000
	Power Cost for Product Water PS		$0
	Power Cost for Brine PS		$0
	Power Cost for Admin Bldgs		$0
	O&M Cost:		**$19,200,000**
	50-Year NPV:		**$769,000,000**

General Notes:
1. All costs are in January 2011 dollars. CPI Index for January 2011 for Los Angeles, CA is 228.652
2. Total labor and chemical costs are escalated from the June 2006 O&M costs presented in Phase II Integrated Resources Plan for the Wastewater Program Technical Memorandum Tillman Advanced Treatment System Basis of Design Criteria and Cost Estimate, dated June 27, 2006, and prepared by CH:CDM.
3. AWPF power usage cost (excl. UV system and conveyance pumping) is escalated from the June 2006 O&M costs presented in Phase II Integrated Resources Plan for the Wastewater Program Technical Memorandum Tillman Advanced Treatment System Basis of Design Criteria and Cost Estimate, dated June 27, 2006, and prepared by CH:CDM.
4. The power usage for UV system is based on the information provided by Calgon Carbon. A 40 mgd UV system for 1.2 log removal of NDMA, Calgon Carbon recommended a 1,600 kW UV system.
5. The power usage for UV system is based on the information provided by Calgon Carbon. A 40 mgd UV system for 1.7 log removal of NDMA, Calgon Carbon recommended a 2,400 kW UV system.
6. A unit cost of $0.12/kW-hr is used for power cost.

Footnotes:
a. See General Note 2. Scaled to 26.9 mgd.
b. See General Note 3. Scaled to 26.9 mgd.
c. See General Note 4. Assumed 1,076 kW UV system for a 26.9 mgd UV system for 1.2 log removal of NDMA.
d. To pump 26.9 mgd of AWPF product water from DCT to Hansen Spreading Grounds.
e. See General Note 2. Scaled to 26.9 mgd.
f. See General Note 3. Scaled to 26.9 mgd.
g. See General Note 5. Assumed 1,614 kW UV system for a 26.9 mgd UV system for 1.7 log removal of NDMA.
h. To pump 41.0 mgd of secondary/tertiary effluent from DCT to the AWPF.
i. To pump 26.9 mgd of AWPF product water from the AWPF to Hansen Spreading Grounds.
j. To pump 7.1 mgd of AWPF backwash and concentrate flow to VORS.
k. The power usage for a administrative building at the AWPF assumes the power consumption of 9.5 watts/sf for typical office/administrative buildings. Assumed 9,000 sf area for administrative building.
l. See General Note 2. Scaled to 31.3 mgd.
m. See General Note 3. Scaled to 31.3 mgd.
n. See General Note 4. Assumed 1,252 kW UV system for a 31.3 mgd UV system for 1.2 log removal of NDMA.
o. To pump 26.9 mgd of AWPF product water from DCT to Hansen Spreading Grounds.
p. See General Note 2. Scaled to 26.9 mgd.
q. See General Note 3. Scaled to 26.9 mgd.
r. See General Note 5. Assumed 1,614 kW UV system for a 26.9 mgd UV system for 1.7 log removal of NDMA.
s. To pump 41.0 mgd of secondary/tertiary effluent from DCT to the AWPF.
t. To pump 26.9 mgd of AWPF product water from the AWPF to Hansen Spreading Grounds.
u. To pump 7.1 mgd of AWPF backwash and concentrate flow to VORS.
v. The power usage for a administrative building at the AWPF assumes the power consumption of 9.5 watts/sf for typical office/administrative buildings. Assumed 9,000 sf area for administrative building.

Appendix G

DCT Maximum Flow Assessment TM

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Summary of Modifications to "DCT Maximum Flow Assessment TM" since Initial Publication on October 6, 2009

The Recycled Water Master Planning (RWMP) effort has spanned three years (April 2009 to March 2012). As is the nature of a planning project, assumptions are typically modified and refined as a project is further developed. The most recent assumptions related to the Groundwater Replenishment (GWR) master planning effort are presented in the GWR Master Planning Report. Assumptions and conclusions presented in this report supersede assumptions included in this technical memorandum (TM). The following table summarizes the modifications applicable to all RWMP TMs and those specifically applicable to this TM are described in the following sections.

Assumption	Modified	Original
Applicable to all RWMP TMs		
Recycled Water Goal	59,000 AFY by 2035 This goal reflects the 2010 LADWP Urban Water Management Plan that was adopted in early 2011, after the original RWMP goals were drafted	50,000 AFY by 2019
Name for Project and Master Planning Reports	Recycled Water Master Planning Documents GWR Master Planning Report NPR Master Planning Report	Recycled Water Master Plan GWR Master Plan NPR Master Plan
Introduction Section	This is superseded by the Introduction Sections in the NPR Master Planning Report.	This section was included in all initial TMs but the terms described have been replaced by the Introduction Section for the NPR Master Planning Report.
NPR Projects Terminology	To avoid confusion related to LADWP's water rate structure, the terms "Tier 1" and "Tier 2" are superseded with the terms "planned" and "potential," respectively. Both planned and potential projects would be considered for implementation by 2035.	"Tier 1" for NPR projects that were originally planned for design and construction by the year 2015. "Tier 2" for NPR projects that were originally being evaluated in the NPR Master Planning Report for potential future implementation after the year 2015.
Name for MF/RO/AOP treatment plant	Advanced water purification facility (AWPF)	Advanced water treatment facility (AWTF)
Name for water produced by AWPF	Purified recycled water	Advanced treated recycled water, highly purified recycled water, etc.
Treatment Plant Acronyms	DCTWRP LAGWRP	DCT LAG
GWR Project Phases	Phase 1 = 15,000 AFY annual recharge goal and 25 mgd AWPF product water capacity Phase 2 = 30,000 AFY annual recharge goal and 35 mgd AWPF product water capacity	Phase 1 = 20 mgd AWPF product water capacity Phase 2 = 40 mgd AWPF product water capacity

The following modifications are specific to this TM.

TM References

Throughout this TM there are references to preliminary TMs that were prepared at the onset of the RWMP effort. Relevant information from these TMs has been updated and incorporated into the four RWMP documents: GWR Master Planning Report; NPR Master Planning Report; TIWRP Barrier Supplement and NPR Concepts Report; and Long-Term Concepts Report.

Section 4 DCTWRP In-Plant Flow Analysis

In this TM, the historical data was analyzed to estimate the percentage of tertiary effluent that is produced from the influent wastewater. The pertinent flows are summarized in Table 4-2. Based on historical flow data from January 2005 through December 2008, approximately 87% of the influent wastewater flow becomes tertiary effluent. New cloth media filters, which have fewer losses than the old granular media filters, came on-line in December 2009 so data from December 2009 through August 2011 were analyzed as part of the GWR Master Planning Report. The DCTWRP tertiary effluent production capacity is estimated to be approximately 92% of the influent flow rate. The updated tertiary effluent production is presented in the GWR Master Planning Report Section 3.7.

Table 4-2: Percentage of Tertiary Effluent Produced from Influent Wastewater Flow (Revised)

Parameter	Value
Aeration Tank Influent Flow	
Phase I Tanks (Average)	34.7 mgd
Phase II Tanks (Average)	34.9 mgd
Average[1]	34.8 mgd
Tertiary Effluent	31.6 mgd
Percent Tertiary Effluent Produced from Influent	92%

Notes:
Data period: December 2009 through August 2011.
[1] For the data period, the Phase I and II aeration tanks were never used at the same time. Therefore, the average of the Phase I and II aeration tank influent flow was used to compare with the average tertiary effluent flow.

Section 5 DCTWRP Effluent Flows Available for Recycling

Table 5-1 in the TM shows the range of tertiary effluent available for GWR and NPR projects between years 2008 and 2040. Note that Phase 1 of the AWPF is now projected to be in operation by 2022, while Phase 2 of the AWPF is slated for 2035. The following modifications are reflected in the table below that replaces Table 5-1 in the TM:

- The estimated high-end for DCTWRP influent flow has been capped at the maximum plant capacity of 80.0 mgd between years 2020 and 2040.
- Percent of tertiary effluent flow produced from DCTWRP influent has been updated from 87% to 92%, therefore increasing the flow range of the estimated tertiary effluent flows.
- The estimated in-plant reuse flow was updated to a set 2.0 mgd based on input from BOS staff.
- The estimated flow range available for GWR and NPR has been modified as a result of the above modifications to percent tertiary effluent production and in-plant reuse flow.

Table 5-1: Comparison of Total DCTWRP Influent Estimates (Revised)

Flow Stream	Flow (mgd)							
	2008	2010	2015	2020	2025	2030	2035	2040
Estimated DCTWRP Influent Flow								
Low end	67.8	68.5	69.6	70.9	72.2	74.5	76.9	79.2
High end	77.8	78.4	79.9	80.0	80.0	80.0	80.0	80.0
Estimated Tertiary Effluent Flow								
Low end	62.4	63.0	64.0	65.2	66.4	68.5	70.7	72.9
High end	71.6	72.1	73.5	73.6	73.6	73.6	73.6	73.6
Estimated In-Plant Reuse	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
LA River	27.0	27.0	27.0	27.0	27.0	27.0	27.0	27.0
Estimated Flow Available for GWR and NPR								
Low end	**33.4**	**34.0**	**35.0**	**36.2**	**37.4**	**39.5**	**41.7**	**43.9**
High end	**42.6**	**43.1**	**44.5**	**44.6**	**44.6**	**44.6**	**44.6**	**44.6**

Section 6 Summary and Next Steps

The initial sizing for the AWPF has been modified to 25 mgd for Phase 1, which would require 32 mgd of tertiary effluent from DCTWRP. The ultimate capacity of the AWPF (Phase 2) has been modified to 35 mgd, which would require 44 mgd of tertiary effluent.

Section 6.1 Confirm DCTWRP Maximum ADWF and Tertiary Effluent Available for Recycling

Updated next steps for the AWPF sizing are included in Section 10, Table 10-1, of the GWR Master Planning Report.

The following next steps have been updated:

- Bullet 1: A full-scale test was initially recommended to measure the current maximum ADWF that can be treated at DCTWRP once the filter upgrades have been completed in 2010. This was based on the assumption that wastewater diversion back to the AVORS after the headworks was possible. However, it has been determined that the bypass gate to AVORS can only handle a maximum of approximately 20 mgd. Hence, with one DCTWRP phase on-line the maximum flow that can pass through the headworks including the bypass is 60 mgd. Therefore, a full-scale test will not be feasible.
- Bullet 2: All DCTWRP tertiary effluent flow information has been updated in the GWR Master Planning Report, Section 3.7 AWPF Capacities. The tertiary effluent flow assumed to the Lakes and LA River is 27 mgd.
- Bullet 3: Refine the DCTWRP flow estimates during preliminary design to incorporate the latest wastewater flow projections from BOS.
- Bullet 5: The primary equalization volume was evaluated as part of the GWR Master Planning Report, Section 5.3.16 DCTWRP Primary Equalization Storage. The GWR Master

Planning Report includes the recommendation to add 6.72 MG of primary equalization volume to achieve a total storage volume of 12.12 MG, which is based on the lower minimum flow on the weekends indicated by the MIKE URBAN Model results. Based on the weekday diurnal curve, the additional primary equality volume would be reduced to 3.11 MG for a total storage volume of 8.51 MG. Further investigation of the decrease in average wastewater flow in the EVIS outfall sewer on weekends is recommended to determine if the weekend flow decrease is accurate and warrants the additional storage volume.

The following next step remains unchanged:

- Bullet 4: Further investigate a way to determine if there are seasonal variations to wastewater flow for the wastewater tributary to DCTWRP that may impact the seasonal availability of tertiary effluent.

Section 6.2 Identify Modifications to Maximize Wastewater Flow to DCTWRP and Supplement Minimum Diurnal Flows

The following next steps have been evaluated further as part of the RWMP documents:

- Bullet 3: The Long-Term Concepts Report (LTCR) identifies concepts to increase GWR in the San Fernando Valley with additional sources. These may be considered in the long term.
- Bullet 4: The flow equalization options to supplement the nighttime minimum diurnal flows were evaluated. See Section 5.3.16 of the GWR Master Planning Report. Note that the wet weather storage basins are not available for primary effluent equalization during dry weather; they will only be used for wet weather flows.

The following next steps remain unchanged:

- Bullet 1: Confirm that all of the primary sewers that cross EVIS can divert wastewater into EVIS in order to maximize influent wastewater flows to DCTWRP.
- Bullet 2: Identify projects to divert additional wastewater to DCTWRP to increase the total flow treated at the plant and maximize the amount tertiary effluent available for recycling.

The original TM follows so these modifications should be considered when reading this TM.

Technical Memorandum

Title:	**DCT Maximum Flow Assessment**
Version:	Draft
Prepared For:	John Hinds, Project Manager, LADWP Doug Walters, Project Manager, BOS Brian Tan, Task 1a Lead, LADWP Hiddo Netto, Task 1a Co-Lead, BOS
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Date:	October 6, 2009
Reference:	Task 1a Groundwater Replenishment Master Plan Task 1.6 DCT Maximum Flow Assessment

1. Introduction

With imported water supplies becoming ever more unpredictable, the Los Angeles Department of Water and Power (LADWP) adopted the Mayor's vision of Securing LA's Water Supply in May 2008, calling for 50,000 acre-feet per year (AFY) of potable supplies to be replaced by recycled water by 2019. To meet this near-term challenge and plan for expanding reuse in the future, LADWP has partnered with the Department of Public Works to develop the Recycled Water Master Plan (RWMP). The RWMP includes 7 major tasks: 1 Groundwater Replenishment (GWR) Master Plan, 2 Non-Potable Reuse (NPR) Master Plan, 3 Advanced Water Treatment (AWT) Pilot Study, 4 Maximum Reuse Concept Report, 5 Satellite Feasibility Concept Report, 6 Existing System Reliability Concept Report, and 7 Training.

The importance of additional water supply options for Los Angeles has become increasingly apparent with continuation of drought conditions, building contention for limited available water supplies both statewide and across the Southwest, and growing awareness of the critical nexus between quality of life/economic stability and available supplies of quality water. Significant attention has focused on the importance of indirect potable reuse given the multiple associated benefits, among them: local control; drought-resistant supplies; beneficial use of a critical, limited resource; sustained availability for future generations; existing infrastructure; lower investment and less environmental impact than other supply options; and demonstrated success nearby, across the nation and throughout the world.

1.1 Task 1 Overview

The purpose of Task 1 is to develop a GWR Master Plan that includes a capital improvement program to implement an advanced water treatment plant (AWTP) and groundwater replenishment using high-quality recycled water in the San Fernando Valley in the Hansen, Pacoima, and possibly Tujunga spreading basins. The AWTP will be fed with effluent from the Donald C. Tillman Water Reclamation Plant (DCT). The GWR Master Plan will plan for in-service dates no later than June 30, 2018 to meet the minimum groundwater replenishment goal of 15,000 acre-feet/year (AFY) by June 30, 2019.

Task 1a includes the preliminary evaluations for the GWR Master Plan, including developing a regulatory approach, completing preliminary evaluations about the DCT plant, developing preliminary groundwater replenishment strategies, completing a technology assessment for the AWTP, selecting a site for the AWTP, and determining the maximum wastewater flow available for treatment at DCT. Task 1b, the IRP Master Plan document, will commence when Task 1a is complete and will incorporate the work completed as part of Task 1a. Task 1a is subdivided into the following standalone tasks to complete the initial GWR studies:

- Task 1.1 – Regulatory Approach and Coordination: Provides a recommended approach for permitting the AWTP and groundwater replenishment with recycled water (Draft Technical Memorandum (TM) dated September 14, 2009).
- Task 1.2 – DCT Data Summary: Provides a summary of historical DCT flow and water quality data for use on the RWMP (Draft TM dated September 1, 2009).

- Task 1.3 – Groundwater and Surface Water Assessment: Initial groundwater and surface water studies to develop groundwater replenishment operational scenarios.
- Task 1.4 – Advanced Water Treatment Technology Assessment: Technology assessment for the treatment processes to be used in the AWTP (Draft TM dated September 1, 2009).
- Task 1.5 – Site Assessment: Comparison of potential sites for the AWTP with a goal of selecting a preferred site to be able to move forward with the GWR Master Plan.
- Task 1.6 – DCT Maximum Flow Assessment: Evaluation of the maximum flows that could be routed to the DCT plan from the Tillman Service Area (TSA) to determine the quantity of water available for existing uses, GWR and NPR (this TM).

1.2 TM Purpose

The purpose of this DCT Maximum Flow Assessment TM is to provide an assessment of the wastewater that could be conveyed to DCT from the Tillman Service Area (TSA) in order to determine how much tertiary effluent is available for recycling. The City has the ability to divert wastewater away from DCT and to the plants downstream from both of the outfall sewers influent to DCT. DCT has a rated capacity of 80 million gallons per day (mgd), but due to ongoing upgrade projects, the plant has been operating at reduced capacity over last 10 years with a portion of the potential influent flows being diverted away from DCT to the downstream plants. The plant will continue to operate at reduced flows until summer 2010 when the filter upgrades are complete.

Upon completion of the filter upgrade project, it is expected that the plant will be operated at 80 mgd from April 15 through October 15, but restricted to 40 mgd from October 15 through April 15 to reserve one treatment phase (40 mgd) and the equalization basins for wet weather storage. In 2010, between the time when the filter upgrades are complete and the before the wet weather season starts (October 15), the City can modify the diversions in the outfall sewers to route the maximum amount of wastewater to DCT to assess actual influent flows and confirm the estimates completed for this TM. Once the wet weather storage basins are constructed, then DCT will be able to operate at 80 mgd year round.

This TM presents an analysis of the maximum flow that could be routed to DCT under current flow conditions, and projections for future wastewater flow increase. These flow projections will be used to evaluate the use of DCT tertiary effluent for existing uses as well as for the potential water recycling projects that could be implemented in the future, including a new AWTP for GWR and expansion of the NPR system.

1.3 Related TMs

This DCT Maximum Flow Assessment TM was completed in conjunction with two Task 5.1.1 TMs: the Draft Wastewater Flow Projections TM and the Draft Wastewater Collection System TM.

In addition, as part of Task 4.1.4, the Los Angeles (LA) River Flow Assessment TM will assess the current conditions and potential options for flows to the LA River. For the purposes of this TM, it is assumed that a minimum flow of 27 mgd would be maintained to the LA River as stated in the City of Los Angeles Integrated Resources Plan Final Environmental Impact Report (CH:CDM, September 2006).

1.4 TM Overview

The remainder of this TM is organized in the following sections:

- Section 2 – TSA Primary Sewer Basins and Outfall Sewers
- Section 3 – DCT Influent Average Dry Weather Flow (ADWF) Estimates
- Section 4 – DCT In-Plant Flow Analysis
- Section 5 – DCT Treated Effluent Estimates
- Section 6 – Recommendations

2. TSA Primary Sewer Basins and Outfall Sewers

This section summarizes and describes the primary sewer basins and influent sewers that are tributary to DCT from the TSA. Refer to the Draft Wastewater Collection System TM (Task 5.1.1) for more detail about the primary sewer basins and outfall sewers.

2.1 TSA Primary Sewer Basins

There are seven primary sewer basins tributary to DCT:

- Chatsworth
- Granada Hills
- Northridge
- Pacoima (divided between TSA and Valley Spring Lane/Forman Ave (VSL/FA) sewer shed)
- Tarzana
- Van Nuys-Sylmar (divided between TSA and VSL/FA)
- Woodland Hills-Canoga Park

TSA is considered part of the Hyperion Service Area (HSA) because DCT functions as a scalping plant within HSA. Excess flows that cannot be treated at DCT because of current flow restrictions at the plant, as well as sidestreams and solids generated at DCT, are routed to HTP. The primary sewer basins within the City are shown in **Figure 2-1** and are described further below.

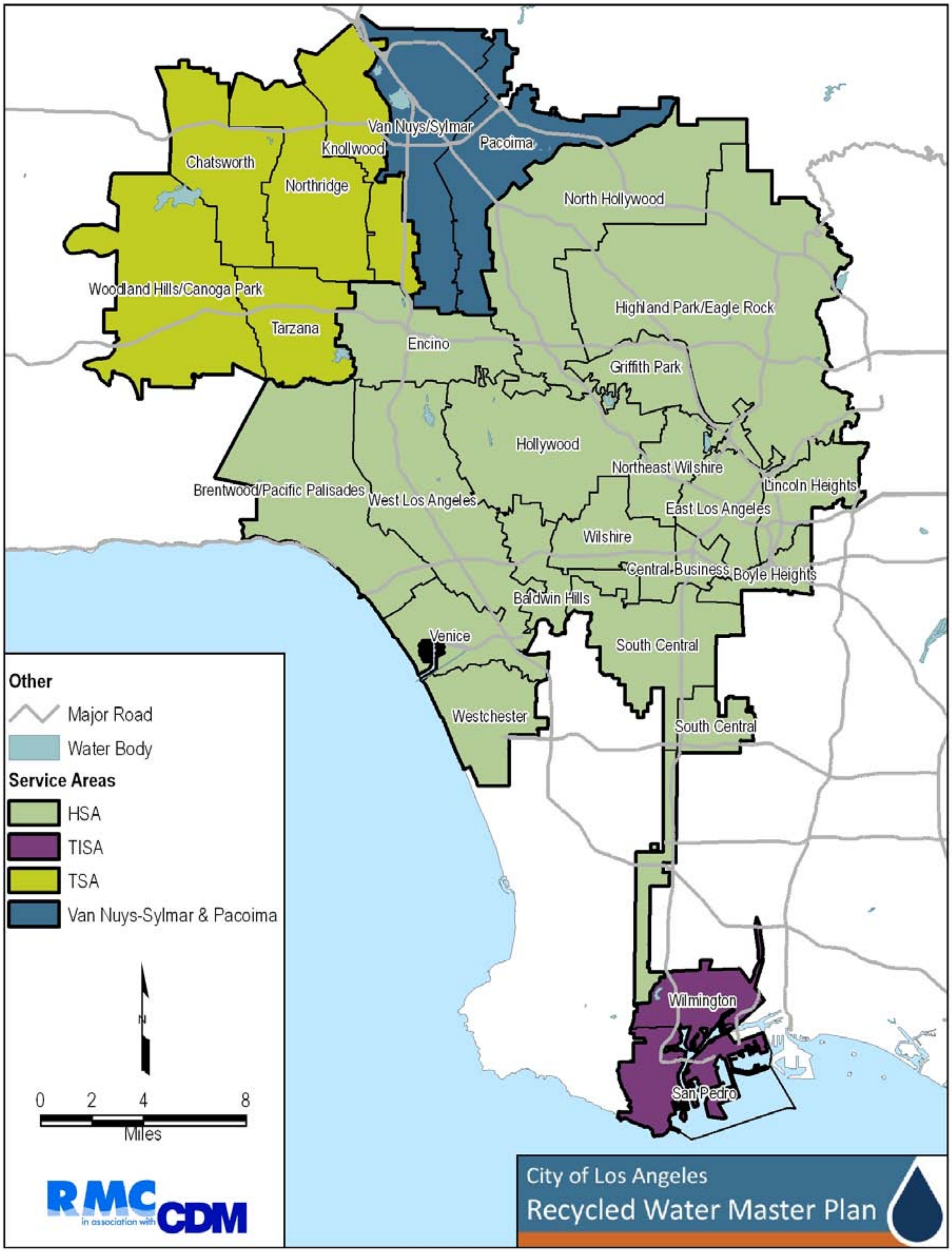
2.1.1 Chatsworth Basin

The Chatsworth Basin is located in northwest Los Angeles at the western end of San Fernando Valley and includes portions of the communities of Chatsworth, Porter Ranch, West Hills, Canoga Park, and Winnetka. This basin covers approximately 14,063 acres (22 square miles). There are approximately 22 miles of primary sewers in this basin, ranging in size from 12 to 33 inches in diameter. About 90% of the primary sewers in this basin were installed between 1940 and 1980 and 10% were installed after 1980. Other facilities within this basin include a diversion structure, two flow splits, and two siphons. The basin does not have any pumping plants.

2.1.2 Granada Hills Basin

The Granada Hills Basin is located in the San Fernando Valley and encompasses the communities of Granada Hills, Mission Hills, North Hills, and sections of Reseda and Van Nuys. This basin covers approximately 12,800 acres (20 square miles). There are approximately 26 miles of primary sewers in this basin, ranging in size from 8 to 33 inches. About 99% of the primary sewers in this basin were installed after 1940. This basin does not have any diversion structures, flow splits, inverted siphons, or pumping plants.

Figure 2-1: City of Los Angeles Primary Sewer Basins



2.1.3 Northridge Basin

The Northridge Basin is located in the western portion of the San Fernando Valley, and is generally north of Victory Boulevard, east of Winnetka Avenue, west of Balboa Boulevard, and south of the Ronald Regan Freeway (State Route 118). An additional 3,800 acres (Porter Ranch area) is situated north of the Ronald Regan Freeway and is bounded to the north by the City boundary. This basin covers approximately 17,557 acres (27.4 square miles). There are approximately 26 miles of primary sewers in this basin, ranging in size from 12 to 54 inches in diameter. About 51% of the primary sewers in this basin were installed before 1960 and 94% before 1980. Other facilities within this basin include two diversion structures, and seven flow splits. The basin does not have any inverted siphons or pumping plants.

2.1.4 Pacoima Basin (Partial)

The Pacoima Basin is located in the northern portion of the San Fernando Valley, and is generally north of Victory Boulevard, east of Van Nuys Boulevard, west of Coldwater Canyon Avenue, south-east of Arroyo Avenue, and northwest of Sheldon Street. The basin is bounded to the north by the City boundary. This basin covers approximately 16,740 acres (26 square miles). There are approximately 22 miles of primary sewers in this basin, ranging in size from 12 to 33 inches in diameter. About 86% of the primary sewers in this basin were installed before 1959 and nearly all were installed before 1972. This basin contains six diversion structures and does not have any flow splits, siphons or pumping plants.

The wastewater generated in the Pacoima Basin is split between the TSA and VSL/FA tributary area. The upper portion of the Pacoima Basin is discharged into the East Valley Interceptor Sewer (EVIS), which is tributary to TSA, and the balance is discharged into the Valley Outfall Relief Sewer (VORS), which is tributary to HSA. The diversion structures within the basin allow some flow to be discharged to either EVIS or to VORS; the diversions are described further in Section 2.2. Bureau of Sanitation (BOS) Wastewater Engineering Services Division (WESD) estimates that approximately 75% of the wastewater flow generated in the Pacoima Basin can be tributary to TSA and 25% tributary to VSL/FA sewer shed.

2.1.5 Tarzana Basin

The Tarzana Basin is located in the west San Fernando Valley. The basin is generally bordered to the west by the De Soto Avenue, to the north by the Vanowen Street, to the east by Balboa Boulevard, and to the south by Mulholland Drive. This basin covers approximately 6,400 acres (10 square miles). There are approximately 10.6 miles of primary sewers in this basin, ranging in size from 8 to 96 inches in diameter for circular pipes, and 15 to 102 inches for square, Burns-McDonnell semi-elliptical, and 147 x 16 semi-elliptical pipes. About 68% of the primary sewers in this basin were installed before 1960 and all were installed before 1980. Other facilities within this basin include six diversion structures, five flow splits, and five inverted siphons. This basin does not have any pumping plants.

2.1.6 Van Nuys-Sylmar Basin (Partial)

The Van Nuys-Sylmar Basin is located in the northern portion of the San Fernando Valley with most of the basin on the east of the 405 Freeway. This basin covers approximately 18,420 acres (28.8 square miles). There are approximately 33 miles of primary sewers in this basin, ranging in size from 10 to 36 inches in diameter. The majority of the primary sewers in this basin were installed before 1960. Other facilities within this basin include eight diversion structures, two flow splits, and one inverted siphon. This basin does not have any pumping plants.

The wastewater generated in the Van Nuys-Sylmar Basin is split between the TSA and VSL/FA tributary area. Similar to the Pacoima Basin, the upper portion of the Van-Nuys Basin is discharged into the EVIS, which is tributary to TSA, and the balance is discharged into the VORS, which is tributary to HSA. The diversion structures within the basin allow some flow to be discharged to either EVIS or to VORS; these diversions are described further in Section 2.2. WESD estimates that approximately 75% of the wastewater flow generated in the Van Nuys-Sylmar Basin can be tributary to TSA and 25% tributary to VSL/FA sewer shed.

2.1.7 Woodland Hills-Canoga Park Basin

The Woodland Hills-Canoga Park Basin is located in the western part of the San Fernando Valley and is generally bordered to the east by Tarzana and Chatsworth Primary Sewer Basins and to the west, north and south by the boundary of Los Angeles and Ventura Counties. This Basin covers approximately 23,204 acres (36.3 square miles). There are approximately 21.5 miles of primary sewers in this basin, ranging in size from 8 to 27 inches in diameter. About 62% of the primary sewers in this basin were installed before 1962 and all were installed before 1974. Other facilities within this basin include one inverted siphon, and one flow split. This basin does not include any diversion structures or pumping plants.

2.2 TSA Outfall Sewers

The primary sewers in each of the primary basin areas discharge into the outfall sewers, which serve as the backbone of the City's wastewater collection system. These outfall sewers collect wastewater from many drainage areas and convey it to one or more of the HSA's wastewater treatment and/or water reclamation plants.

There are four outfall sewers that collect wastewater from the primary sewer basins within the TSA, which include the following:

- Additional Valley Outfall Relief Sewer (AVORS)
- East Valley Interceptor Sewer (EVIS)
- North Outfall Sewer (NOS)
- Valley Outfall Relief Sewer (VORS)

This section describes these four outfall sewers. There are a series of diversions between primary sewers and outfall sewers, as well as between the outfall sewers themselves, which are also described in this section. Of most importance to this evaluation are the diversions that can route wastewater around DCT, such as the diversion structures on the AVORS and EVIS outfalls just upstream of DCT and the diversions on EVIS that can bypass wastewater to the VORS (downstream of DCT). The outfalls and primary sewers in the seven TSA primary sewer basins are shown in **Figure 2-2**. **Table 2-1** summarizes which TSA primary sewer basins discharge into which outfall sewers.

Figure 2-2: Outfall Sewers and Primary Sewers in TSA

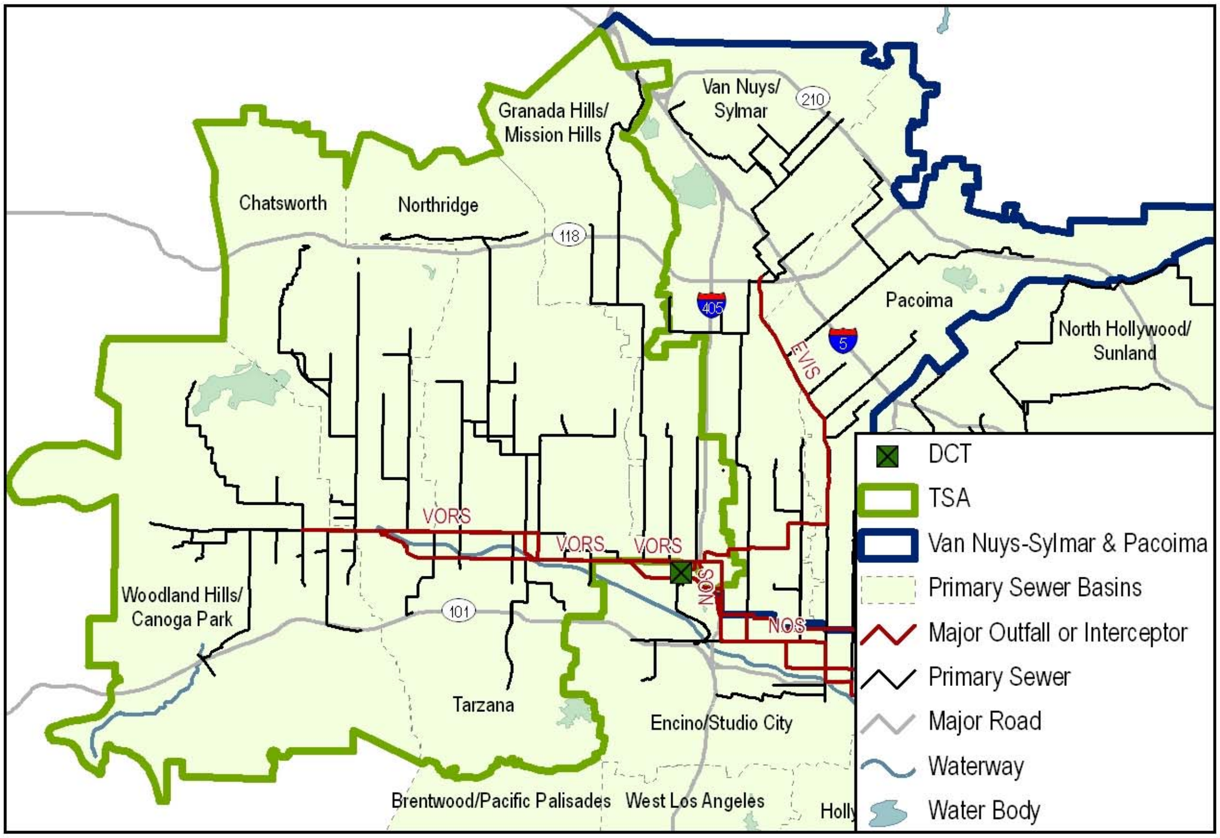


Table 2-1: TSA Outfall Sewers and Associated Primary Sewer Basins

Primary Sewer Basin	Outfall Sewers			
	AVORS	EVIS	NOS	VORS
Chatsworth	X		X	X
Granada Hills		X	X	X
Northridge	X		X	X
Pacoima		X		X[a]
Tarzana	X		X	X
Van Nuys-Sylmar		X		X[a]
Woodland Hills-Canoga Park	X		X	X

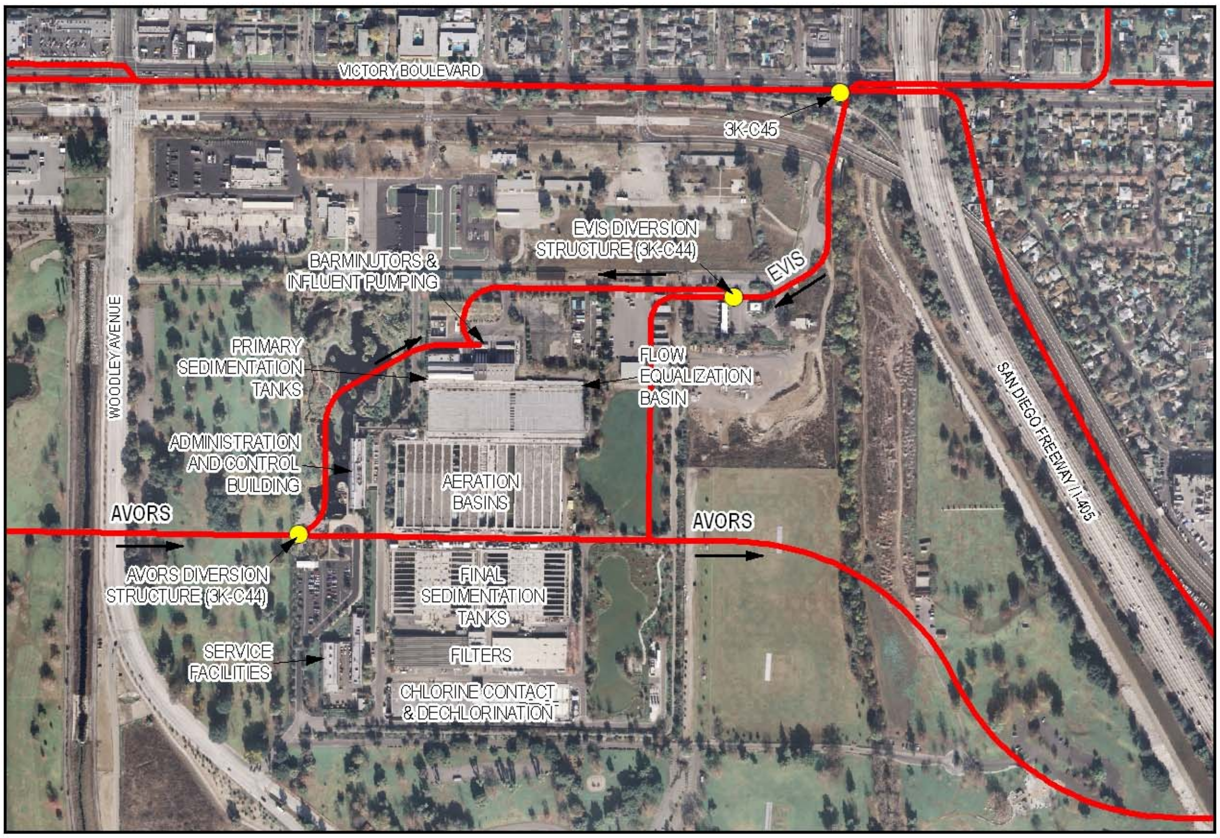
Footnote:

a. A portion of the Pacoima and Van Nuys-Sylmar primary sewer basins discharge into the VORS downstream of DCT.

2.2.1 Additional Valley Outfall Relief Sewer (AVORS)

AVORS and EVIS convey influent wastewater to DCT. **Figure 2-3** shows the AVORS and EVIS routing around the DCT plant, as well as the AVORS and EVIS diversion structures just upstream of the DCT plant. DCT operators use these two diversion structures to manage the DCT influent flow. After DCT, AVORS conveys treatment plant bypass and solids into the East Valley Relief Sewer (EVRS), and ultimately to HTP.

Figure 2-3: AVORS and EVIS Configuration at DCT Influent



There are two diversions on AVORS upstream of DCT, which are summarized in **Table 2-2.** The diversion at Vanowen St. at Lurline Ave. diverts into the VORS, which is ultimately combined with EVIS upstream of DCT, so the setting of this diversion will not impact the maximum flow to DCT. The AVORS diversion structure at DCT, located in the Japanese Garden beneath what is known as Tortoise Island, contains two sluice gates: the plant feed gate and the diversion gate. The gates are automated and are controlled manually from the DCT control room to maintain the desired influent flow to DCT. Typical operation involves adjusting these two gates to regulate the flow into DCT and bypassing the remainder of the flow to EVRS. The gates are automated and are manually adjusted by the DCT operators from the DCT control room to maintain an appropriate level in the influent pump stations wet wells. When maximizing the flow to DCT, the AVORS bypass should be closed to route all flow to DCT.

Table 2-2: AVORS Diversions

Figure No.[a]	Location	Diversion Purpose "From" → "To"
3K-C46	Vanowen St. Lurline Ave.	AVORS → VORS
3K-C44	AVORS Diversion Structure at DCT	AVORS → DCT

Footnotes:

a. Diversion structure figures are included in Attachment A.

2.2.2 East Valley Interceptor Sewer (EVIS)

EVIS is a major sewer constructed to route flows to the DCT from the City of San Fernando and the communities of Sylmar, Pacoima, Mission Hills, Sepulveda, Panorama City, and the northern portion of Van Nuys. At the EVIS diversion structure upstream of DCT, wastewater can be bypassed around DCT to AVORS on the east side of DCT.

The EVIS diversion structure contains three gates: the plant feed gate, diversion gate, and maintenance bypass gate. The gates are automated and are operated manually from the DCT control room to maintain the desired influent flow to DCT. Similarly to the AVORS, the typical operation of the EVIS diversion structure involves adjusting the plant feed gate and the diversion gate to regulate the flow into DCT and bypass the remainder of the flow. The feed gate diverts wastewater westerly, where it curves southward to join the DCT influent from the AVORS diversion before entering the headworks influent channel. The diversion gate bypasses flow along the eastern plant boundary to the AVORS. When maximizing the flow to DCT, the EVIS bypass should be closed to route all flow to DCT. The maintenance bypass gate is typically closed.

There are several diversion structures upstream on EVIS that allow wastewater to either be routed to DCT through EVIS or bypass the wastewater to other outfall sewers downstream of DCT, such as VORS or NOS, which convey wastewater to HTP. To maximize flow to DCT, these diversions would need to be modified to route flow to DCT via EVIS instead. These EVIS diversions, 11 in total, are shown in **Figure 2-4** and summarized in **Table 2-3**.

Figure 2-4: EVIS Diversions

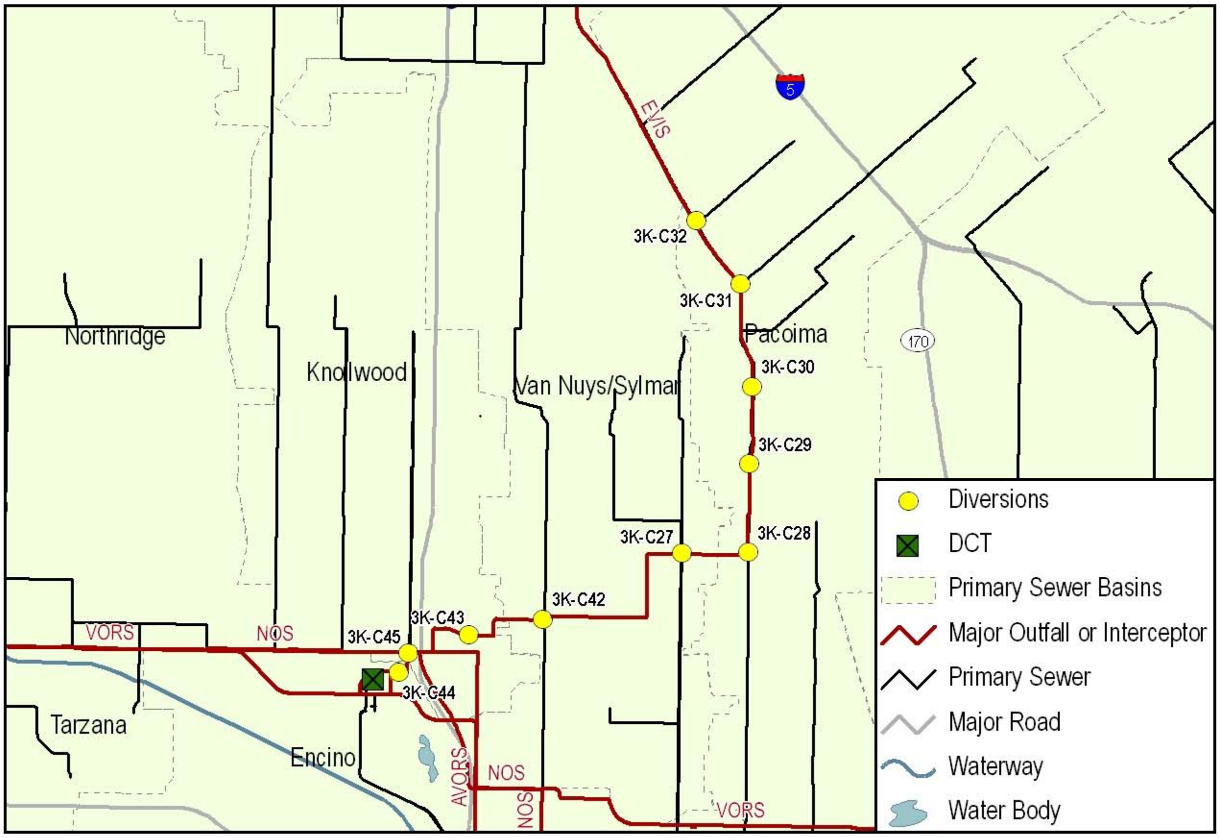


Table 2-3: EVIS Diversions[a]

Figure No.[c]	Location	Diversion Purpose "From" → "To"
3K-C33	Chatsworth St. Woodman Ave.	Arleta Sewer → Lemona Sewer *or* Arleta Sewer → EVIS
3K-C32	Osborne St. Woodman Ave.	Osborne Sewer → Woodman Sewer[b] *or* Osborne Sewer → EVIS
3K-C31	Branford St. Woodman Ave.	Branford Sewer → Woodman Sewer[b] *or* Branford Sewer → EVIS
3K-C30	Strathern St. Woodman Ave.	Unnamed 12" Sewer → Woodman Sewer[b] *or* Unnamed 12" Sewer → EVIS
3K-C29	Woodman Pl. Woodman Ave.	Woodman Sewer → Woodman Sewer[b] *or* Woodman Sewer → EVIS
3K-C28	Hart St. Woodman Ave.	Woodman Sewer[b] → EVIS *or* Woodman Sewer → VORS (downstream of DCT)
3K-C37	Hart St. Hazeltine Ave.	Stansbury Sewer → EVIS *or* Stansbury Sewer → VORS (downstream of DCT)
3K-C42	Kittridge St. Kester Ave.	Kester Sewer → EVIS *or* Kester Sewer → NOS or VORS (downstream of DCT)
3K-C43	Hamlin St. (Haynes St.) Sepulveda Blvd.	Unnamed 15" Sewer → EVIS *or* Unnamed 15" Sewer → NOS (downstream of DCT)
3K-C45	Victory Blvd. Haskell Ave.	VORS + Haskell Sewer + EVIS → EVIS *or* VORS + Haskell Sewer → EVIS & EVIS → VORS
3K-C44	EVIS Diversion Structure at DCT	EVIS → DCT *or* EVIS → AVORS (downstream of DCT)

Footnotes:

a. Diversions are listed from north to south.
b. Diverting Woodman Sewer to EVIS at Hart St./Woodman Ave. would divert all wastewater possibly bypassed at upstream diversions (north to Chatsworth St./Woodman Ave.). Therefore, only the Hart St./Woodman Ave. diversion would need to be set to divert into wastewater to capture the Woodman Sewer flows to this point.
c. Diversion structure figures are included in Attachment A.

2.2.3 North Outfall Sewer (NOS)

The NOS can discharge into VORS at several diversions upstream of DCT, which are summarized in **Table 2-4**. The current diversion settings for the NOS diversions are not critical for maximizing the flow to DCT because all of the flows are eventually routed to DCT. The flows collected by the NOS are diverted into the VORS, which is ultimately combined with EVIS and routed to DCT.

Table 2-4: NOS Diversions

Figure No.[a]	Location	Diversion Purpose "From" → "To"
3K-C55	Vanowen St. Winnetka Ave.	NOS → VORS
3K-C54	Vanowen St. Tampa Ave.	NOS → VORS
3K-C53	Vanowen St. Wilbur Ave.	NOS → VORS
3K-C52	Vanowen St. Etiwanda Ave.	NOS → VORS
3K-C49	Haynes St. White Oak Ave.	NOS → VORS
3K-C48	Victory Blvd. Balboa Ave.	NOS → VORS
3K-C46	Victory Blvd. Woodley Ave.	NOS → VORS

Footnotes:

a. Diversion structure figures are included in Attachment A.

2.2.4 Valley Outfall Relief Sewer (VORS)

VORS can discharge into other outfall sewers at several diversions upstream of DCT, which are summarized in **Table 2-4**. As with the NOS, the current diversion settings for the VORS diversions are not critical for maximizing the flow to DCT because all of the flows are eventually routed to DCT. The flows collected by the VORS are combined with EVIS and routed to DCT.

Table 2-4: NOS Diversions

Figure No.[a]	Location	Diversion Purpose "From" → "To"
3K-C50	Victory Blvd. Lindley Ave.	VORS → AVORS
3K-C47	Victory Blvd. Balboa Ave.	VORS → AVORS
3K-C45	Victory Blvd. Haskell Ave.	VORS → EVIS

Footnotes:
a. Diversion structure figures are included in Attachment A.

3. DCT Influent ADWF Estimates

The theoretical maximum ADWF tributary to DCT was estimated using flow projections from WESD. WESD uses a combination of the Sewer Flow Estimating Model (SFEM) and the MIKE URBAN Model to estimate the flows. Since the flow to DCT was estimated using an assumed percentage of flow from the Pacoima and Van Nuys-Sylmar primary sewer basins, which are only partially tributary to DCT, the MIKE URBAN Model results were also inspected to determine how much flow could be routed to DCT from various diversions. Background information on flow projections for the City's wastewater system can be obtained in the Draft Wastewater Flow Projections TM (Task 5.1.1).

This TM focuses on ADWF projections because these conditions will be used to establish the normal flow split between effluent uses. It is assumed that peak flows in excess of the effluent uses would be discharged to the LA River, as is the current practice.

This section presents the theoretical maximum ADWF flows and diurnal flow curves for DCT.

3.1 Theoretical Maximum ADWF Estimates

For the purposes of this TM, two estimates of theoretical maximum influent flow to DCT were prepared:

- WESD's DCT flow estimate using the primary sewer basin ADWF projections. The total ADWF was assumed for each of the five primary sewer basins tributary to DCT (Chatsworth, Granada Hills, Northridge, Tarzana, and Woodland Hills-Canoga Park) and 75% of the total primary sewer basin flow was assumed for the Pacoima and Van Nuys-Sylmar primary basins.
- MIKE URBAN Model results were used to confirm the 75% flow assumption for the Pacoima and Van Nuys-Sylmar primary basins. The flow to DCT was estimated by inspecting the flows at various points in the model, including the total AVORS and EVIS flows upstream of DCT and the flows available at individual EVIS diversions if set to bypass the EVIS outfall sewer in the model.

3.1.1 Primary Sewer Basin ADWF Projections

The City estimated the maximum flow to DCT using data from SFEM and MIKE URBAN Model. The City estimated the maximum flow to DCT by summing ADWF for the tributary primary sewer basins of Chatsworth, Granada Hills, Northridge, Tarzana, and Woodland Hills-Canoga Park, as well as 75% of both Pacoima and Van Nuys-Sylmar. This 75% assumption is due to only a portion of the Pacoima and Van Nuys-Sylmar basins being tributary to DCT. This assumption does not represent current conditions, but instead attempts to describe the potential to maximize flow to DCT. ADWF flows were received from the City for 2008, 2025, 2050 and interim years were interpolated.

Table 3-1 summarizes the ADWF for each primary sewer basin tributary to DCT, the resulting total flow estimate to DCT, and the WESD DCT flow projections included in the Draft Wastewater Projections TM (Task 5.1.1).

Table 3-1: ADWF Projections Back-Calculated from Adjusted ADWF

Primary Sewer Basin	ADWF projections (mgd)[a]							
	Current (2008)	2010	2015	2020	2025	2030	2035	2040
Chatsworth	8.0	8.1	8.2	8.4	8.5	8.8	9.1	9.5
Granada Hills	10.3	10.5	10.7	10.9	11.1	11.4	11.7	12.0
Northridge	9.2	9.3	9.5	9.7	9.9	10.2	10.5	10.8
Pacoima[b]	11.2	11.3	11.5	11.7	11.9	12.3	12.7	13.1
Tarzana	5.5	5.6	5.7	5.8	5.9	6.1	6.3	6.4
Van Nuys-Sylmar[b]	14.4	14.6	14.8	15.1	15.3	15.8	16.4	16.9
Woodland Hills-Canoga Park	9.1	9.2	9.3	9.5	9.7	10.0	10.2	10.5
Total[c]	67.8	68.5	69.7	71.0	72.4	74.6	77.0	79.3
WESD DCT Flow Projections[d]	67.8	68.5	69.6	70.9	72.2	74.5	76.9	79.2

Footnote:

a. Adjusted for average GWI. See Draft Wastewater Projections TM (Task 5.1.1).
b. Assumed to contribute 75% of the total basin flow to DCT.
c. Total differs from the WESD DCT Flow Projections due to rounding errors.
d. Draft Wastewater Projections TM (Task 5.1.1).

3.1.2 ADWF Projections Using MIKE URBAN Model Results

The ADWF was also estimated using the City's MIKE URBAN Model results to confirm the 75% flow contribution from the Pacoima and Van Nuys-Sylmar primary sewer basins. The ADWF was estimated from the model results by examining the individual diversions that control the flow to DCT. The MIKE URBAN Model results were viewed using MIKE VIEW. The process that was used to further evaluate DCT-tributary flows in the MIKE URBAN Model is as follows:

- Determine the wastewater flow in AVORS and EVIS upstream of the plant influent diversion structures to estimate how much flow could be routed to DCT if the bypass gates were closed.
- Evaluate the diversion settings for the Pacoima and Van Nuys-Sylmar primary sewers at the intersections with the EVIS to determine if additional wastewater could be routed into EVIS and, therefore, into DCT.

WESD provided MIKE URBAN Model results for planning years 2008, 2025, and 2050. Flows in intermediate years were interpolated.

All of the flows from Chatsworth, Granada Hills, Northridge, Tarzana, and Woodland Hills-Canoga Park are already tributary to DCT, so no flow adjustments were necessary in these areas. One exception is the Hamlin St./Sepulveda Blvd. (3K-C43) diversion in Granada Hills, which can divert wastewater from a 15-inch sewer into EVIS just upstream of the EVIS diversion structure at DCT. This diversion could possibly add additional flow to DCT, but the amount of flow is unknown because this diversion was not included in the MIKE URBAN Model.

For the Pacoima and Van Nuys-Sylmar primary sewers that intersect with EVIS, each diversion was examined to determine which settings would maximize flow to DCT. **Table 3-2** summarizes the current settings of the diversions and the additional potential flow to DCT. Note that these are the same diversions that are summarized in **Table 2-3** for the EVIS outfall sewer.

Table 3-2: Maximizing Flow to DCT from EVIS Diversions

Figure No.	Location	Requires Construction?	Setting in MIKE URBAN Model	Additional Flow (mgd)		
				2008	2025	2050
3K-C28	Hart St. Woodman Ave.	No	0% to EVIS	5.8[a]	6.2[a]	7.0[a]
3K-C37	Hart St. Hazeltine Ave.	No	0% to EVIS	2.3	2.4	2.8
3K-C42	Kittridge St. Kester Ave.	No	0% to EVIS	4.4	4.7	5.4
3K-C43	Hamlin St. (Haynes St.) Sepulveda Blvd.	Maybe Diversion not shown in MIKE URBAN Model	-	Unknown	Unknown	Unknown
3K-C45	Victory Blvd. [b] Haskell Ave.	No	100% to EVIS	0	0	0
Total Additional Flow to DCT				12.5	13.3	15.2

Footnotes:

a. Assumes no upstream diversions from Woodman Sewer to EVIS. All Woodman flows would be diverted to EVIS at Hart St./Woodman Ave.

Based on the settings in the MIKE URBAN Model and as shown in **Table 3-2**, there are three diversions that need to be modified to re-route flow to DCT. The diversion at Hamlin St./Sepulveda Blvd. is not shown in the MIKE URBAN Model and its existence and setting should be confirmed in order to maximize flow to DCT. Two of the diversions upstream of the Hart St./Woodman Ave. diversion are also not shown in the model (3K-C30 and 3K-C31) and their existence and setting should also be confirmed. Since the wastewater flows upstream of the Hart St./Woodman Ave. diversion can be diverted at the Hart St./Woodman Ave. diversion, the status of the upstream diversions is not as critical as the Hamlin St./Sepulveda Blvd. diversion.

Table 3-3 and **Figure 3-1** summarize the estimated flow to DCT using the MIKE URBAN Model results.

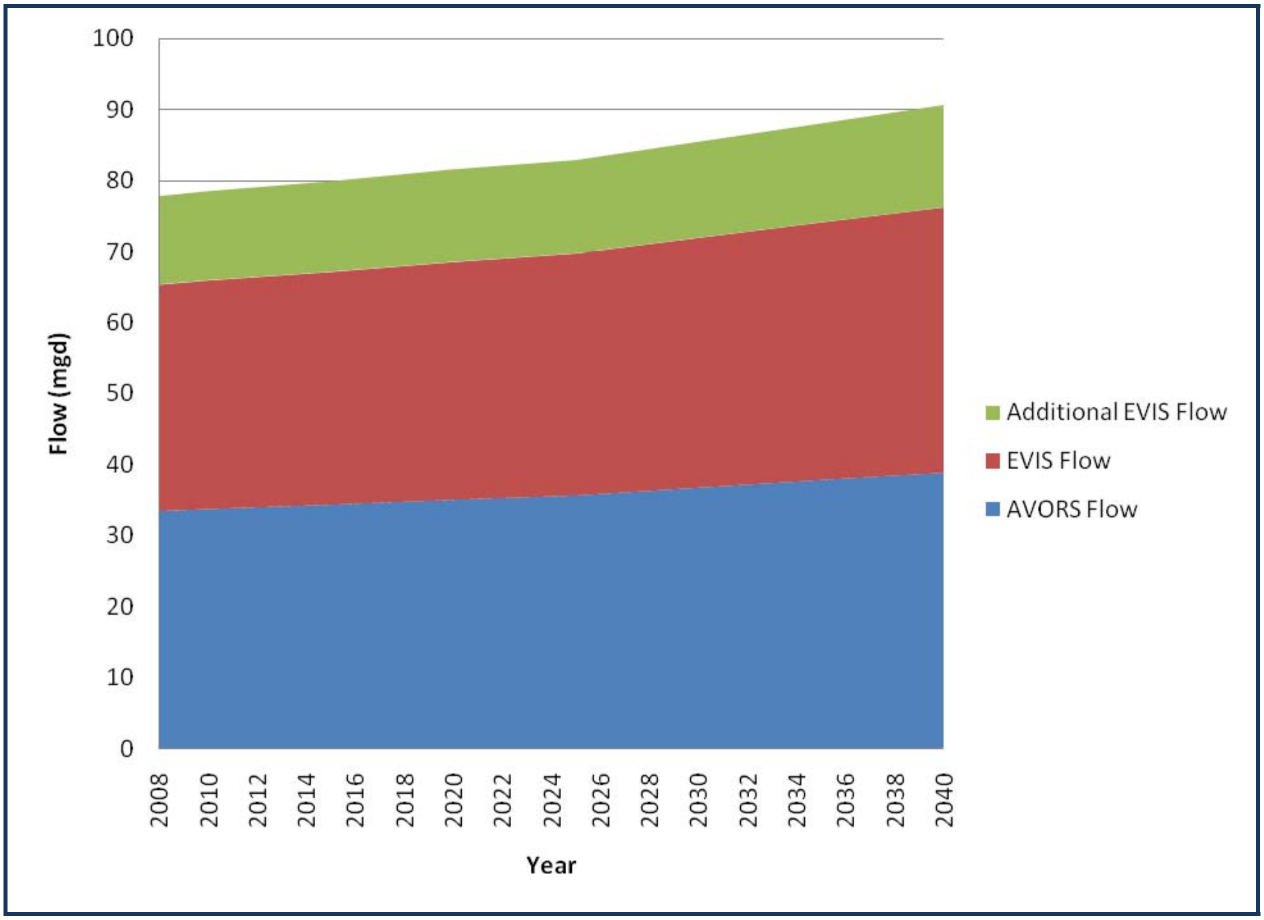
Table 3-3: Total DCT Influent Based on MIKE URBAN Diversions Investigation

Location	Flow (mgd)							
	2008	2010	2015	2020	2025	2030	2035	2040
AVORS Flow (Upstream of AVORS Diversion Structure)	33.4	33.7	34.3	35.0	35.6	36.7	37.8	38.8
EVIS Flow (Upstream of EVIS Diversion Structure)	31.9	32.2	32.8	33.5	34.1	35.2	36.3	37.4
Additional EVIS Flow[a]	12.5	12.6	12.8	13.1	13.3	13.6	14.0	14.5
Total Flow to DCT	77.8	78.4	79.9	81.5	83.0	85.5	88.1	90.7

Footnotes:

a. Summarized in Table 3-2. Intermediate years interpolated from 2008, 2025, 2050 estimates.

Figure 3-1: Total DCT Influent Based on MIKE URBAN Diversions Investigation



3.1.3 Summary of DCT Influent ADWF Estimates

The two theoretical DCT maximum ADWF estimates are summarized in **Table 3-4**. The estimate generated from the MIKE URBAN Model results is approximately 14-15% higher than the estimate generated from the ADWF estimates for the DCT-tributary primary sewer basins. These results indicate that the assumption that 75% of the Pacoima and Van Nuys-Sylmar primary basin flows are tributary to DCT may be low.

Table 3-4: Comparison of Total DCT Influent Estimates

Estimate	Flow (mgd)							
	2008	2010	2015	2020	2025	2030	2035	2040
Primary Sewer Basin ADWF Projections[a]	67.8	68.5	69.6	70.9	72.2	74.5	76.9	79.2
ADWF Projections Using MIKE URBAN Model Results	77.8	78.4	79.9	81.5	83.0	85.5	88.1	90.7
% Difference	14.7%	14.5%	14.8%	15.0%	14.8%	14.8%	14.6%	14.5%

Footnotes:

a. Assumes 75% of the Pacoima and Van Nuys-Sylmar primary basin flows are tributary to DCT.

WESD has two upcoming projects that will help refine these maximum DCT flow estimates. One project includes a model run simulating the maximum flow to DCT, which can be used to confirm the estimate completed using the MIKE URBAN Model results. The second project will investigate the current downward trend in wastewater flows and the resulting impact on higher influent wastewater concentrations.

Since the flow estimates differ by about 10 mgd for the planning period (through 2040), both flow estimates are carried forward to estimate the quantity of tertiary effluent that may be available in the future. These estimates will need to be refined as additional information is available from WESD.

3.2 Flow Variations

There are two types of flow variations that need to be considered for planning: diurnal and seasonal flow variations. These are discussed further in this section.

3.2.1 Daily Flow Variations

Diurnal flows are important for the RWMP to determine how the tertiary effluent flow will drop at night when the minimum flow occurs. A diurnal flow for unrestricted wastewater flow into DCT cannot be estimated from historical DCT influent flow data since the plant has been operating at a lower capacity to accommodate ongoing construction projects. A portion of the influent wastewater is routed into DCT and a portion is continuously bypassed around DCT to HTP. Therefore, the diurnal flow curves generated by the MIKE URBAN Model were used to estimate a theoretical diurnal flow to DCT if the flow was unrestricted.

DCT receives influent wastewater from the AVORS and EVIS. The weekday and weekend diurnal flow curves for these two outfall sewers were extracted from the MIKE URBAN Model and combined to show an estimated overall diurnal curve for DCT. The daily minimum and peak flow factors are summarized in **Table 3-5** for the AVORS, EVIS, and combined diurnal flow curves. The estimated weekday and weekend diurnal DCT flow curves are shown in **Figures 3-2 and 3-3**, respectively.

Table 3-5: Estimated DCT Daily Minimum and Peak Flows with Unrestricted Influent Flow

Diurnal Curve	Daily Minimum		Daily Peak 1		Daily Peak 2	
	Peaking Factor	Approx. Time	Peaking Factor	Approx. Time	Peaking Factor	Approx. Time
AVORS						
Weekday	0.54	5:00	1.29	10:30	1.20	22:15
Weekend	0.46	6:15	1.41	13:00	1.18	21:30
EVIS						
Weekday	0.42	4:30	1.26	9:45	1.30	21:00
Weekend	0.34	6:30	1.48	13:00	1.23	22:00
Combined (DCT Influent)						
Weekday	0.49	4:45	1.27	10:00	1.24	21:45
Weekend	0.41	6:15	1.44	13:00	1.20	22:00

Figure 3-2: Estimated DCT Weekday Diurnal Curve

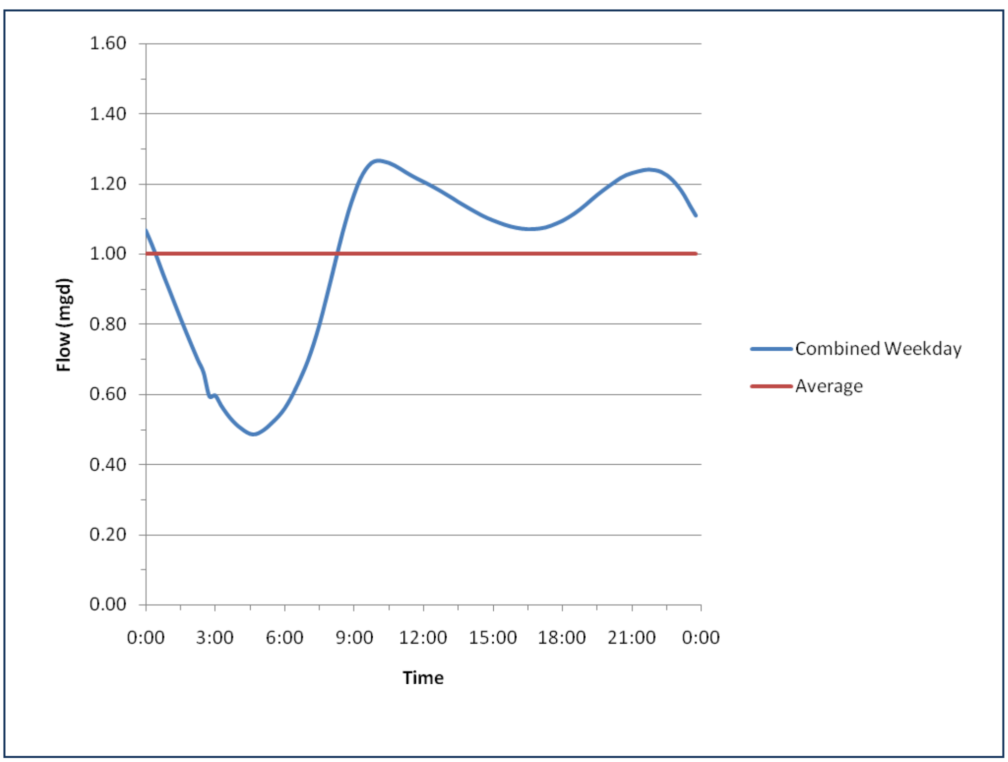
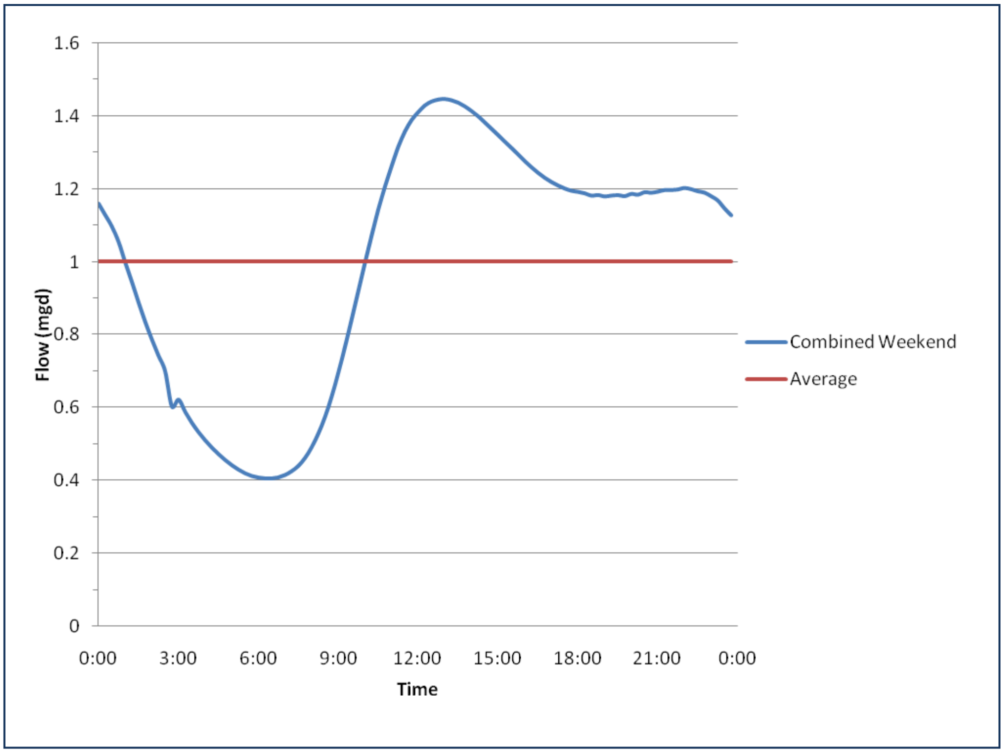


Figure 3-3: Estimated DCT Weekend Diurnal Curve



As shown in **Table 3-5** and **Figures 3-2 and 3-3**, the estimated DCT diurnal flow curve has a significant drop in flow during nighttime hours and reaches the lowest flow of 35 to 40 mgd (for year 2015) at about 4:45 am. With unrestricted wastewater flow, the influent wastewater would have two daily peaks: the first in late morning at about 10:00 am and the second in the evening at about 9:45 pm. Both peaks would be around 87 to 100 mgd (for year 2015). The results are slightly different for estimated weekend flows.

Since DCT is a scalping plant, the peak daily flows in excess of 80 mgd would be bypassed downstream treatment plants under normal operation. It would be ideal to capture these peak flows at DCT for treatment during nighttime low flows rather than diverting these flows away from DCT. In addition, since the preferred operation of AWTPs is as close to constant flow as possible, the lower low nighttime flows would require the AWTP to increase flows during the day and decrease flows at night. The changing flows throughout the day will also make it more difficult for plant operators to balance the distribution of recycled water between the effluent uses.

Methods to increase the flows at night, including projects to divert additional wastewater to the plant during nighttime low flows and storage/equalization of untreated or treated wastewater, should be considered to minimize the nighttime low flow impacts on the future recycled water projects. DCT has 3.2 million gallons (MG) of primary influent storage available in the nine rectangular flow equalization tanks as well as the existing Title 22 distribution system that could be used to store tertiary effluent upstream of the AWTP. The City will also be constructing 15 MG of wet weather storage at DCT, which could potentially be used for flow equalization during dry weather (this project is discussed further in the Draft DCT Data Summary TM (Task 1.2)).

Upon inspection of the MIKE URBAN Model results, the estimated weekend flows for EVIS are slightly lower than weekday flow estimates. The AVORS flow estimates do not change between the weekday and weekend projections. These results should be investigated further to determine if the flow decrease is appropriate for the tributary area to determine if the weekend flow decrease should be taken into account in the planning process.

3.2.2 Seasonal Flow Variations

The City does not currently have a way to estimate the seasonal flow variations for the DCT influent flows. There is a gauging station in the AVORS outfall sewer upstream of the AVORS diversion structure at DCT, but this gauging station only stores flow data for 36 days. During wet weather when the ground is saturated there is typically a higher GWI component to the wastewater flow, as well as a faster increase in peak flows since saturated ground conditions increases stormwater runoff. This issue should be investigated in more detail to determine if seasonal flow variations might impact the DCT recycled water projects.

4. DCT In-Plant Flow Analysis

Summaries of the DCT influent and effluent flows are included in the Draft DCT Data Assessment TM (Task 1.2). This section re-summarizes the tertiary effluent flow distribution and presents an estimate of how much tertiary effluent is produced from the influent wastewater for the purpose of estimating how much tertiary effluent will be produced in the future.

Table 4-1 summarizes the DCT tertiary effluent flows. The DCT effluent uses are described in the Draft DCT Data Summary TM (Task 1.2, September 1, 2009) Section 3.2. The complete DCT flow data tables are included in Attachment A of the Draft DCT Data Summary TM.

Table 4-1: DCT Tertiary Effluent Flow Summary

DCT Tertiary Effluent Uses	Maximum Effluent Flow			Average Effluent Flow			Minimum Effluent Flow		
	AFY	mgd	%[a]	AFY	mgd	%[a]	AFY	mgd	%[a]
Lake Balboa[b]	17,400	15.5	26	14,800	13.2	30	10,500	9.4	25
Wildlife Lake[b]	9,000	8.0	14	7,700	6.8	15	5,500	4.9	13
Japanese Garden[b]	5,800	5.2	9	4,700	4.2	9.4	3,600	3.2	6
High Pressure In-Plant Reuse[b]	2,300	2.0	4	1,800	1.6	3.6	600	0.5	2
Low Pressure In-Plant Reuse[b]	2,800	2.5	6	1,100	1.0	2.2	400	0.3	1
Balboa Pump Station[c] (LADWP)	3,000	2.7	7	1,500	1.4	3.1	200	0.2	0.5
LA River[b]	37,000	33.0	48	11,500	10.2	23.2	1,500	1.4	4.4
Total ADWF	-	-	-	43,100	38.4	-	-	-	-

Footnotes:

a. Percentage of total plant flow. Maximum and minimum percentages are compared the maximum or minimum plant flow corresponding to the month in which the flow occurred.
b. Based on data from January 2005 through December 2008.
c. Based on data from January 2008 through August 2009.
d. The sum of the flows from all effluent uses may not match the secondary effluent flow due to the inaccuracy of flow meters at the plant.

~~The historical data was analyzed to estimate the percentage of tertiary effluent that is produced from the influent wastewater. The pertinent flows are summarized in **Table 4-2**. Based on historical flow data, approximately 87% of the influent wastewater flow becomes tertiary effluent.~~

~~Table 4-2: Percentage of Tertiary Effluent Produced from Influent Wastewater Flow~~

~~Flow Stream~~	~~Flow (mgd)~~[a]
~~Aeration Tank Influent~~[b]	
~~Phase 1~~	~~29.7~~
~~Phase 2~~	~~14.6~~
~~Subtotal~~	~~44.3~~
~~Tertiary Effluent~~[c]	~~38.4~~
~~Percent Tertiary Effluent Produced from Influent~~	~~87%~~

~~Footnotes:~~

a. ~~Based on data from January 2005 through December 2008, except for Balboa Pump Station flows (a portion of the tertiary effluent), which is based on data from January 2008 through August 2009.~~

b. ~~Because the DCT influent pumps are constant speed, a higher wastewater flow is pumped into the plant and treated through the headworks than the rest of the plant. The excess flow is bypassed back to AVORS before primary treatment. Therefore, the aeration tank influent flow represents the influent wastewater flow.~~

c. ~~Summary of average tertiary effluent flows from Table 4-1.~~

5. DCT Effluent Flows Available for Recycling

This section investigates how much flow at DCT would be available for GWR and NPR. As determined previously in this TM, there were two different estimates of the maximum flow to DCT, which are summarized in **Table 3-5**. Both estimates are used to develop a range of estimated effluent available for recycling.

Table 5-2 summarizes the other uses of the DCT tertiary effluent that need to be fulfilled before the water can be used for GWR and NPR projects. The estimated tertiary effluent flow is calculated assuming 87% of the influent is treated to tertiary standards, due to sludge wasting and other uses in the treatment processes. The effluent uses that will continue in the future are as follows:

- In-plant reuse (high pressure and low pressure effluent): based on historical data, the in-plant reuse is 6.8% of the tertiary effluent. It is assumed that this same percentage of tertiary effluent will be used for in-plant uses as the influent flow increases.
- LA River: A discussion/analysis of the LA River flow from DCT is being developed under the Draft LA River Flow Assessment TM (Task 4.1.4). For this TM, the flow to the LA River is assumed to be 27 mgd, which was the documented minimum flow in the City of Los Angeles Integrated Resources Plan Final Environmental Impact Report (CH:CDM, September 2006). This flow includes flows to Lake Balboa, Wildlife Lake, and the Japanese Garden, which are eventually discharged to the LA River, as well as flow that is discharged directly to the LA River.

As shown in **Table 5-1**, the tertiary effluent available for GWR and NPR projects ranges between 29.5-34.2 mgd for in 2015, near the time when the AWTP would start operation, and increases to 37.2-42.3 mgd during the planning year of 2040. If the flow to the LA River is decreased, additional tertiary effluent would be available for reuse.

Table 5-1: Comparison of Total DCT Influent Estimates

Flow Stream	Flow (mgd)							
	2008	2010	2015	2020	2025	2030	2035	2040
Estimated DCT Influent Flow								
Low end	67.8	68.5	69.6	70.9	72.2	74.5	76.9	79.2
High end	77.8	78.4	79.9	81.5	83.0	85.5	88.1	90.7
Estimated Tertiary Effluent Flow[a]								
Low end	59.0	59.6	60.6	61.7	62.8	64.8	66.9	68.9
High end	67.7	68.2	69.5	70.9	72.2	74.4	76.6	78.9
Estimated In-Plant Reuse[b]								
Low end	4.0	4.1	4.1	4.2	4.3	4.4	4.5	4.7
High end	4.6	4.6	4.7	4.8	4.9	5.1	5.2	5.4
LA River[c]	27.0	27.0	27.0	27.0	27.0	27.0	27.0	27.0
Estimated Flow Available for GWR and NPR								
Low end	**28.0**	**28.5**	**29.4**	**30.5**	**31.5**	**33.4**	**35.4**	**37.2**
High end	**36.1**	**36.6**	**37.8**	**39.1**	**40.3**	**42.3**	**44.4**	**46.5**

Footnotes:

a. Tertiary effluent flow is assumed to be 87% of influent flow based on review of historical plant data. See Table 4-2.

b. Assumed to be 6.8% of the tertiary effluent flow based on review of historical plant data. See Table 4-1.

c. A discussion/analysis of the LA River flow from DCT is being developed under the Draft LA River Flow Assessment TM (Task 4.1.4). For this TM, this minimum flow was assumed to the LA River based on the City of Los Angeles Integrated Resources Plan Final Environmental Impact Report (CH:CDM, September 2006).

6. Summary and Next Steps

The flow projections summarized in this TM will be used to evaluate the feasibility and size of potential projects at DCT, which include constructing a new AWTP for GWR and expanding the NPR system. Once the initial evaluation GWR and NPR evaluations are completed as part of the Tasks 1a and 2a, respectively, and the concepts for maximizing recycling are formulated as part of Task 4a, then overall project concepts will be evaluated using an integrated alternatives analysis. The trade-offs between expanding GWR and NPR using DCT effluent will be compared to determine the preferred alternatives for expansion of water recycling at DCT.

The initial sizing for the AWTP for GWR is 20 mgd for a 50% recycled water GWR project, which would require 25 mgd of tertiary effluent. The ultimate capacity of this AWTP would be 40 mgd for a "100%" recycled water GWR project, which would require 50 mgd of tertiary effluent. These capacities are currently being refined as part of Task 1a, but are anticipated to be of this magnitude. Based on the 2015 flow estimates of 29.4 to 37.8 mgd, implementing a 20 mgd AWTP plant would leave between 4.4 and 12.8 mgd available for NPR.

To further define the maximum ADWF available from DCT and support the development of recycling projects, the following next steps should be considered.

6.1 Confirm DCT Maximum ADWF and Tertiary Effluent Available for Recycling

Since the theoretical DCT maximum ADWF estimates presented in this TM differ by approximately 10 mgd through the 2040 planning year, and there are planned BOS projects to confirm wastewater flow projections and model the maximum DCT influent flow, the following additional steps are recommended to further confirm the DCT influent flow and amount of tertiary effluent available for recycling. In addition, the LA River flow requirements are being evaluated further as part of Task 4.1.4 and the results of this evaluation must be taken into account when estimating the amount of tertiary effluent available for recycling.

- Complete a full-scale test to measure the current maximum ADWF that can be treated at DCT once the filter upgrades are complete in 2010. To be able to determine the maximum flow available, the primary sewer diversions on the EVIS outfall sewer need to be set to divert flows into EVIS and not into VORS. Since it is possible to divert wastewater back to AVORS after the headworks, the City could consider conducting this full-scale test before the filter upgrades are complete.
- BOS is currently evaluating the recent flow decrease in the City's wastewater system due to the current drought, as well as an associated increase in influent constituents. Once this evaluation is complete, the results should be used to modify the DCT maximum ADWF estimates to reflect potential decreases in flow due to drought conditions.
- Complete the Draft LA River Flow Assessment TM (Task 4.1.4), which will include a discussion/analysis of the LA River flow from DCT, to refine the estimate of tertiary effluent available for recycling.

- Further investigate a way to determine if there are seasonal variations to wastewater flow for the wastewater tributary to DCT that may impact the seasonal availability of tertiary effluent.
- Further investigation of the decrease in average wastewater flow in the EVIS outfall sewer on weekends, which is indicated by the MIKE URBAN Model results, to determine if the flow decrease is appropriate and should be addressed as part of the RWMP recommendations.

6.2 Identify Modifications to Maximize Wastewater Flow to DCT and Supplement Minimum Diurnal Flows

In order to maximize the wastewater flows to DCT, additional projects should be investigated. These include projects to allow the DCT-tributary wastewater to be conveyed to DCT through the EVIS outfall sewer as well as capturing peak daytime flows to supplement nighttime low flows to attempt to provide as constant of tertiary effluent flow as possible. Additional projects should be investigated to supplement the minimum day flows either through flow equalization or supplemental pumping to provide a constant flow throughout the day.

- Confirm that all of the primary sewers that cross EVIS can divert wastewater into EVIS in order to maximize influent wastewater flows to DCT. The Advanced Planning Report (City of Los Angeles, 1989) drawings indicate that all of the primary sewers that cross EVIS have the ability to divert into EVIS, but these diversions were not all reflected in the MIKE URBAN Model and this report is 20 years old. If a primary sewer does not currently connect to EVIS, then the City should consider adding diversions at these locations.
- Since the wastewater projections show that the maximum ADWF tributary to DCT will be less than the 80 mgd plant capacity, identify projects to divert additional wastewater to DCT to increase the total flow treated at the plant and maximize the amount tertiary effluent available for recycling. This would likely require pump stations downstream of DCT to pump wastewater collected from downstream service areas for treatment at DCT. Candidate projects should take into account supplementing the nighttime, minimum diurnal flows to allow DCT to produce 80 mgd throughout the diurnal flow curve.
- Identify additional tertiary effluent that could be used as AWTP plant influent or to supplement the non-potable distribution system, including tertiary effluent from the City's Los Angeles-Glendale Water Reclamation Plant (LAG) and the City of Burbank Water Reclamation Plant (BWRP).
- Evaluate potential flow equalization options to supplement the nighttime minimum diurnal flows. DCT has 3.2 MG of primary influent storage available in the nine rectangular flow equalization tanks as well as the existing Title 22 distribution system that could be used to store tertiary effluent upstream of the AWTP. The City will also be constructing 15 MG of wet weather storage at DCT, which could potentially be used for flow equalization during dry weather.

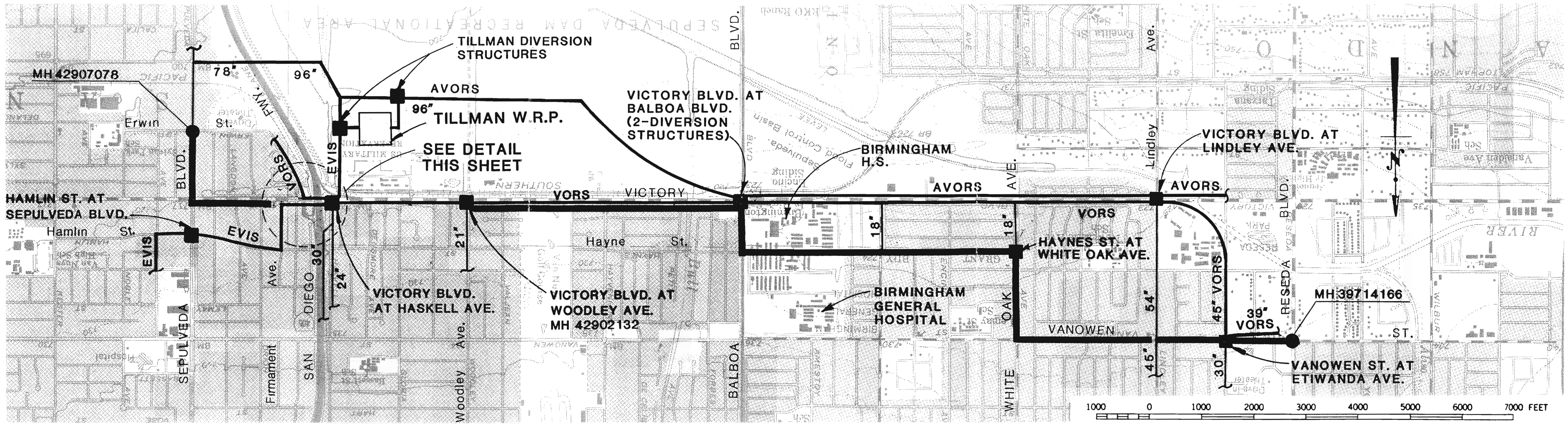
References

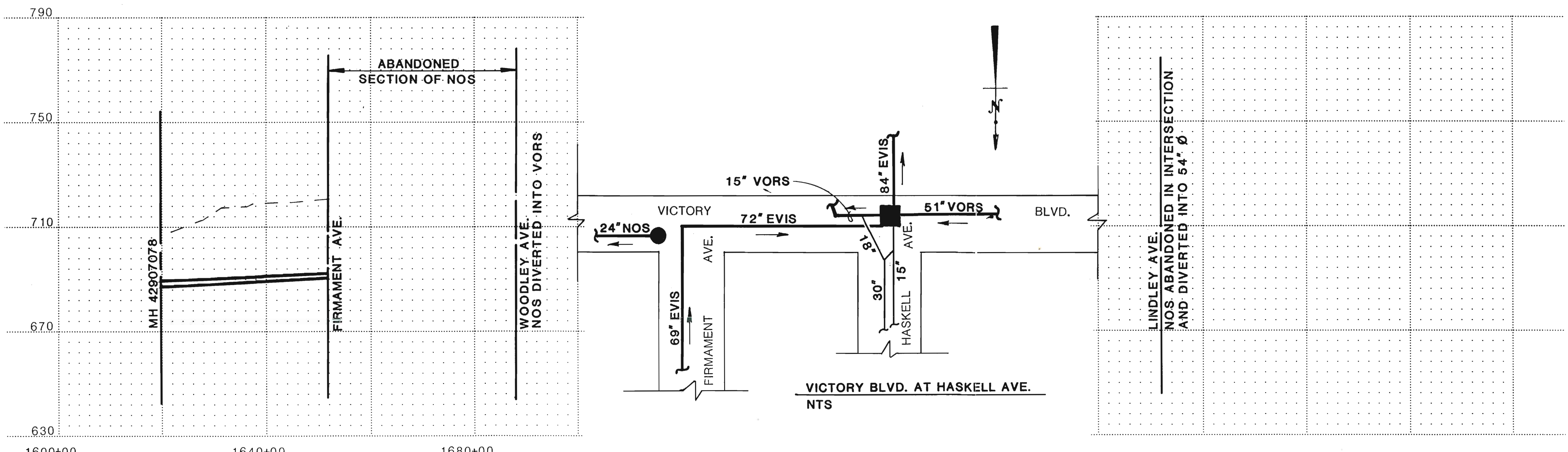
1. Bureau of Sanitation (BOS), Department of Public Works, City of Los Angeles, 2008, Chatsworth Primary Basin Master Plan.
2. Bureau of Sanitation (BOS), Department of Public Works, City of Los Angeles, 2008, Granada Hills Primary Basin Master Plan.
3. Bureau of Sanitation (BOS), Department of Public Works, City of Los Angeles, 2008, Northridge Primary Basin Master Plan.
4. Bureau of Sanitation (BOS), Department of Public Works, City of Los Angeles, 2008, Pacoima Primary Basin Master Plan.
5. Bureau of Sanitation (BOS), Department of Public Works, City of Los Angeles, 2008, Tarzana Primary Basin Master Plan.
6. Bureau of Sanitation (BOS), Department of Public Works, City of Los Angeles, 2008, Van Nuys-Sylmar Primary Basin Master Plan.
7. Bureau of Sanitation (BOS), Department of Public Works, City of Los Angeles, 2008, Woodland Hills-Canoga Park Primary Basin Master Plan.
8. CH:CDM, 2004, City of Los Angeles Integrated Resources Plan, Facilities Plan Volume 1: Wastewater Management, Section 5: Existing Collection System.
9. RMC/CDM, 2009, Draft Wastewater Flow Projections Technical Memorandum, Task 5.1.1.
10. RMC/CDM, 2009, Draft Wastewater Collection System Technical Memorandum, Task 5.1.1.
11. Wastewater Engineering Services Division (WESD), Bureau of Sanitation (BOS), Department of Public Works, City of Los Angeles, September 2009, Updated Average Dry Weather Flow Projections.
12. Wastewater Engineering Services Division (WESD), Bureau of Sanitation (BOS), Department of Public Works, City of Los Angeles, September 2009, MIKE URBAN Model Results.

Attachment A Diversions in TSA Outfall Sewers

Table A-1: Summary of TSA Diversion Drawings

Drawing Number	Drawing Title
3K-B3-15	NOS – Erwin St. to Reseda Blvd.
3K-B3-16	NOS – Reseda Blvd to Topanga Canyon Blvd.
3K-B10-2	VORS – Addison St. to Oxnard St.
3K-B10-3	VORS – Oxnard St. to Vanowen St.
3K-B10-4	VORS – Vanowen St. to Topanga Canyon Blvd.
3K-B11-1	ORS – Kester Ave. to Louise Ave.
3K-B11-2	VORS – Louise Ave. to Haynes St.
3K-B11-3	VORS – Haynes St. to Topanga Canyon Blvd.
3K-B13-1	EVIS – Tillman W.R.P to Hazeltine Ave.
3K-B13-2	EVIS – Hazeltine Ave. to Branford St.
3K-B13-3	EVIS – Branford St. to Chatsworth St.
3K-C28	Hart Street at Woodman Avenue
3K-C29	Woodman Place at Woodman Avenue
3K-C30	Strathern Street at Woodman Avenue
3K-C31	Branford Street at Woodman Avenue
3K-C32	Osborne Street at Woodman Avenue
3K-C33	Chatsworth Street at Woodman Avenue
3K-C37	Hart Street at Hazeltine Avenue
3K-C42	Kittridge Street at Kester Avenue
3K-C43	Hamlin Street at Sepulveda Boulevard
3K-C44	Tillman Water Reclamation Plant
3K-C45	Victory Boulevard at Haskell Avenue
3K-C46	Victory Boulevard at Woodley Avenue
3K-C47	Victory Boulevard at Balboa Avenue #1
3K-C48	Victory Boulevard at Balboa Avenue #2
3K-C49	Haynes Street at White Oak Avenue
3K-C50	Victory Boulevard at Lindley Avenue
3K-C52	Vanowen Street at Etiwanda Avenue
3K-C53	Vanowen Street at Wilbur Avenue
3K-C54	Vanowen Street at Tampa Avenue
3K-C55	Vanowen Street at Winnetka Avenue





LEGEND

- ■ DIVERSION STRUCTURE
- ● MANHOLE
- ••• SIPHON
- — — APPROXIMATE GROUND ELEVATION DURING CONSTRUCTION
- ═ SEWER CROWN AND INVERT

SCALE

1"=40' VERTICAL

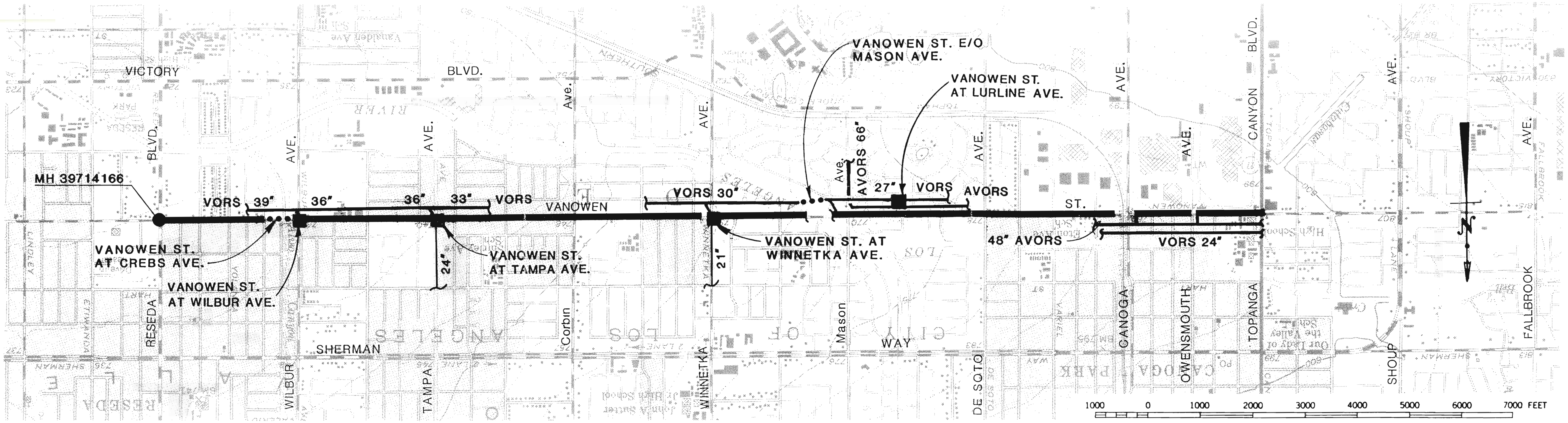
1"=2000' HORIZONTAL

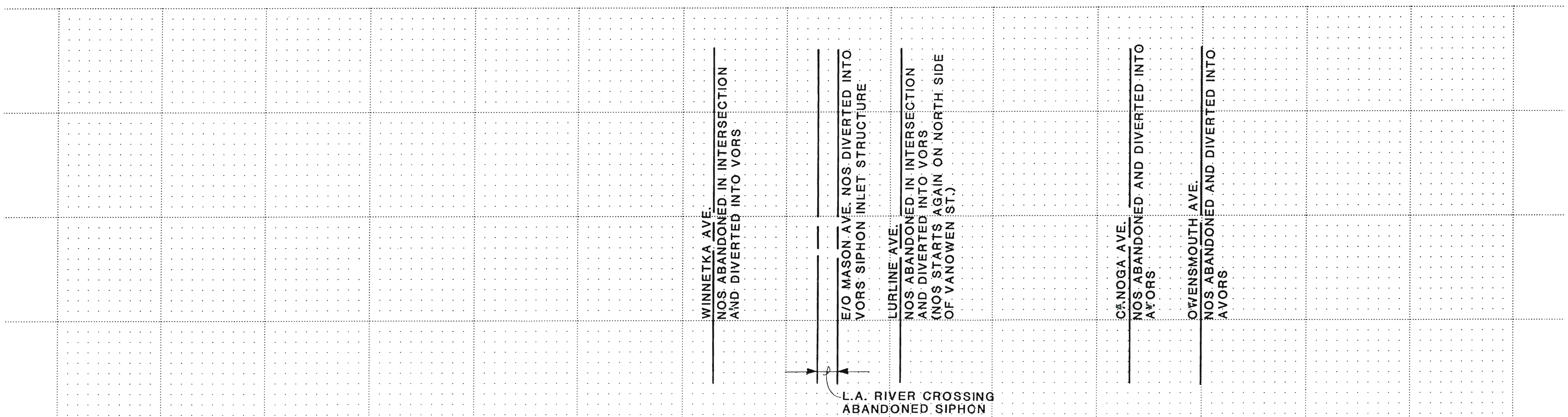
FIGURE 3K-B3-15

NORTH OUTFALL SEWER ERWIN ST. TO RESEDA BLVD.

CLEAN WATER PROGRAM

City of Los Angeles





LEGEND

- ■ DIVERSION STRUCTURE
- ● MANHOLE
- • • • SIPHON
- — — — APPROXIMATE GROUND ELEVATION DURING CONSTRUCTION
- ——— SEWER CROWN AND INVERT

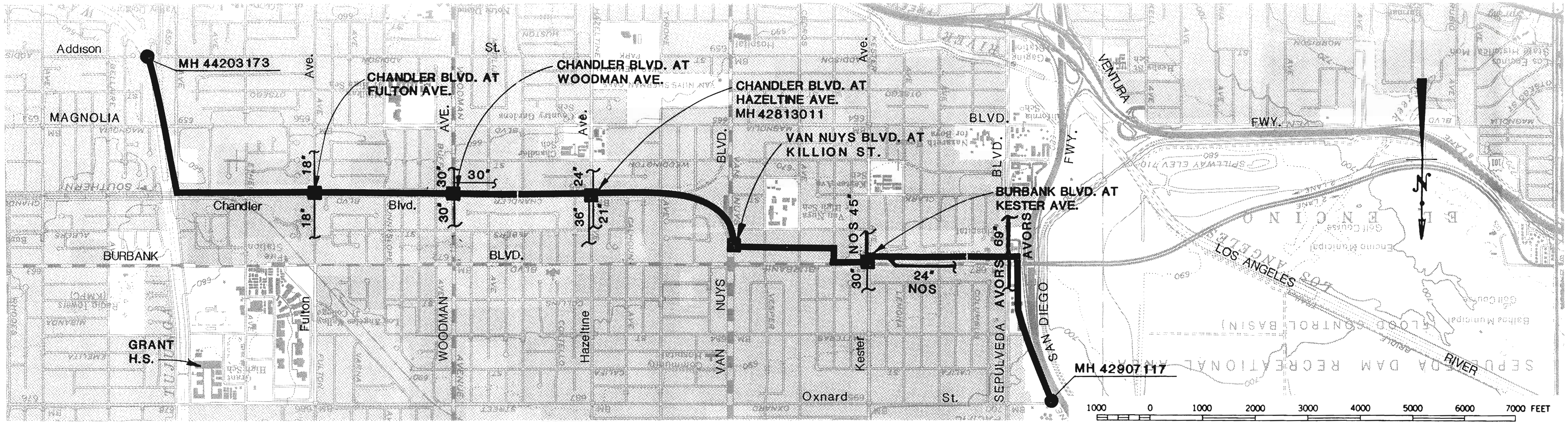
SCALE

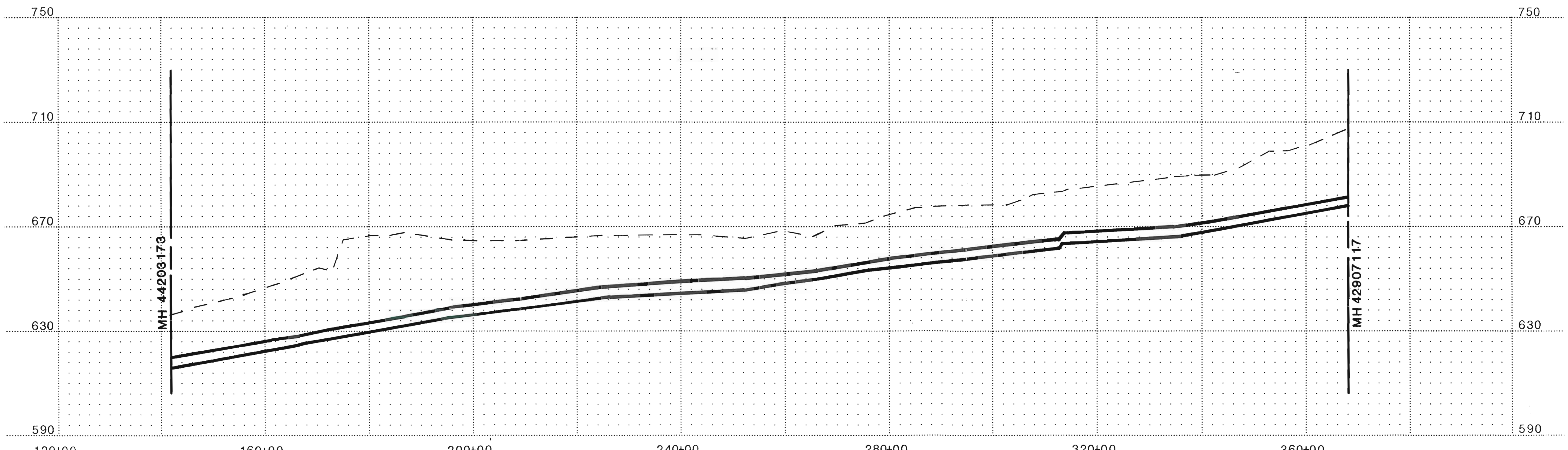
1"=40' VERTICAL

1"=2000' HORIZONTAL

FIGURE 3K-B3-16
NORTH OUTFALL SEWER
RESEDA BLVD. TO TOPANGA CANYON BLVD.

CLEAN WATER PROGRAM
City of Los Angeles





LEGEND

- ■ DIVERSION STRUCTURE
- ● MANHOLE
- ••• SIPHON
- – – – APPROXIMATE GROUND ELEVATION DURING CONSTRUCTION
- ▬▬ SEWER CROWN AND INVERT

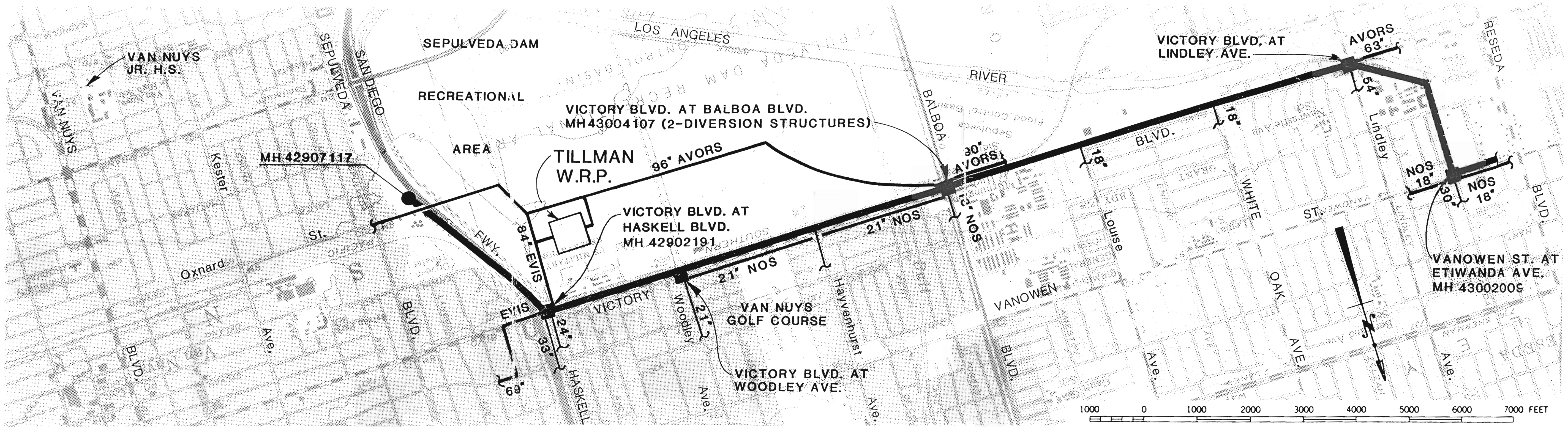
SCALE

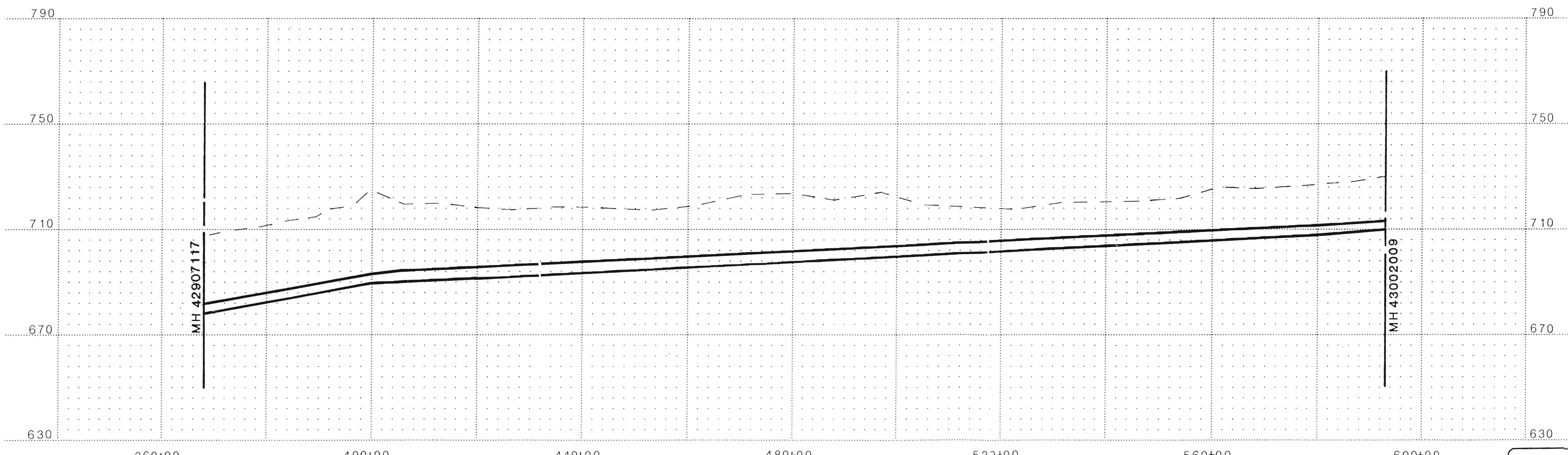
1"=40' VERTICAL

1"=2000' HORIZONTAL

FIGURE 3K-B10-2

VALLEY OUTFALL RELIEF SEWER ADDISON ST. TO OXNARD ST.





LEGEND

- DIVERSION STRUCTURE
- MANHOLE
- SIPHON
- APPROXIMATE GROUND ELEVATION DURING CONSTRUCTION
- SEWER CROWN AND INVERT

SCALE

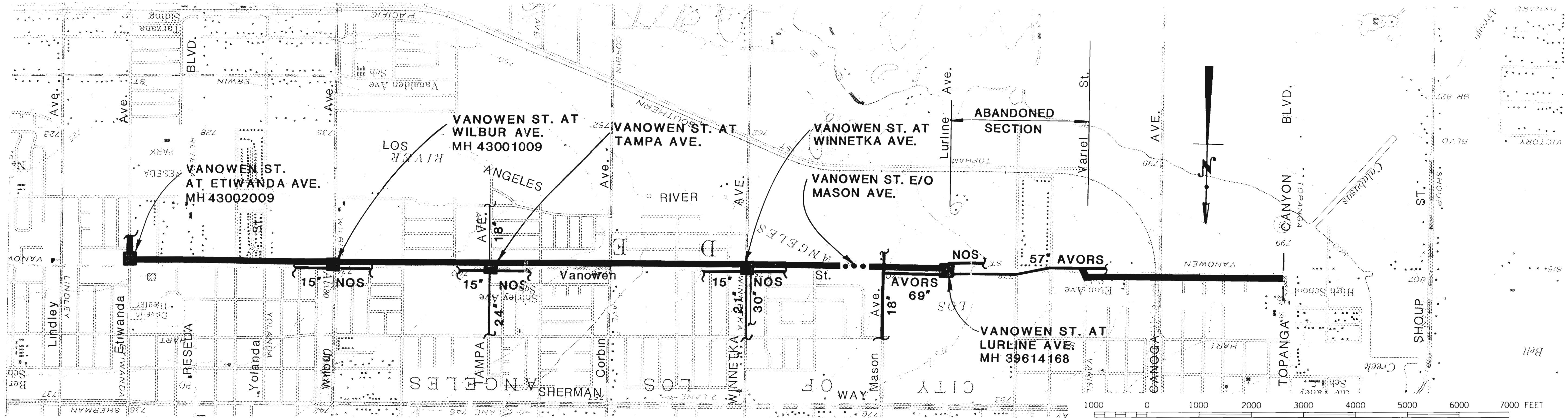
1"=40' VERTICAL

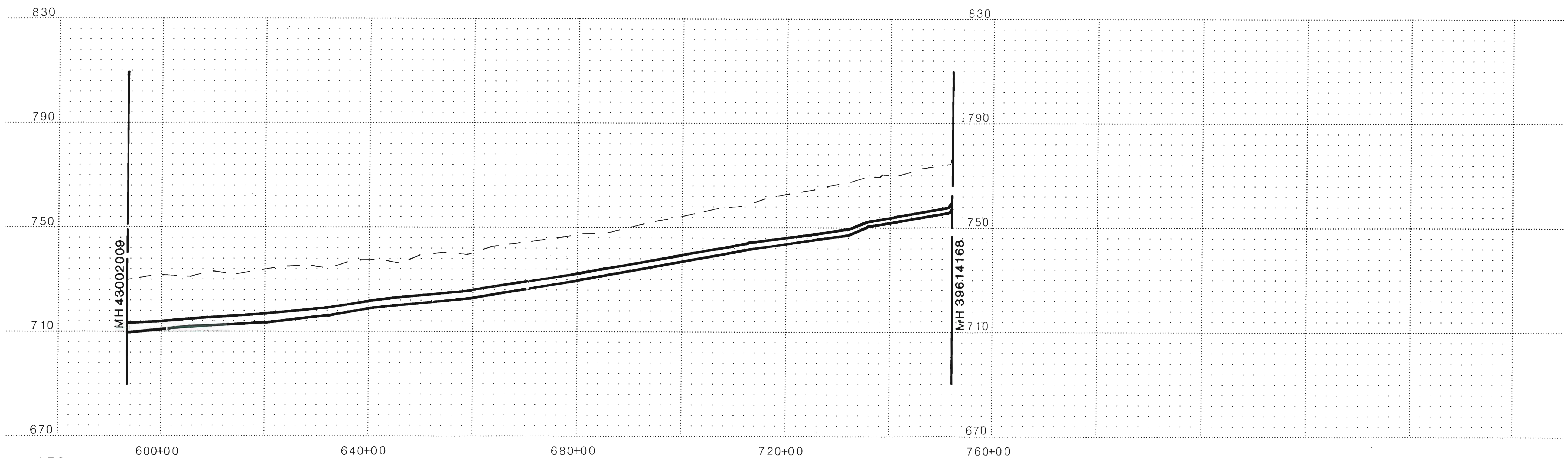
1"=2000' HORIZONTAL

CLEAN WATER PROGRAM
City of Los Angeles

FIGURE 3K-B10-3

VALLEY OUTFALL RELIEF SEWER OXNARD ST. TO VANOWEN ST.





LEGEND

- DIVERSION STRUCTURE
- MANHOLE
- SIPHON
- APPROXIMATE GROUND ELEVATION DURING CONSTRUCTION
- SEWER CROWN AND INVERT

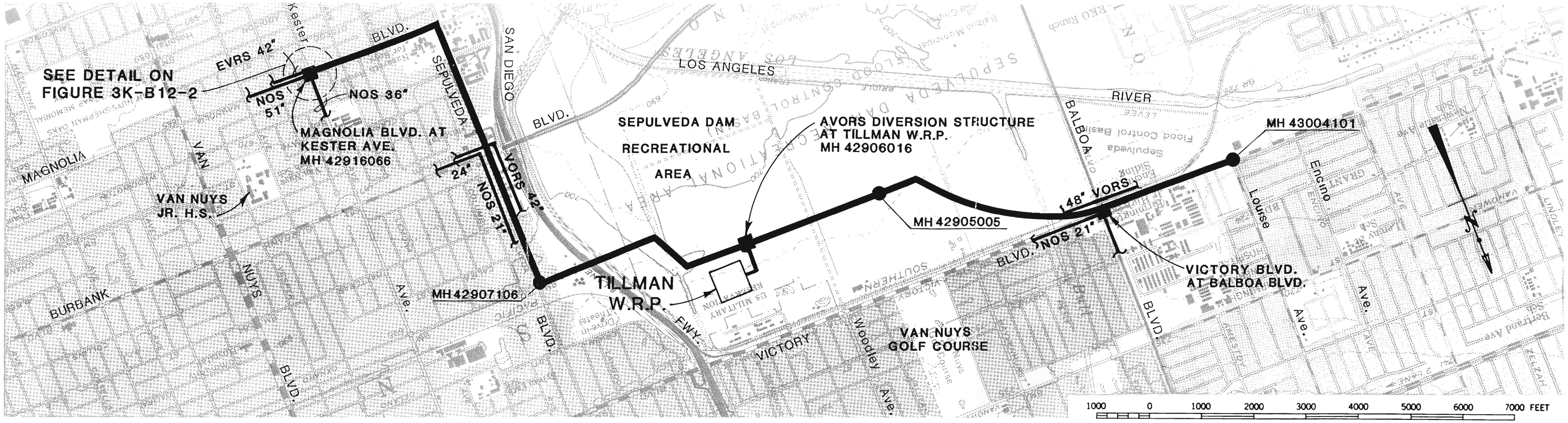
SCALE

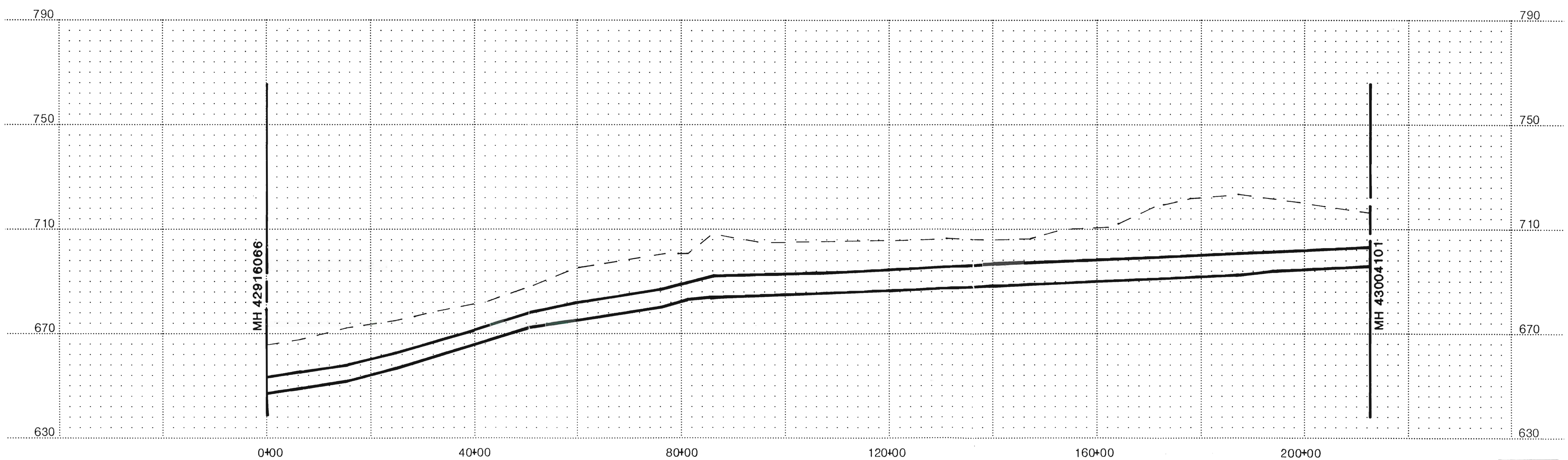
1"=40' VERTICAL

1"=2000' HORIZONTAL

FIGURE 3K-B10-4
VALLEY OUTFALL RELIEF SEWER
VANOWEN ST. TO TOPANGA CANYON BLVD.

CLEAN WATER PROGRAM
City of Los Angeles





LEGEND

■ DIVERSION STRUCTURE

● MANHOLE

••• SIPHON

– – – APPROXIMATE GROUND ELEVATION DURING CONSTRUCTION

——— SEWER CROWN AND INVERT

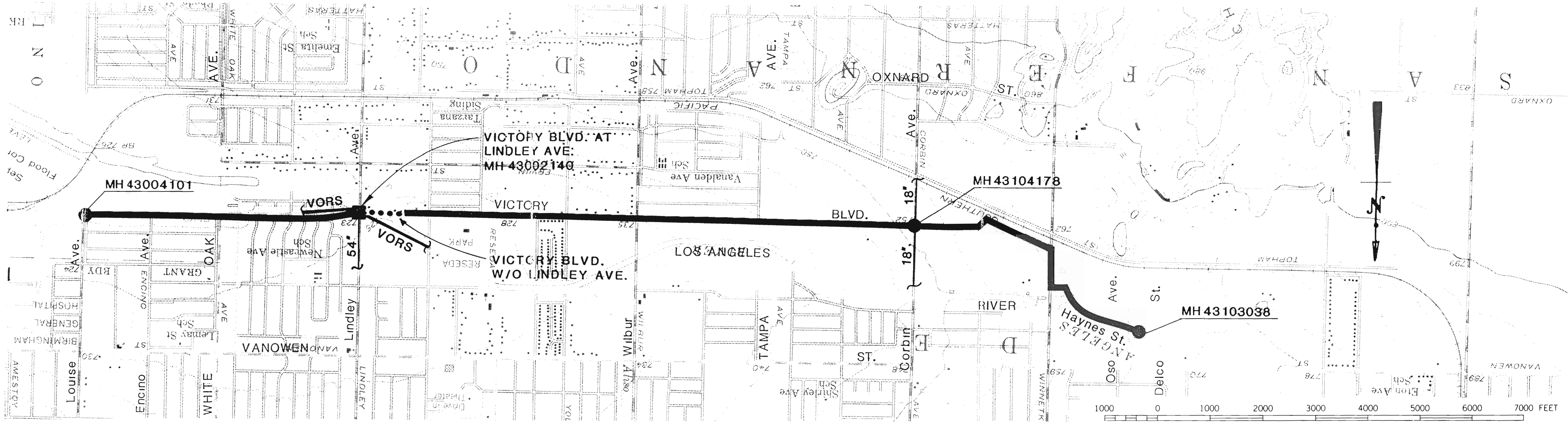
SCALE

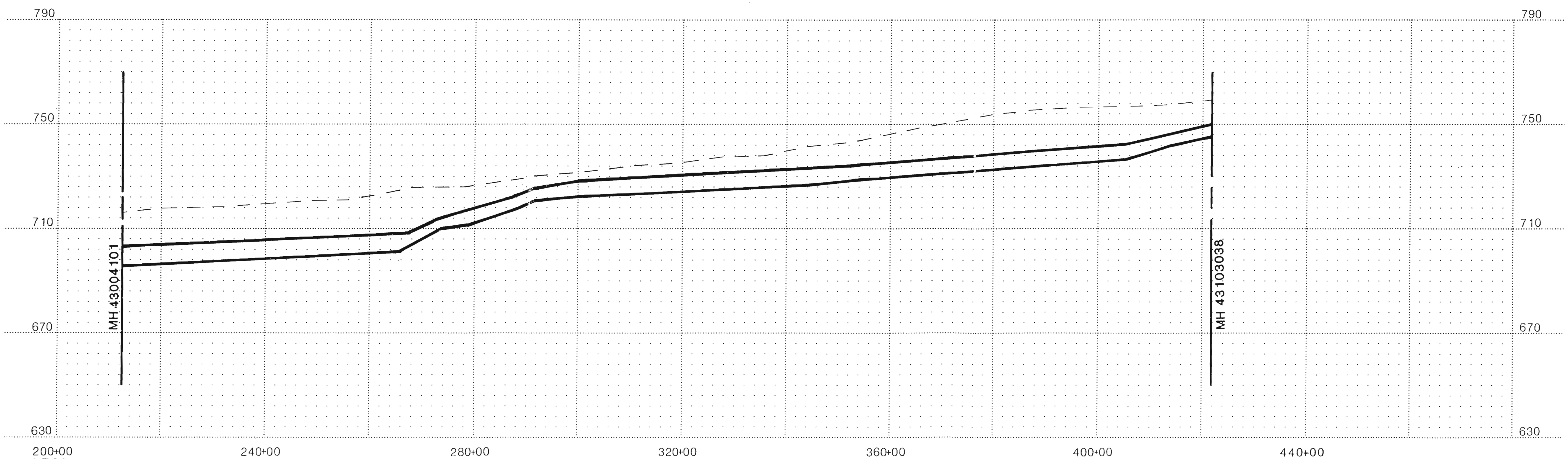
1"=40' VERTICAL

1"=2000' HORIZONTAL

FIGURE 3K-B11-1
ADDITIONAL VALLEY OUTFALL RELIEF SEWER KESTER AVE. TO LOUISE AVE.

CLEAN WATER PROGRAM
City of Los Angeles





LEGEND

- ■ DIVERSION STRUCTURE
- ● MANHOLE
- ••• SIPHON
- — — APPROXIMATE GROUND ELEVATION DURING CONSTRUCTION
- —— SEWER CROWN AND INVERT

SCALE

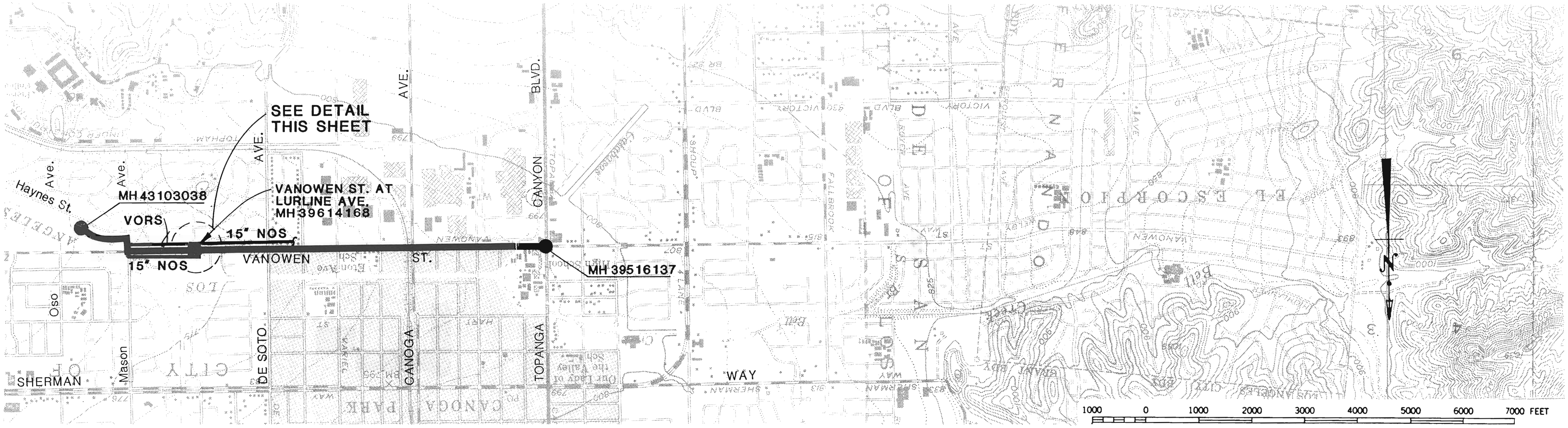
1"=40' VERTICAL

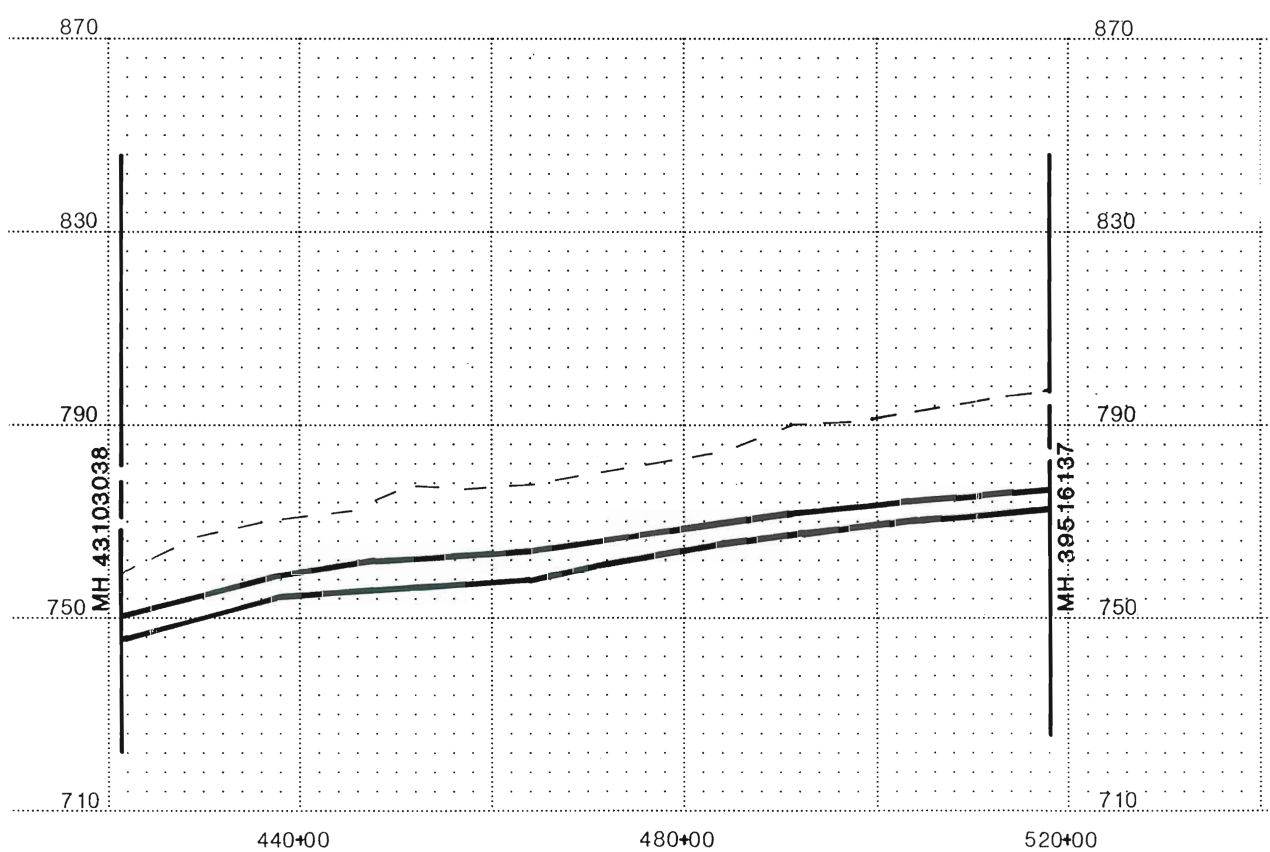
1"=2000' HORIZONTAL

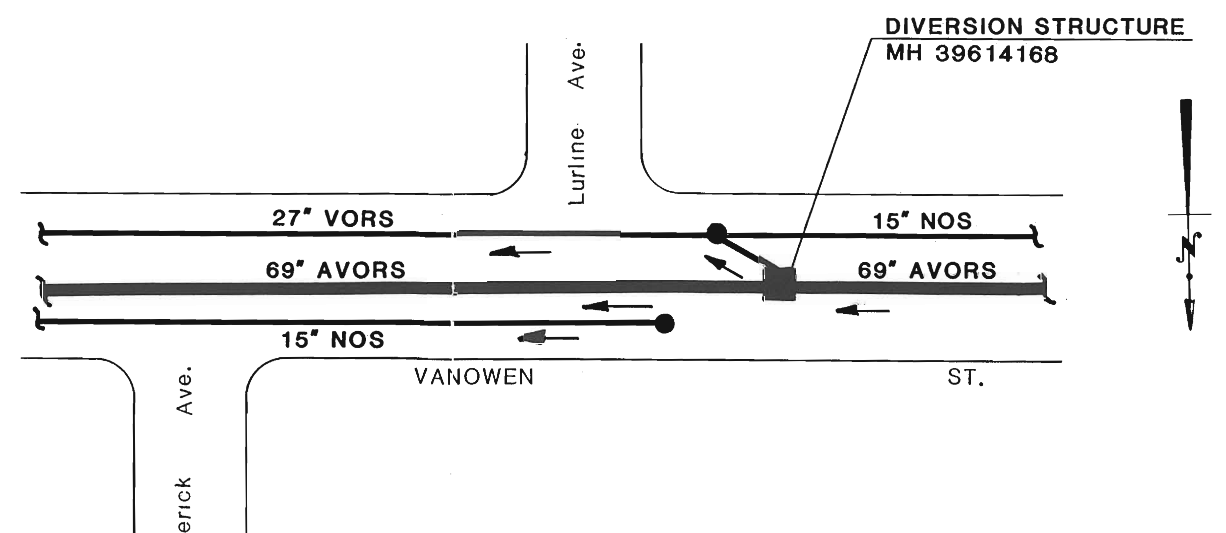
FIGURE 3K-B11-2

ADDITIONAL VALLEY OUTFALL RELIEF SEWER LOUISE AVE. TO HAYNES ST.

CLEAN WATER PROGRAM
City of Los Angeles







VANOWEN ST. AT LURLINE AVE.
NTS

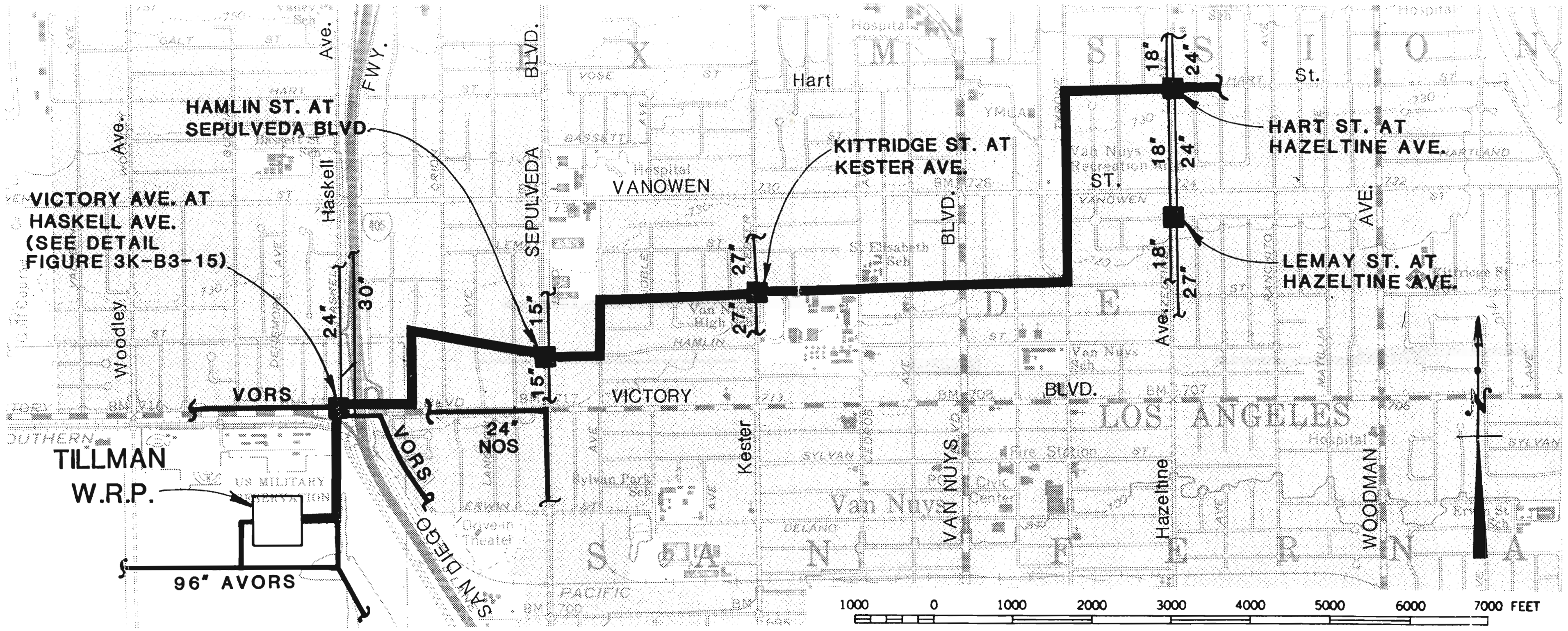
LEGEND

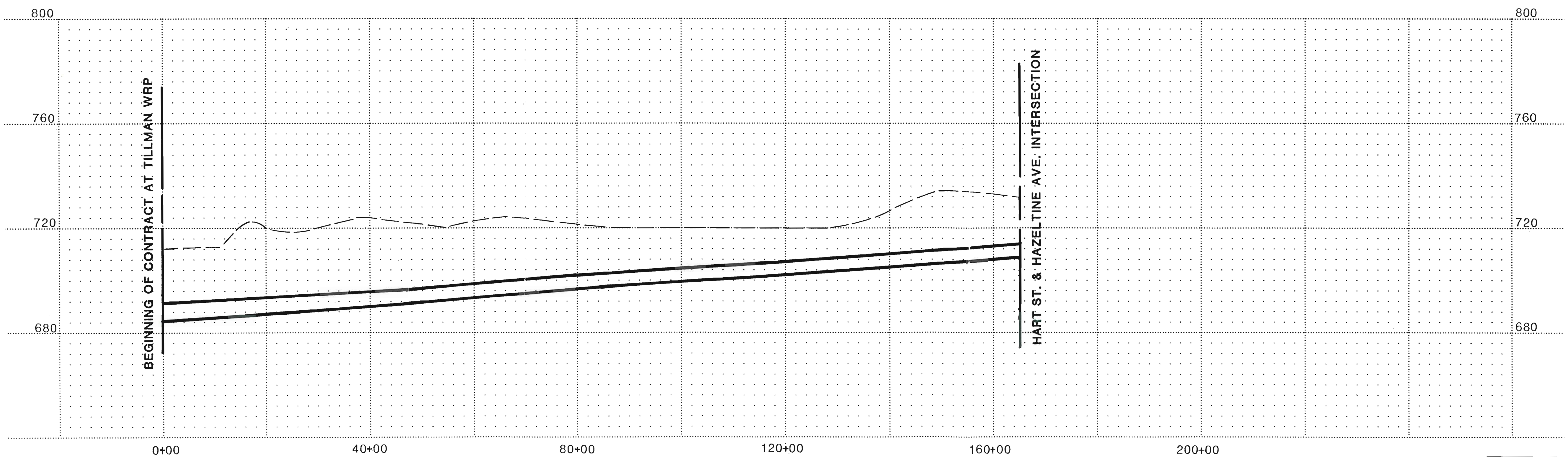
- ■ DIVERSION STRUCTURE
- ● MANHOLE
- ••• SIPHON
- — — APPROXIMATE GROUND ELEVATION DURING CONSTRUCTION
- ▬ SEWER CROWN AND INVERT

SCALE

1"=40' VERTICAL
1"=2000' HORIZONTAL

FIGURE 3K-B11-3
ADDITIONAL VALLEY OUTFALL RELIEF SEWER
HAYNES ST. TO TOPANGA CANYON BLVD.





LEGEND

- ■ DIVERSION STRUCTURE
- ● MANHOLE
- ••• SIPHON
- – – – APPROXIMATE GROUND ELEVATION DURING CONSTRUCTION
- ——— SEWER CROWN AND INVERT

SCALE

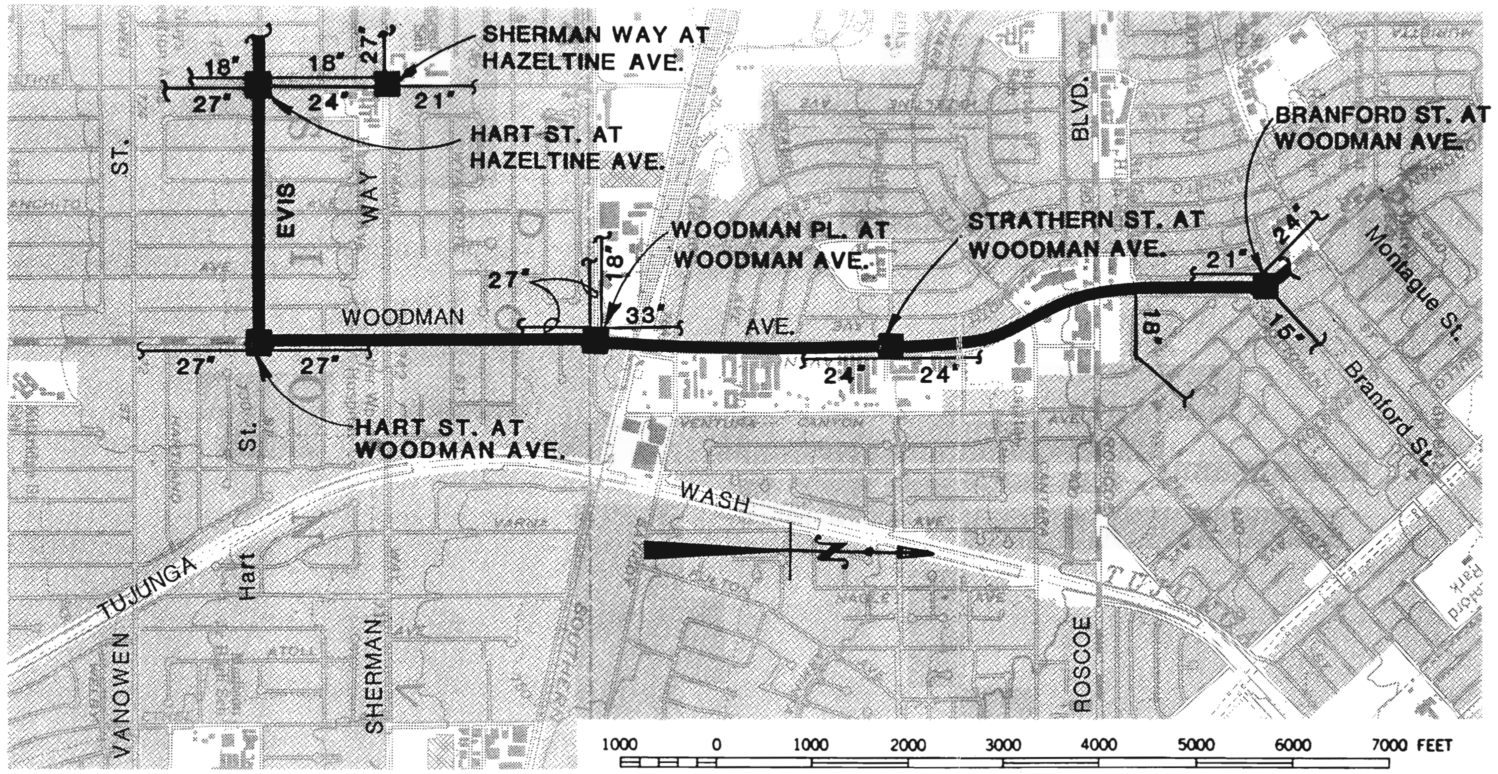
1"=40' VERTICAL

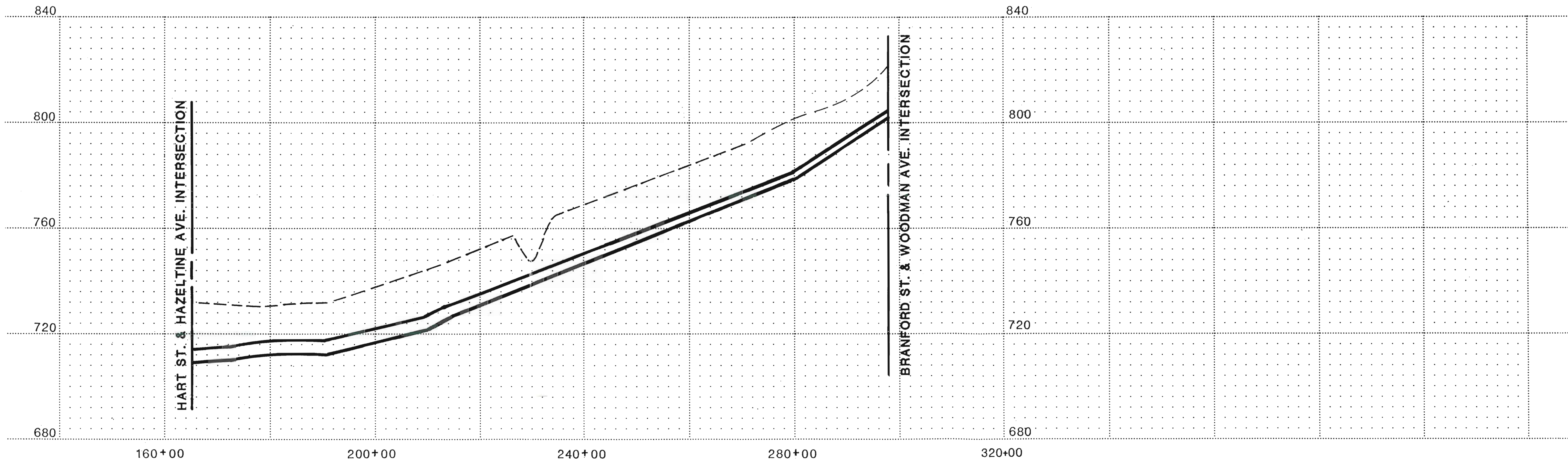
1"=2000' HORIZONTAL

FIGURE 3K-B13-1
EAST VALLEY INTERCEPTOR SEWER
TILLMAN W.R.P. TO HAZELTINE AVE.

CLEAN WATER PROGRAM

City of Los Angeles





LEGEND

- DIVERSION STRUCTURE
- MANHOLE
- SIPHON
- APPROXIMATE GROUND ELEVATION DURING CONSTRUCTION
- SEWER CROWN AND INVERT

SCALE

1"=40' VERTICAL

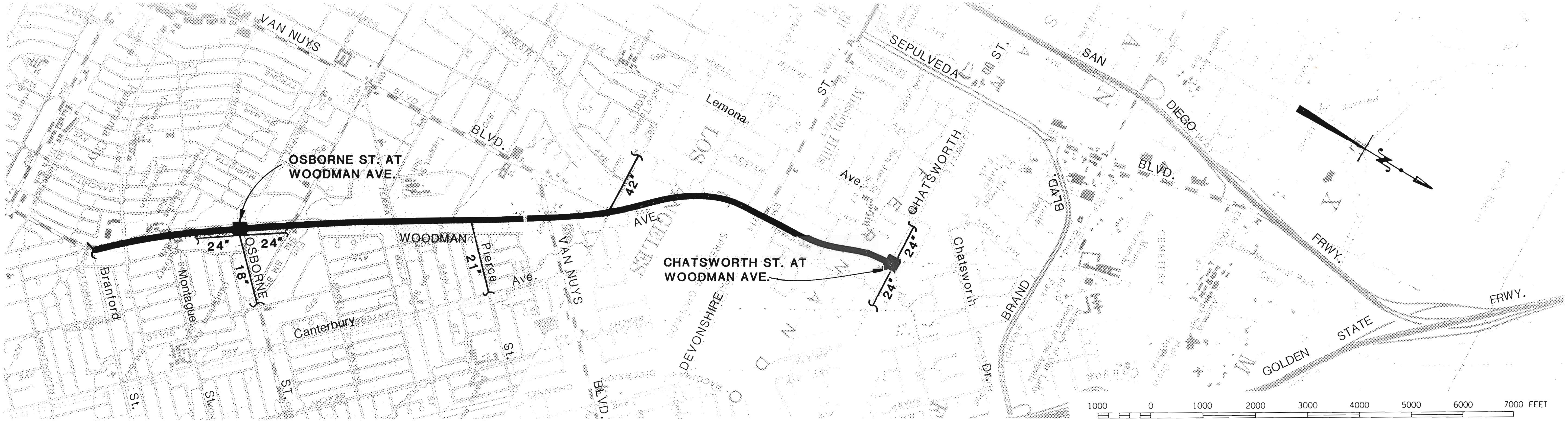
1"=2000' HORIZONTAL

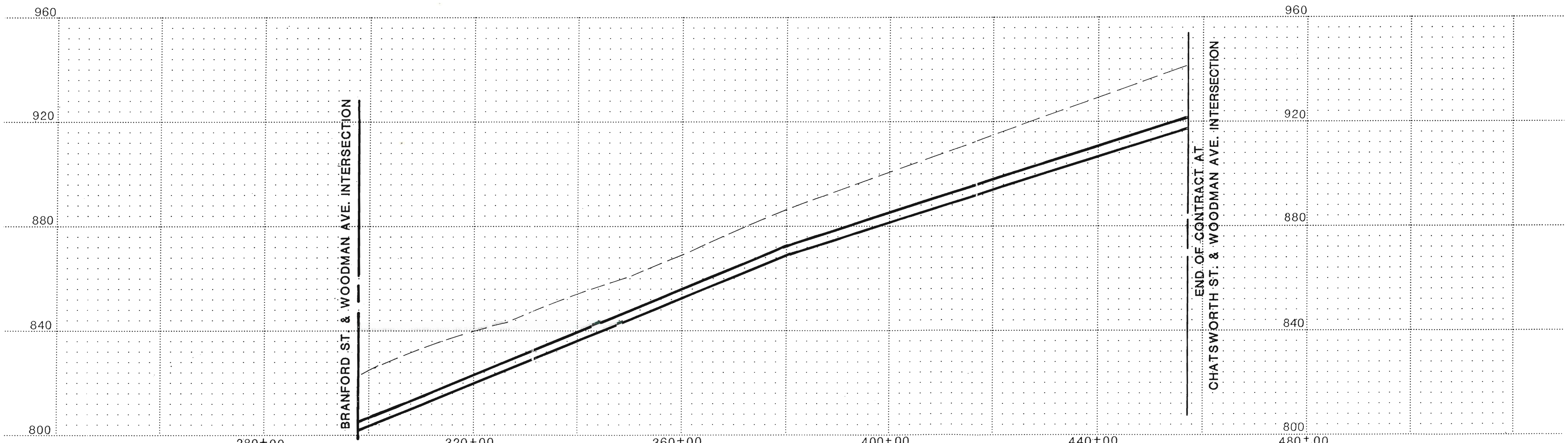
FIGURE 3K-B13-2

EAST VALLEY INTERCEPTOR SEWER HAZELTINE AVE. TO BRANFORD ST.

CLEAN WATER PROGRAM

City of Los Angeles





LEGEND

- ■ DIVERSION STRUCTURE
- ● MANHOLE
- ••• SIPHON
- — — APPROXIMATE GROUND ELEVATION DURING CONSTRUCTION
- —— SEWER CROWN AND INVERT

SCALE

1"=40' VERTICAL

1"=2000' HORIZONTAL

FIGURE 3K-B13-3
EAST VALLEY INTERCEPTOR SEWER
BRANFORD ST. TO CHATSWORTH ST.

CLEAN WATER PROGRAM
City of Los Angeles

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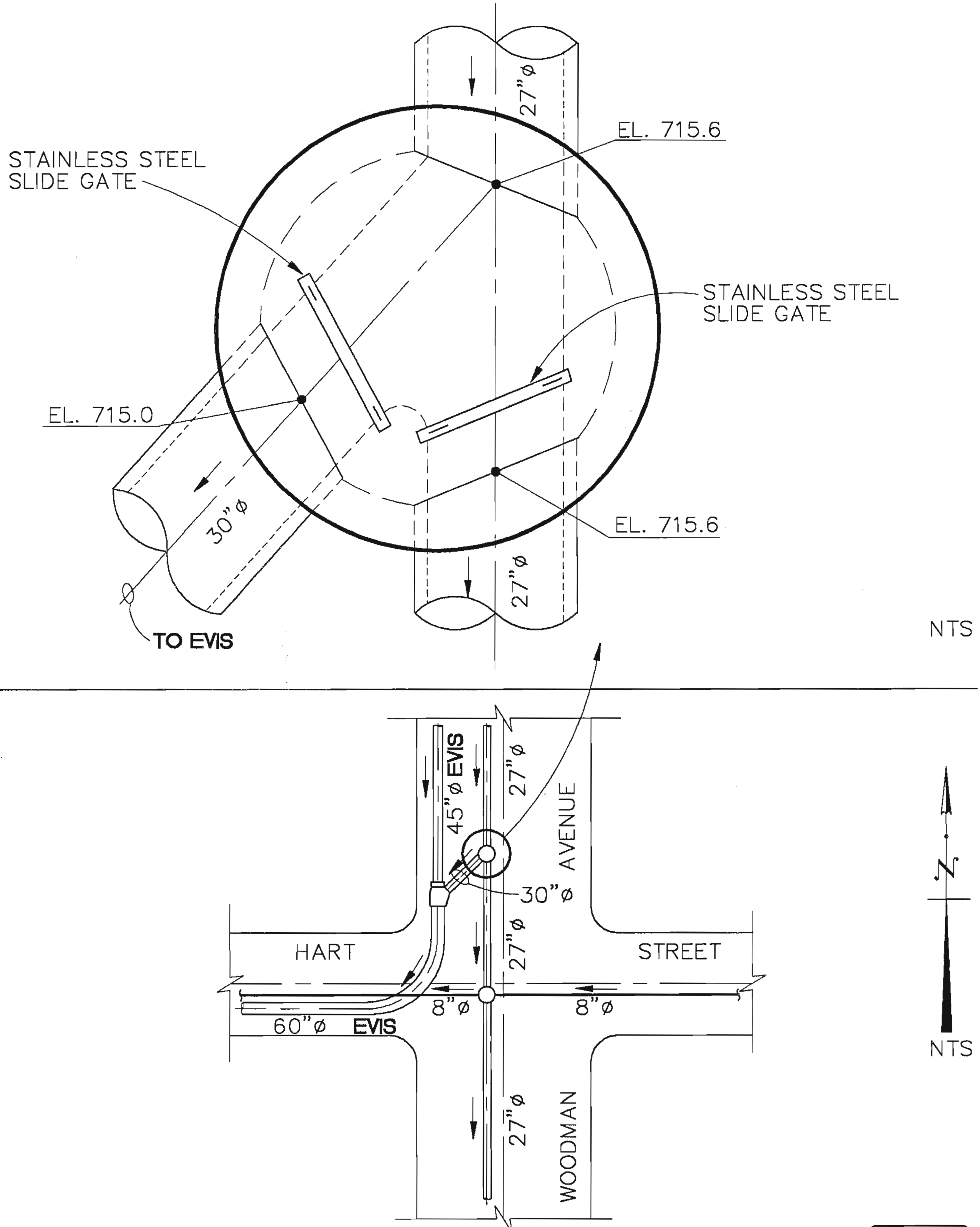
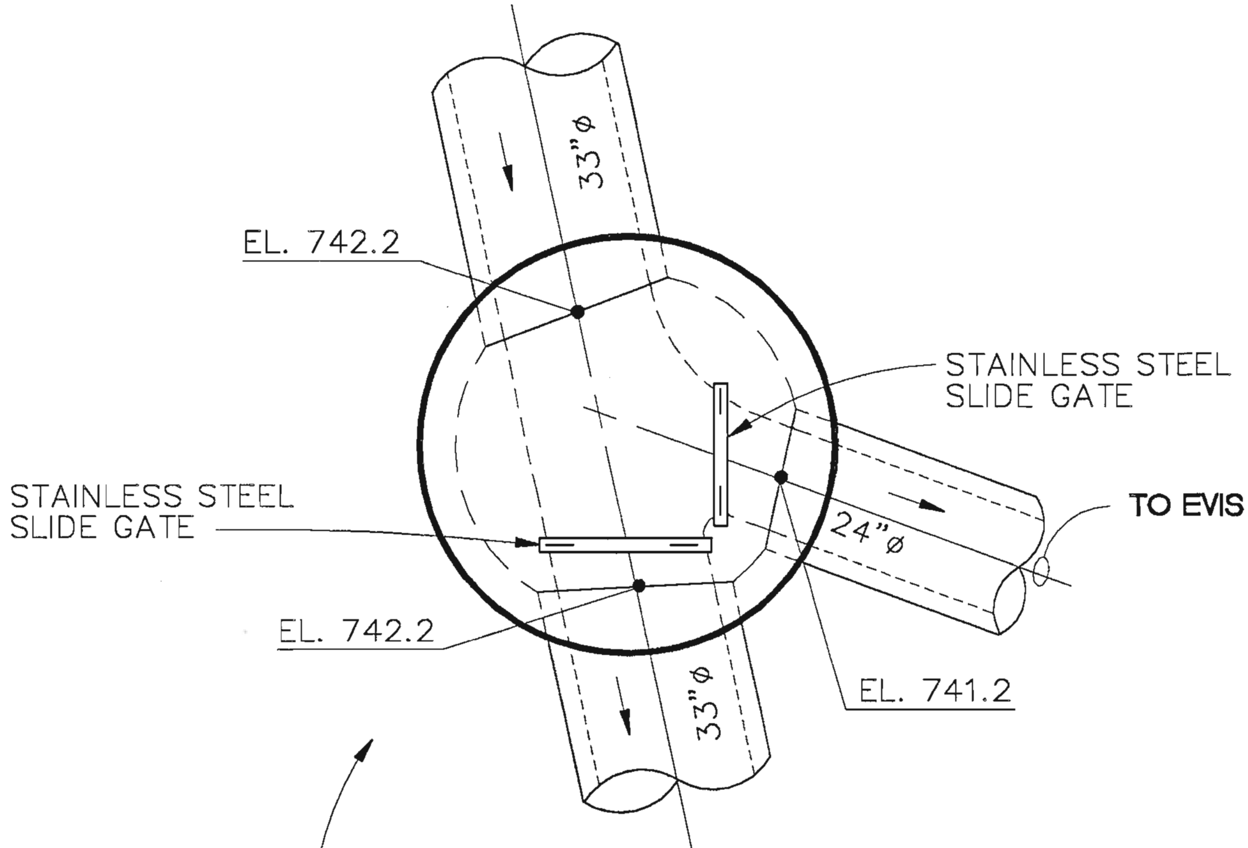


FIGURE 3K–C28
HART STREET AT WOODMAN AVENUE
DIVERSION STRUCTURE



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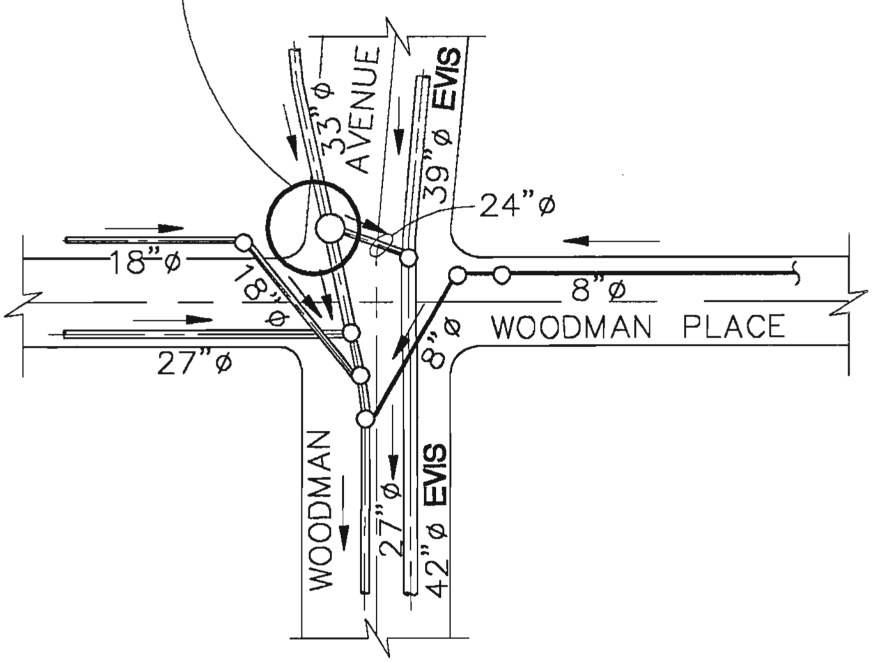

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FIGURE 3K–C29
WOODMAN PLACE AT WOODMAN AVENUE
DIVERSION STRUCTURE

CLEAN WATER PROGRAM
City of Los Angeles

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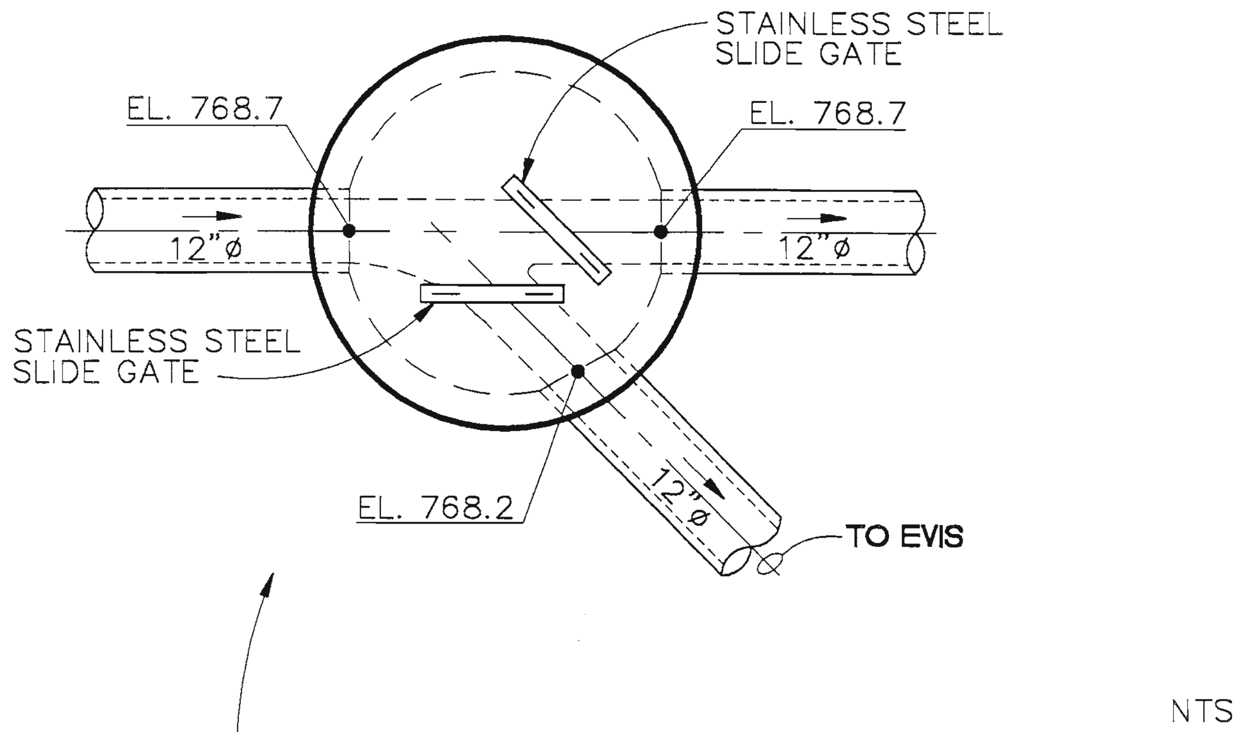

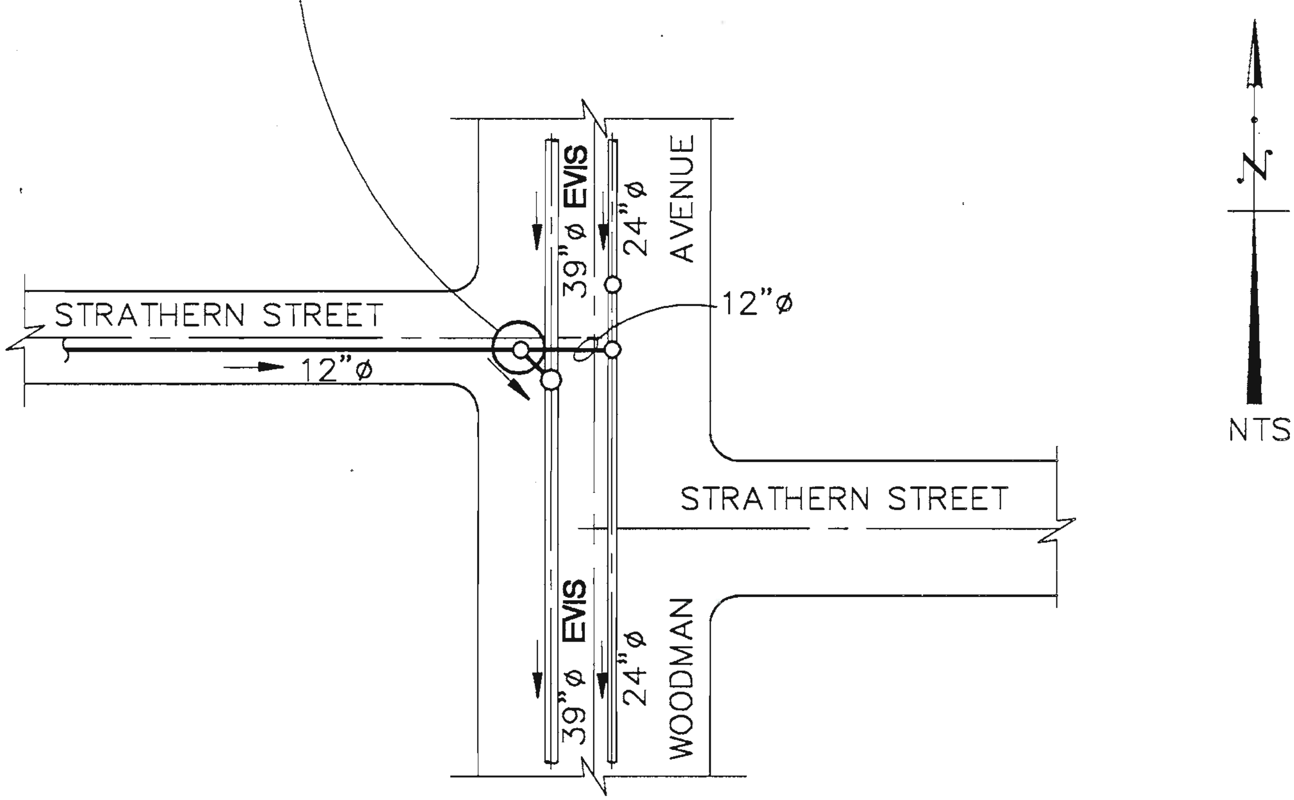

FIGURE 3K–C30
STRATHERN STREET AT WOODMAN AVENUE
DIVERSION STRUCTURE

CLEAN WATER PROGRAM
City of Los Angeles

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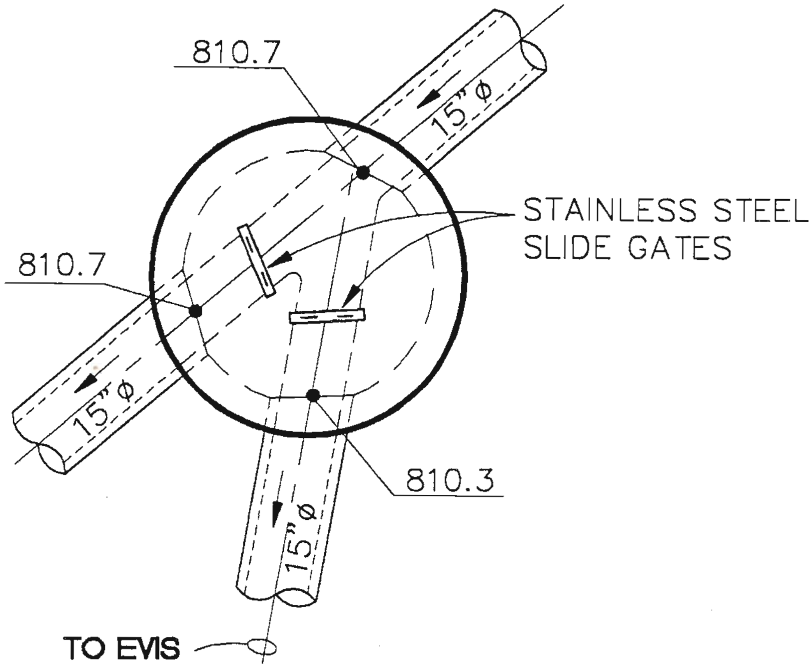

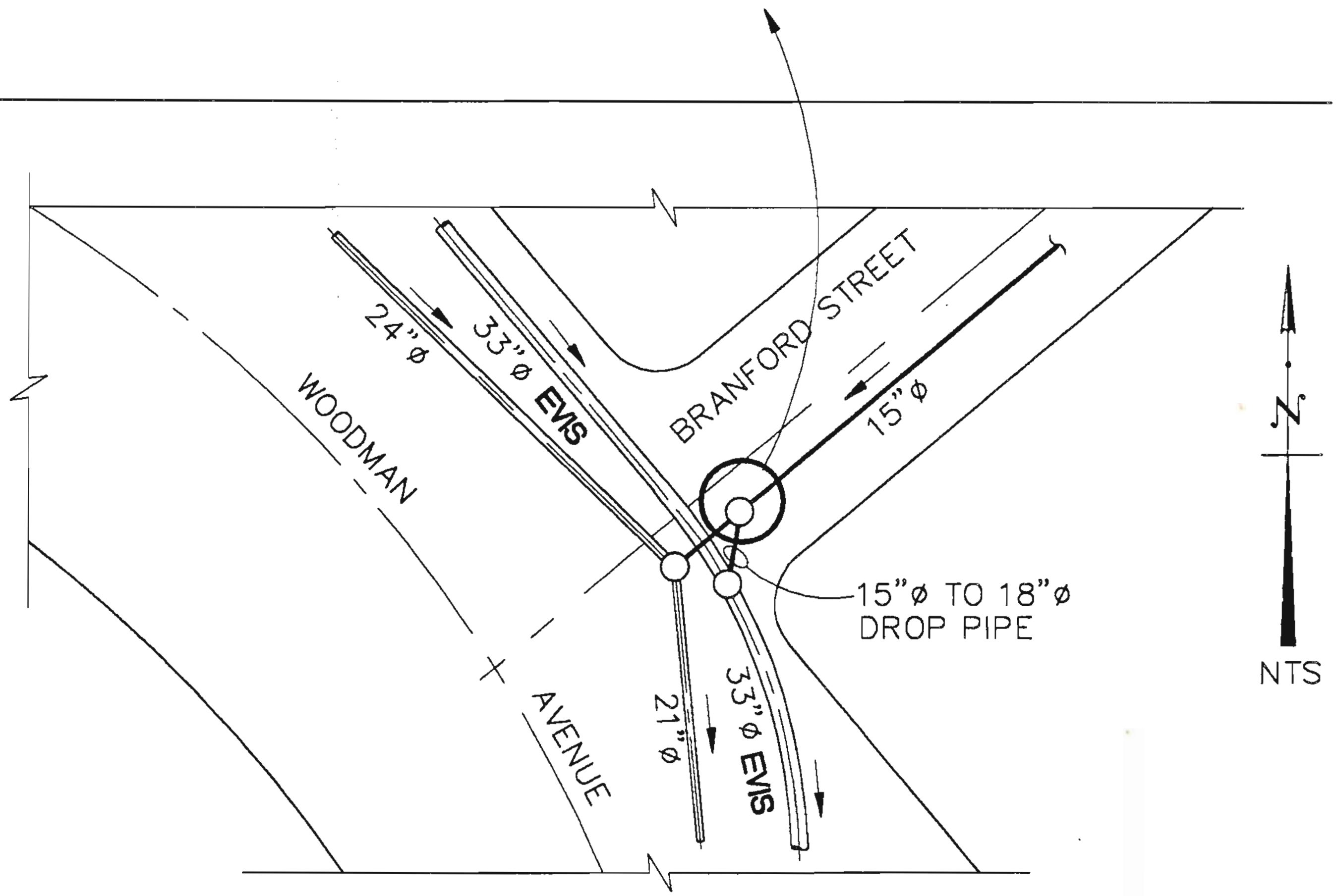

FIGURE 3K–C31
BRANFORD STREET AT WOODMAN AVENUE
DIVERSION STRUCTURE

CLEAN WATER PROGRAM
City of Los Angeles

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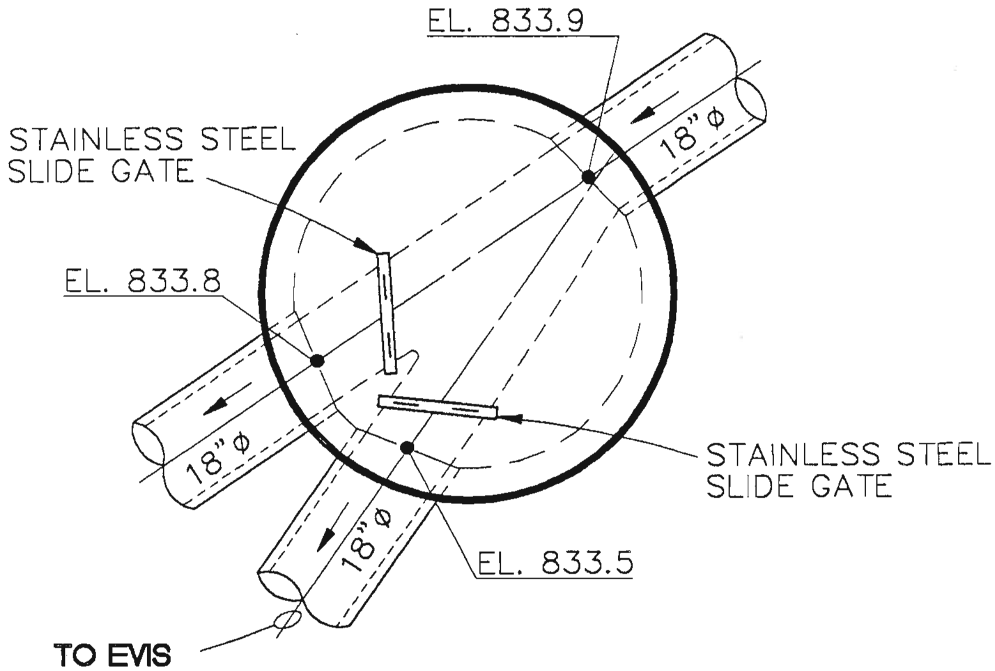

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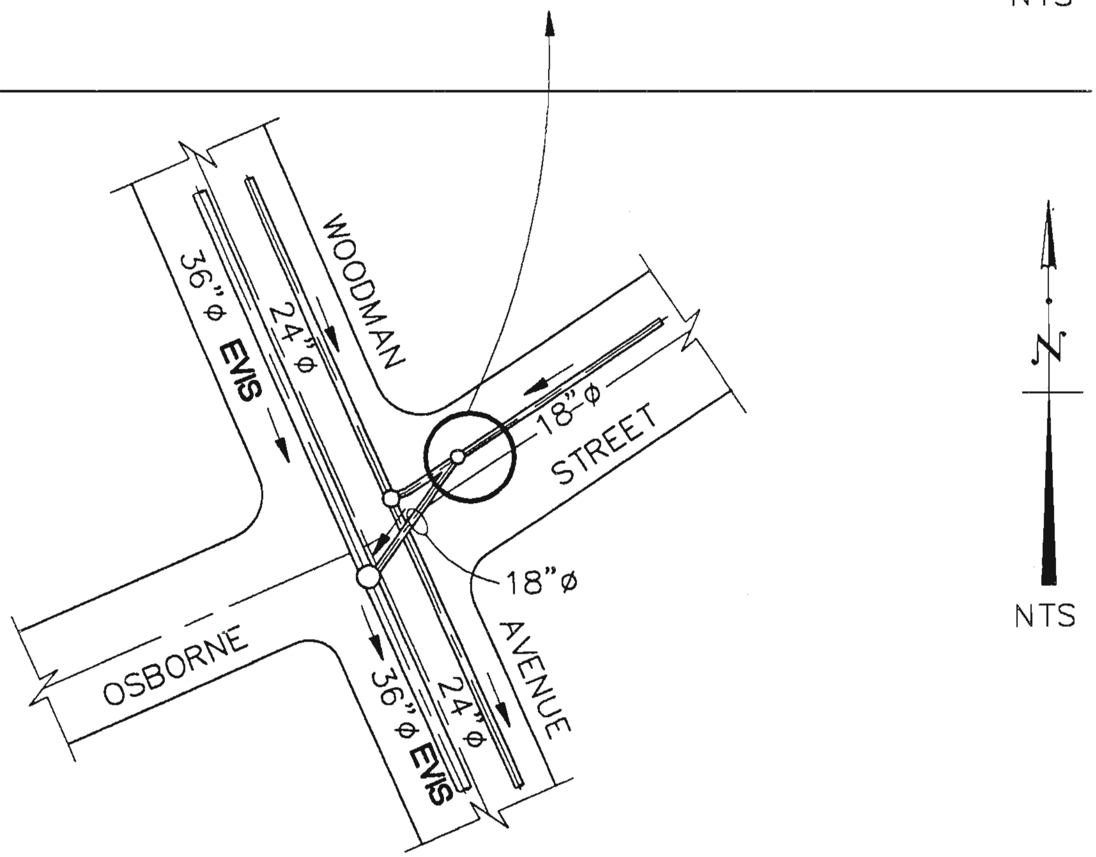

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FIGURE 3K–C32
OSBORNE STREET AT WOODMAN AVENUE
DIVERSION STRUCTURE

CLEAN WATER PROGRAM
City of Los Angeles

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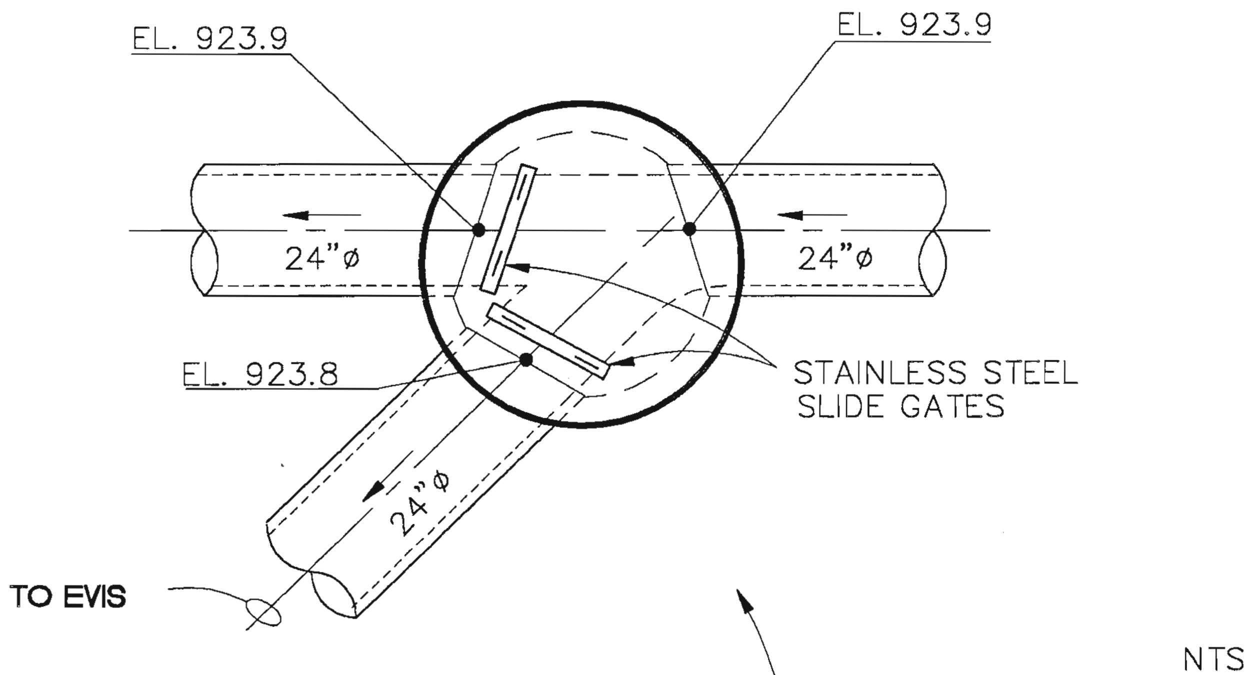

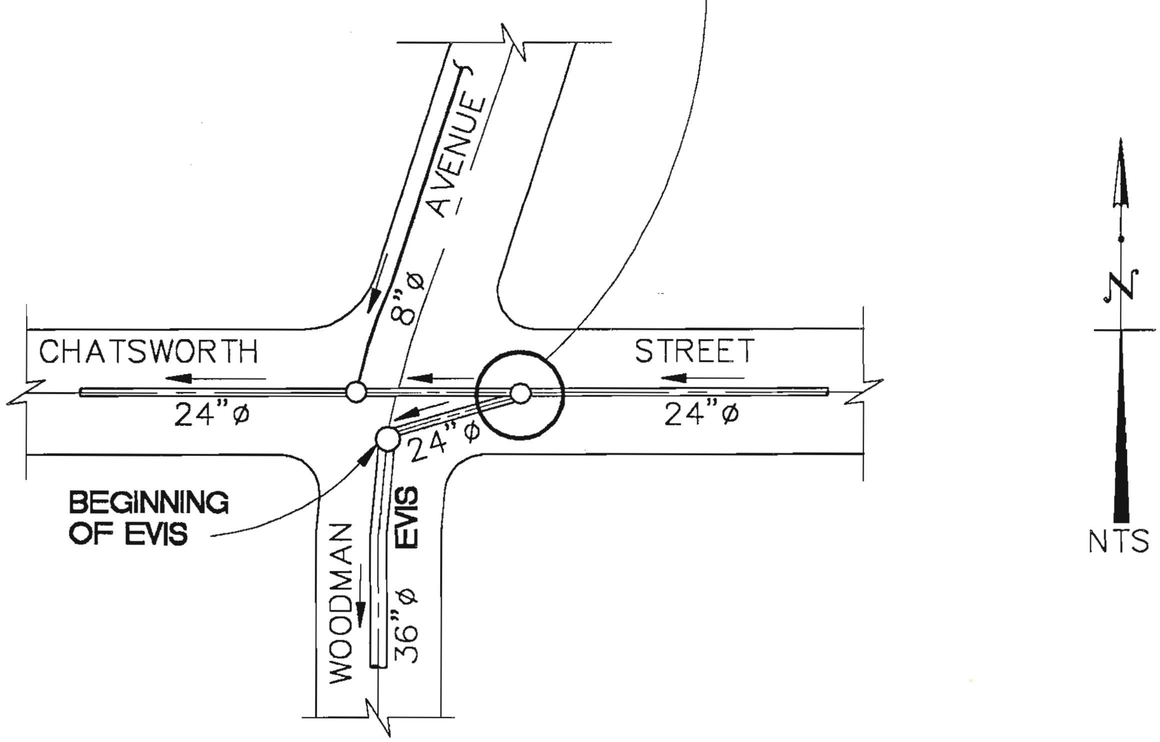

FIGURE 3K-C33
CHATSWORTH STREET AT WOODMAN AVENUE
DIVERSION STRUCTURE

CLEAN WATER PROGRAM
City of Los Angeles

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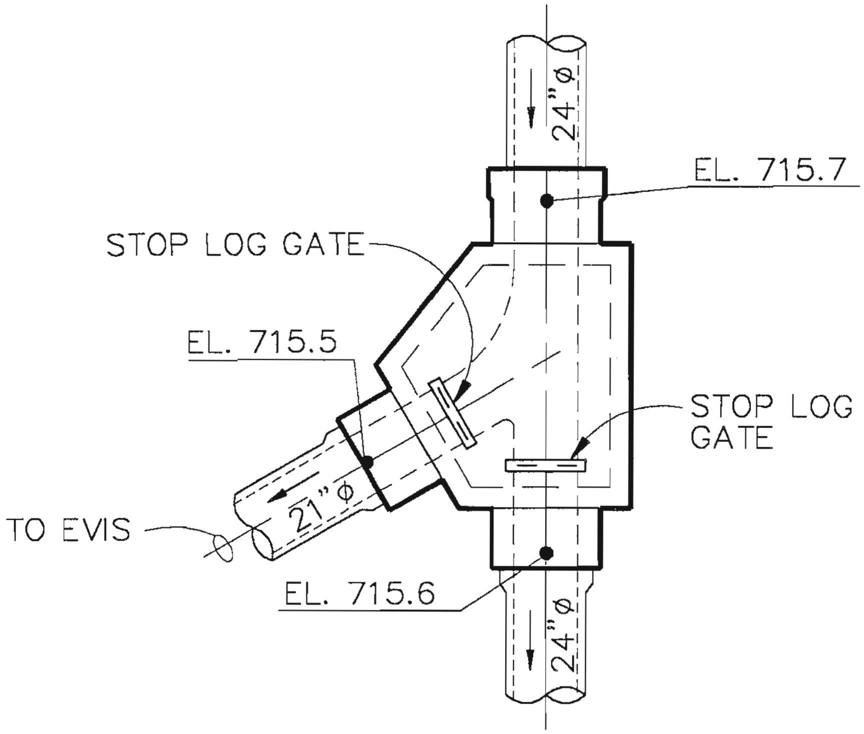

NOTE:
VERIFY STRUCTURE AGAINST
FIELD CHANGE.

NTS

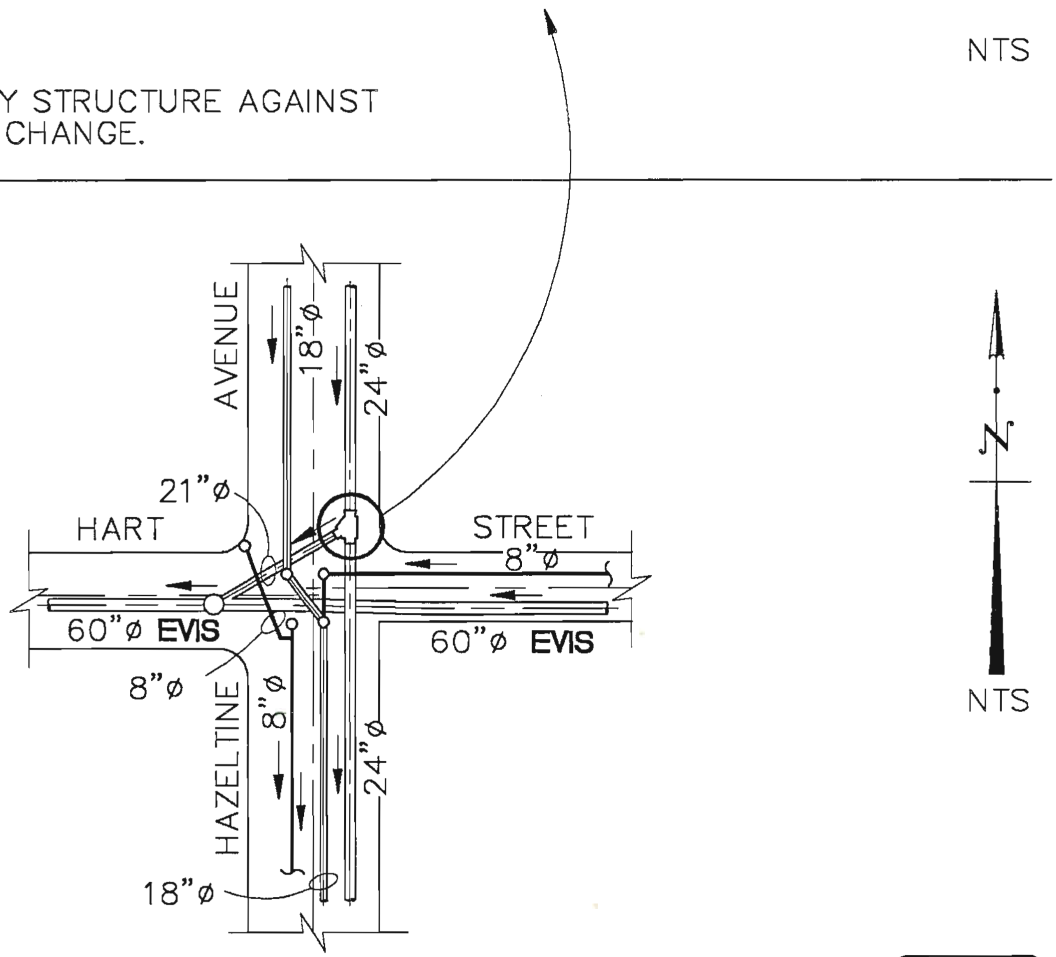

FIGURE 3K–C37
HART STREET AT HAZELTINE AVENUE
DIVERSION STRUCTURE

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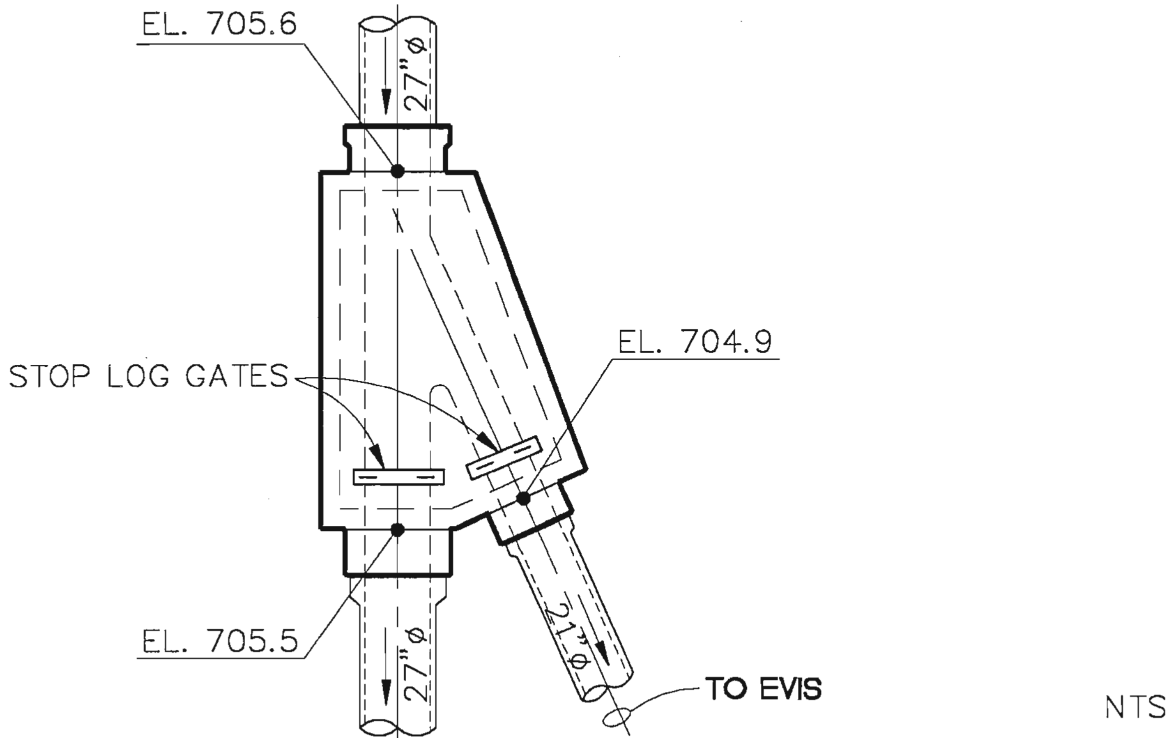

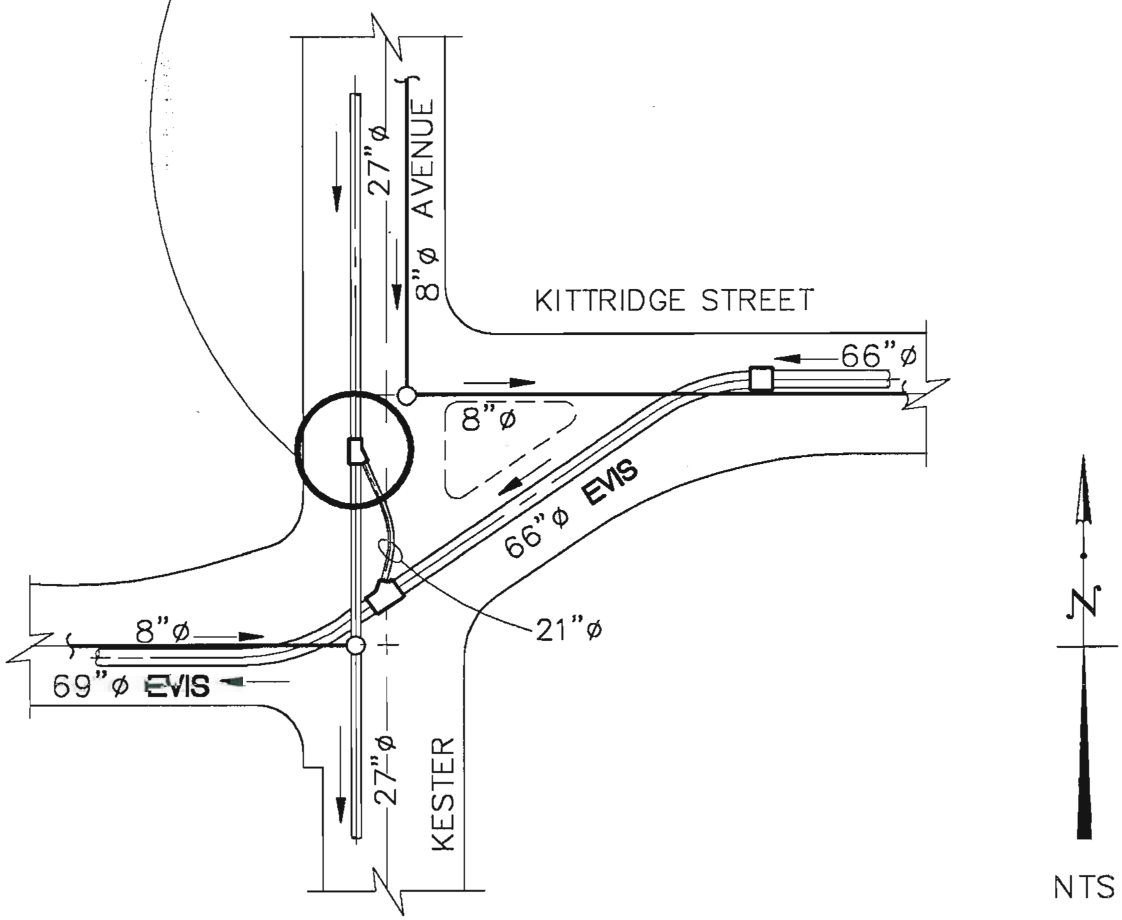

FIGURE 3K–C42
KITTRIDGE STREET AT KESTER AVENUE
DIVERSION STRUCTURE

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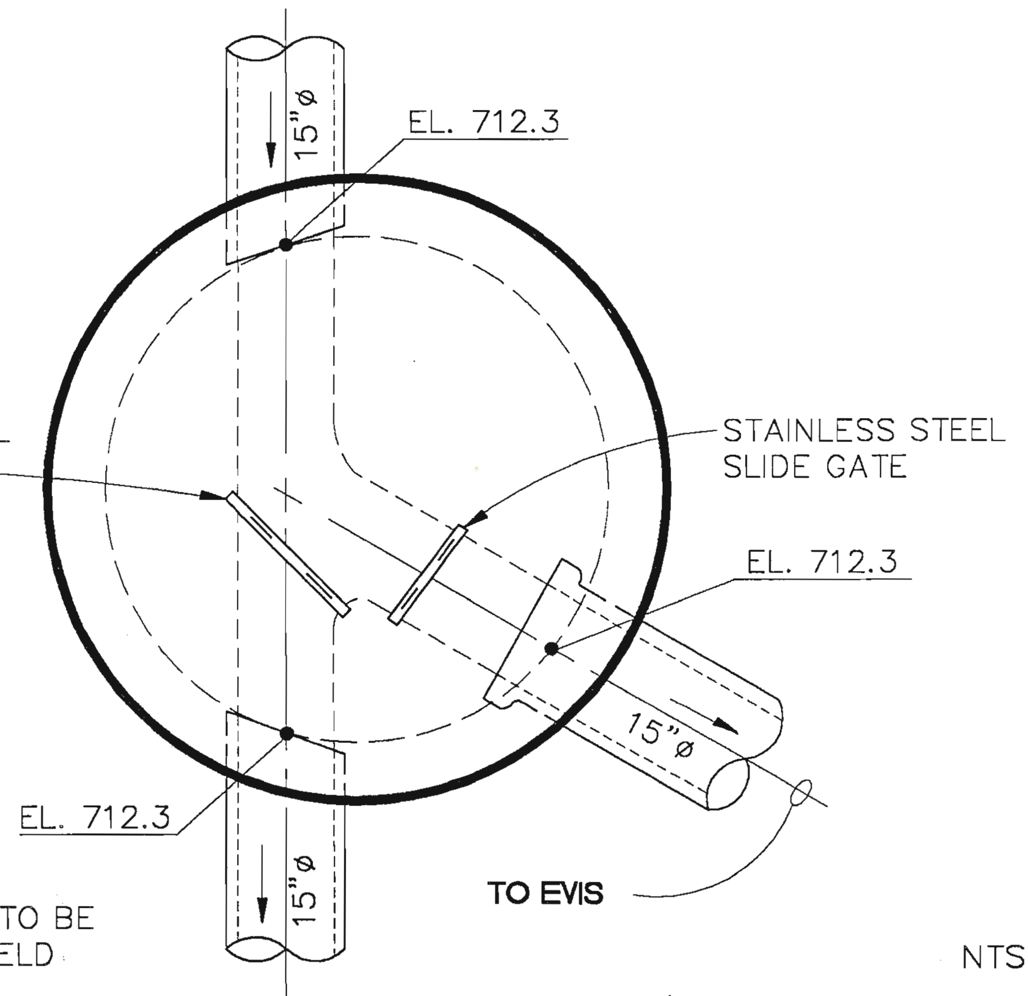

NOTE:
THIS DETAIL NEEDS TO BE UPDATED DUE TO FIELD ALIGNMENT CHANGE

NTS

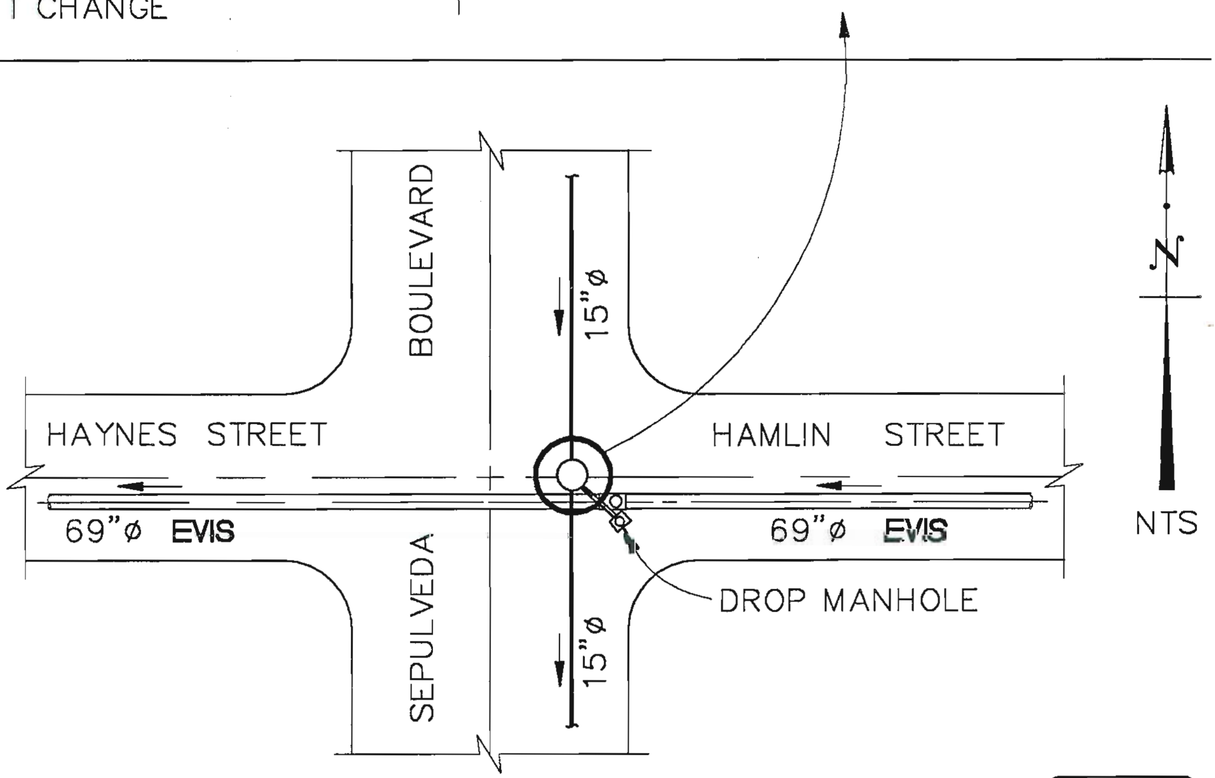

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FIGURE 3K–C43
HAMLIN STREET AT SEPULVEDA BOULEVARD
DIVERSION STRUCTURE

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City of Los Angeles

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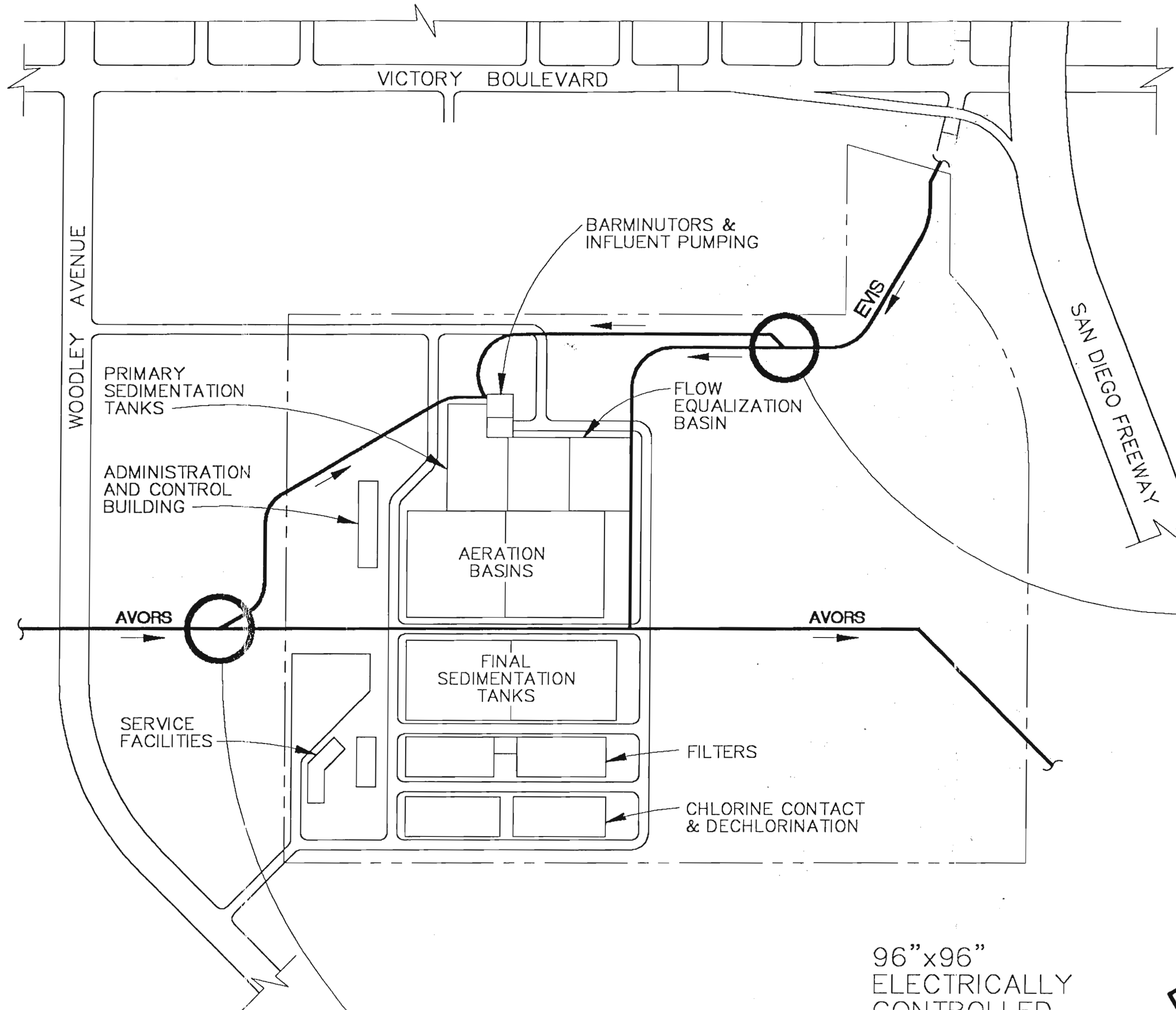
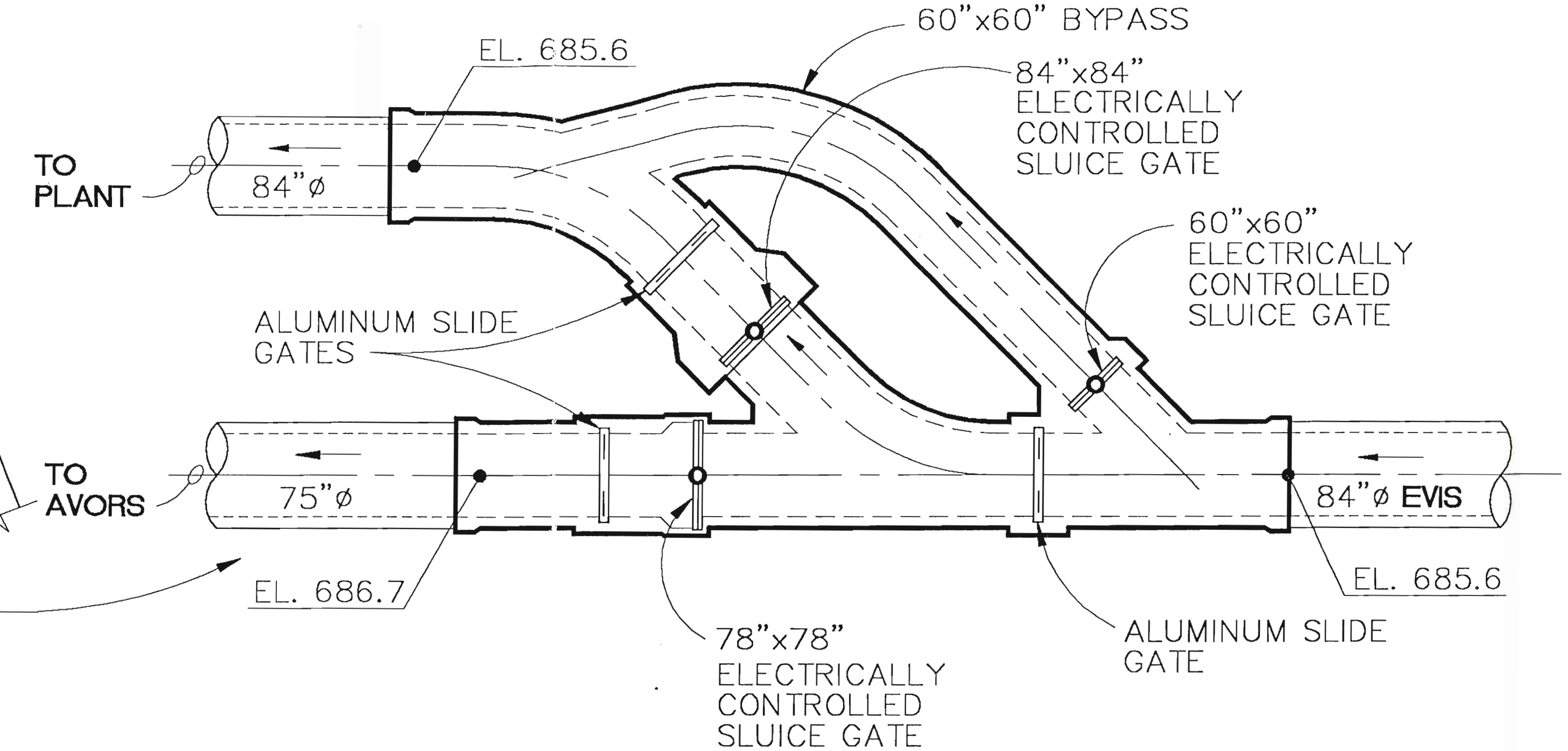
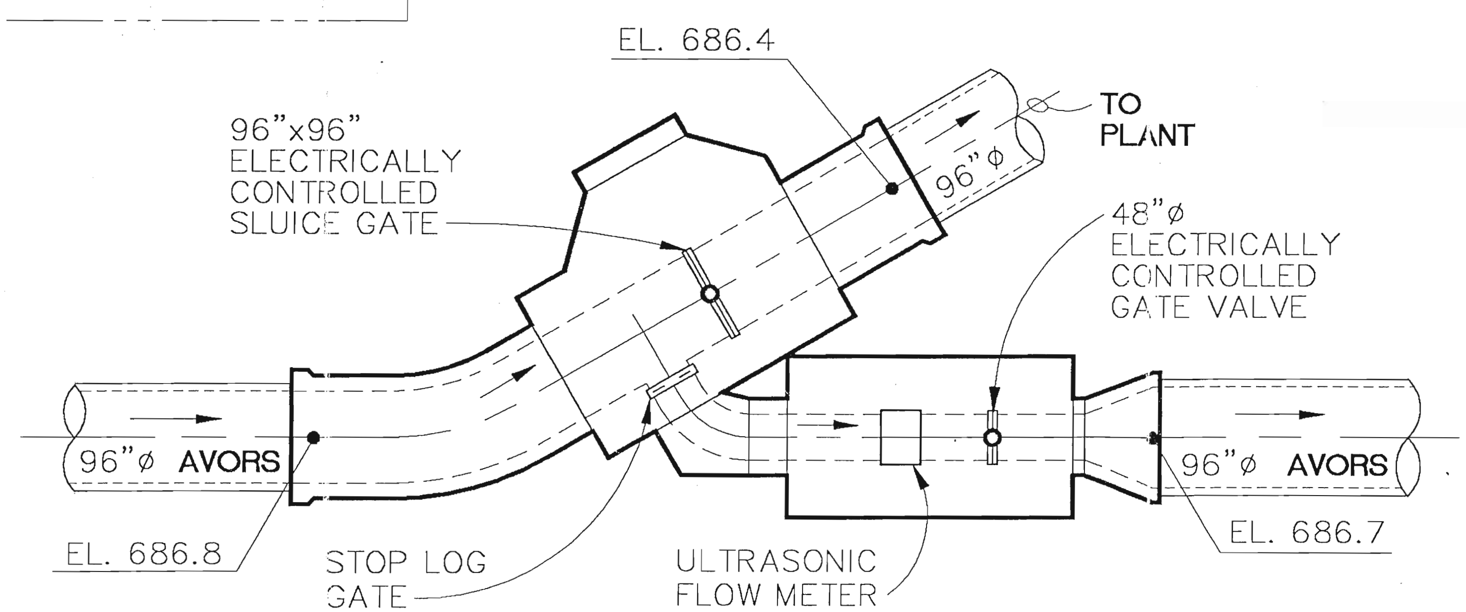




EVIS DIVERSION STRUCTURE

NTS



AVORS DIVERSION STRUCTURE

NTS

N

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FIGURE 3K-C44
TILLMAN WATER RECLAMATION PLANT
DIVERSION STRUCTURES

CLEAN WATER PROGRAM
City of Los Angeles

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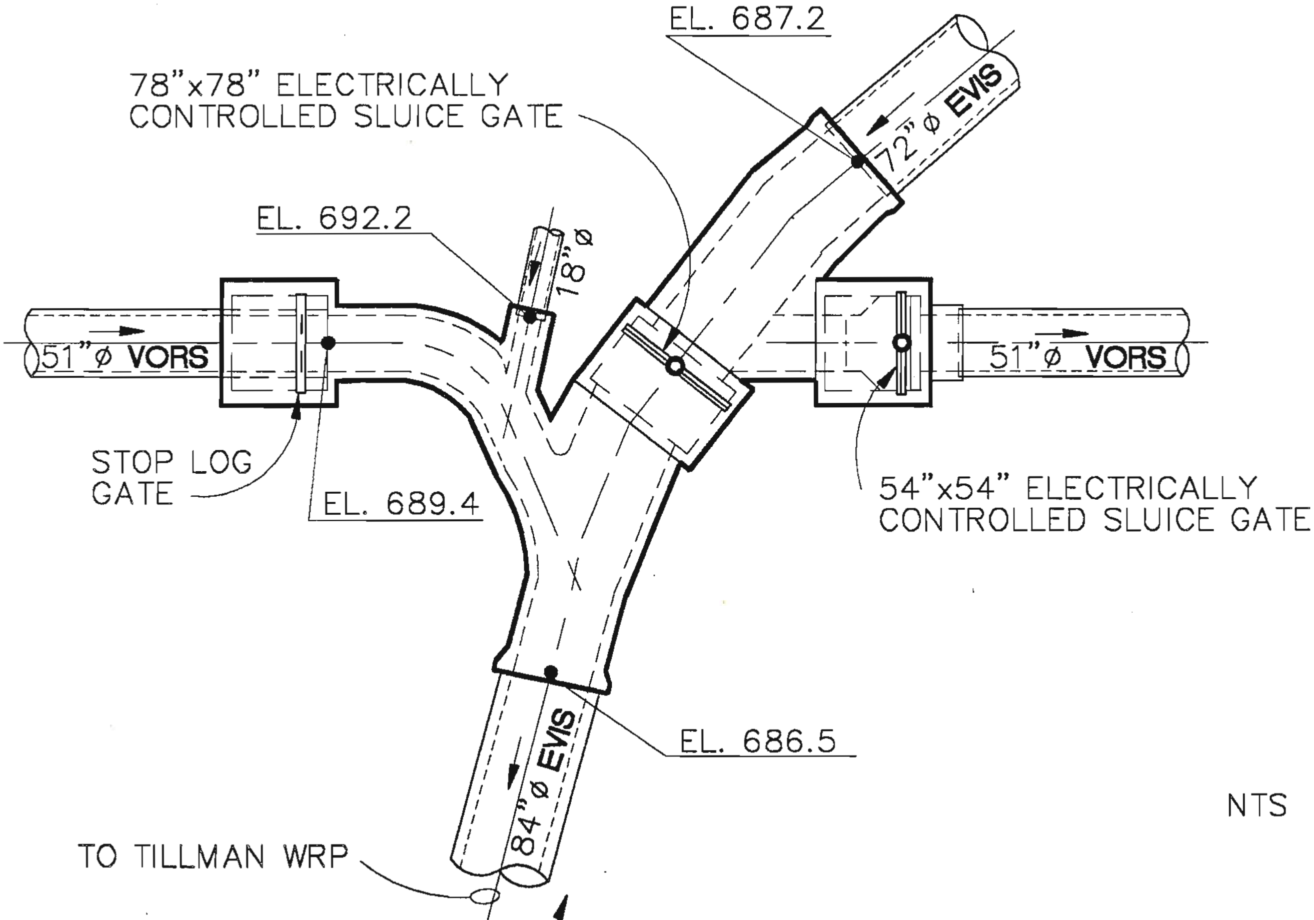

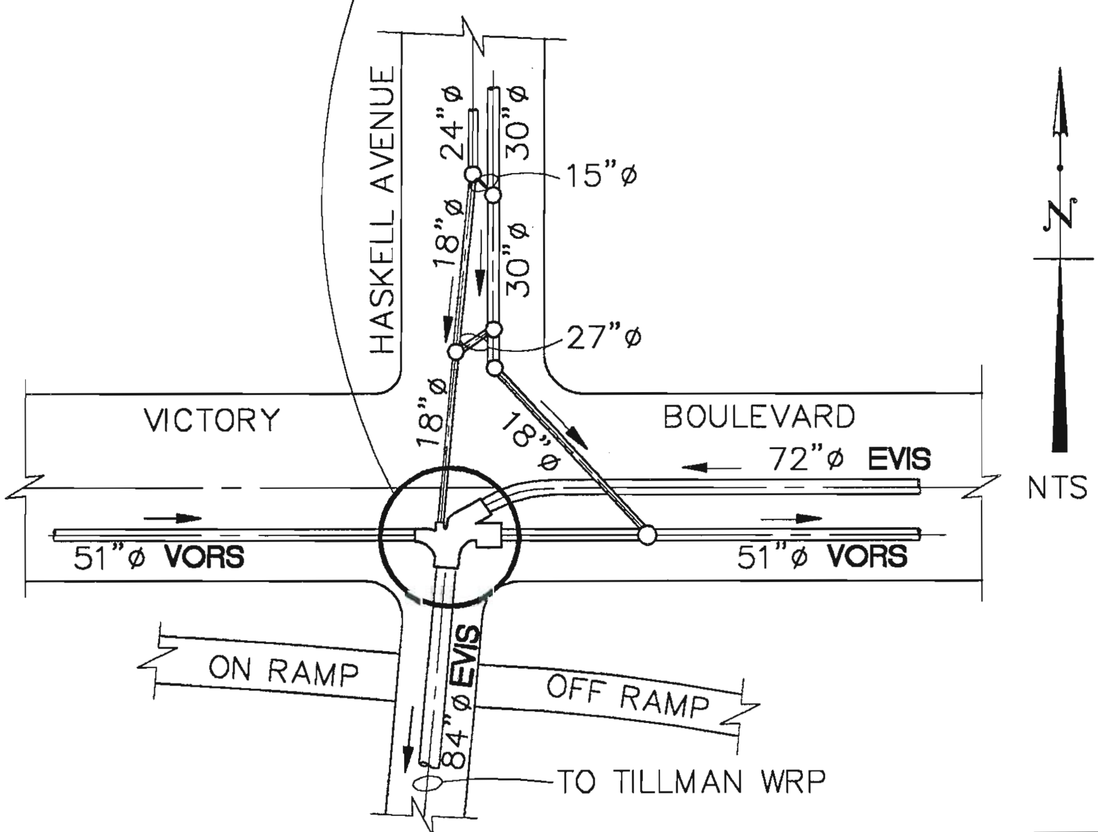

FIGURE 3K–C45

VICTORY BOULEVARD AT HASKELL AVENUE DIVERSION STRUCTURE

CLEAN WATER PROGRAM
City of Los Angeles

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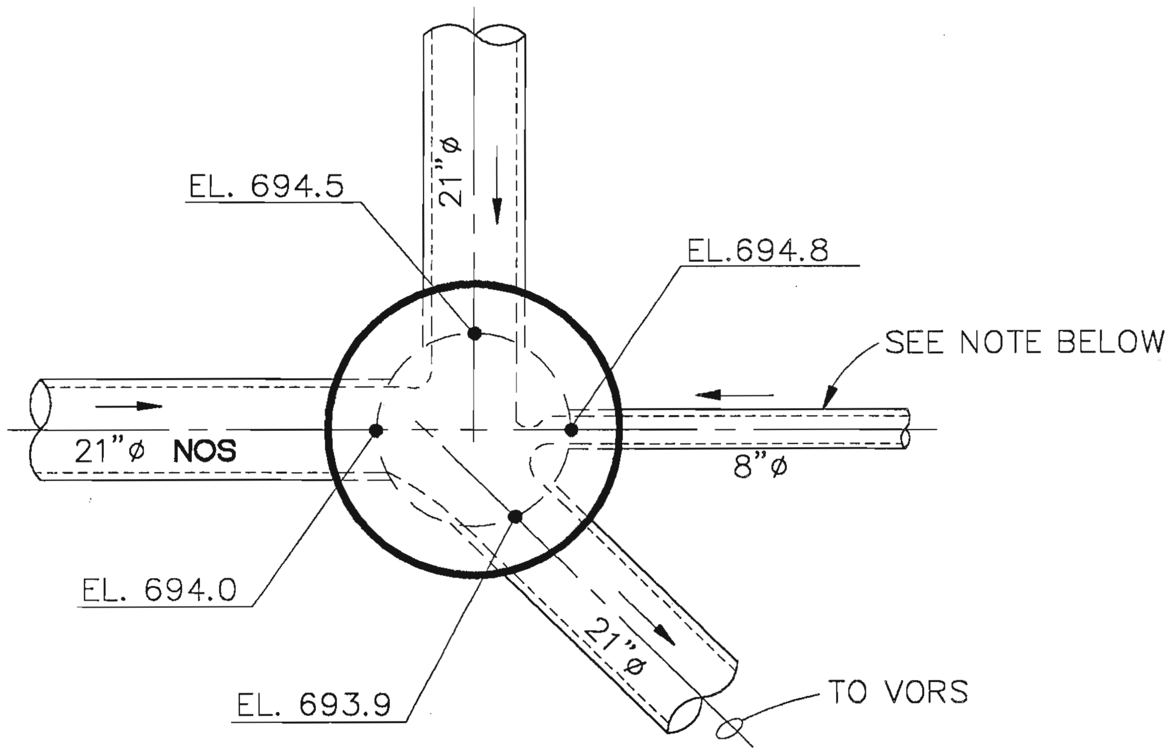

NOTE:
THIS DIVERSION STRUCTURE HAS BEEN MODIFIED AS SHOWN PER EVIS CONSTRUCTION DRAWING NO. D-24375.

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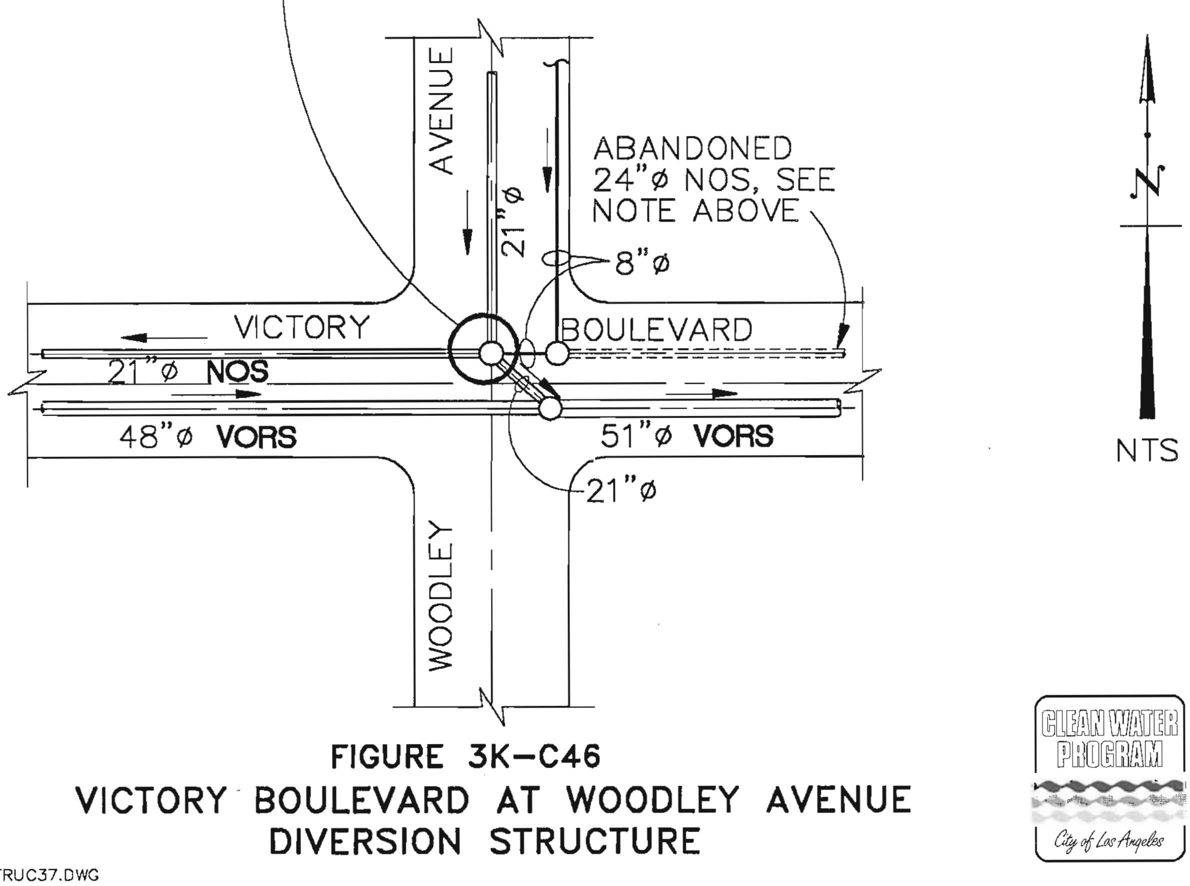

FIGURE 3K-C46
VICTORY BOULEVARD AT WOODLEY AVENUE DIVERSION STRUCTURE

CLEAN WATER PROGRAM
City of Los Angeles

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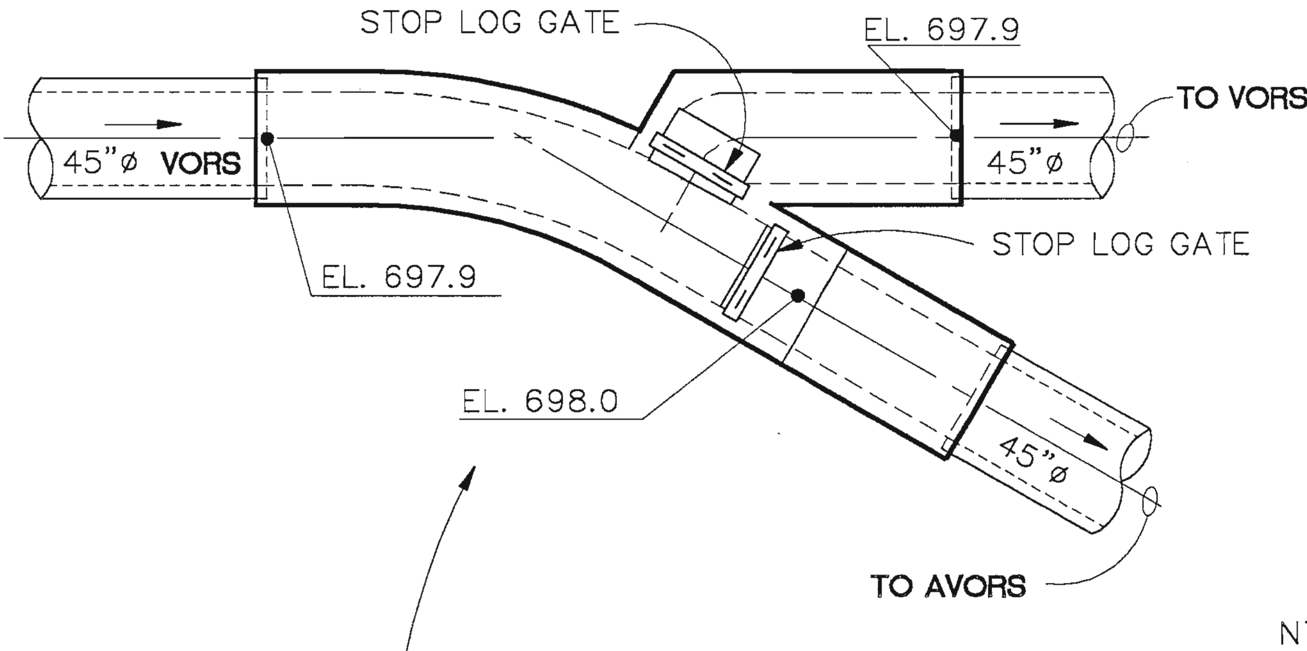

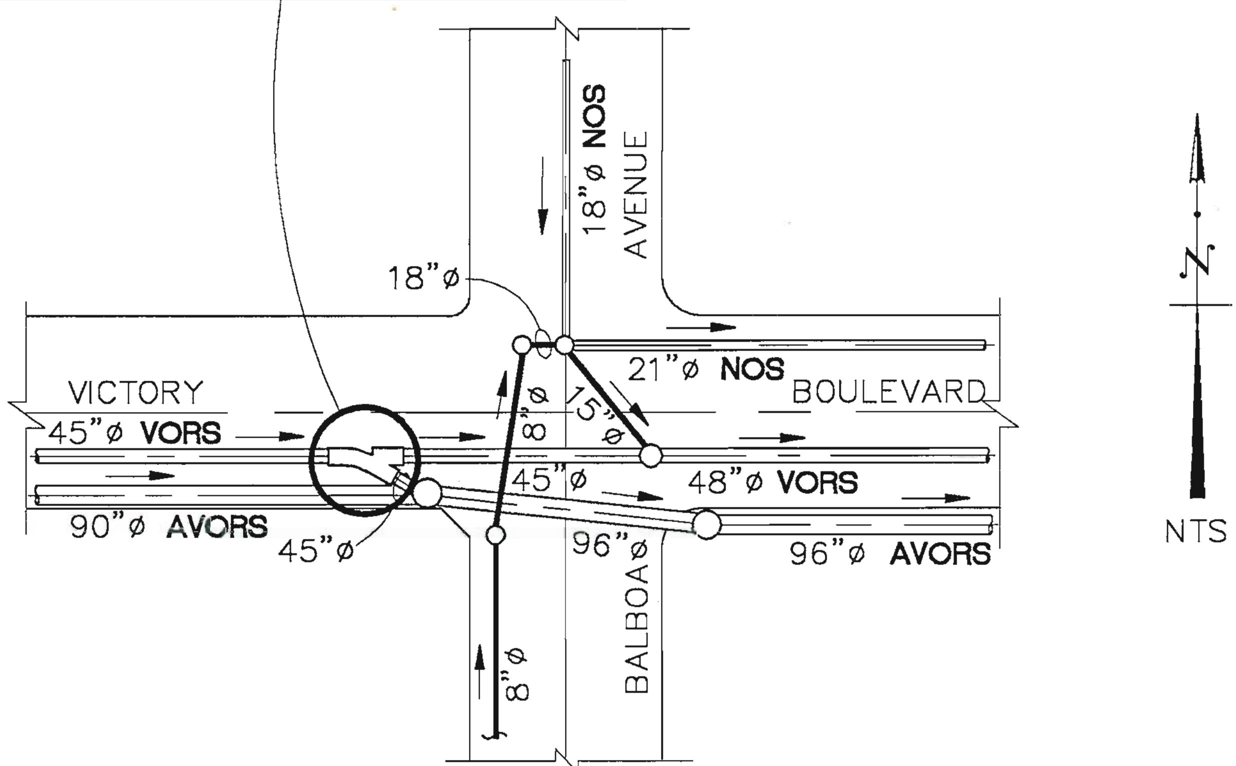

FIGURE 3K-C47
VICTORY BOULEVARD AT BALBOA AVENUE #1
DIVERSION STRUCTURE

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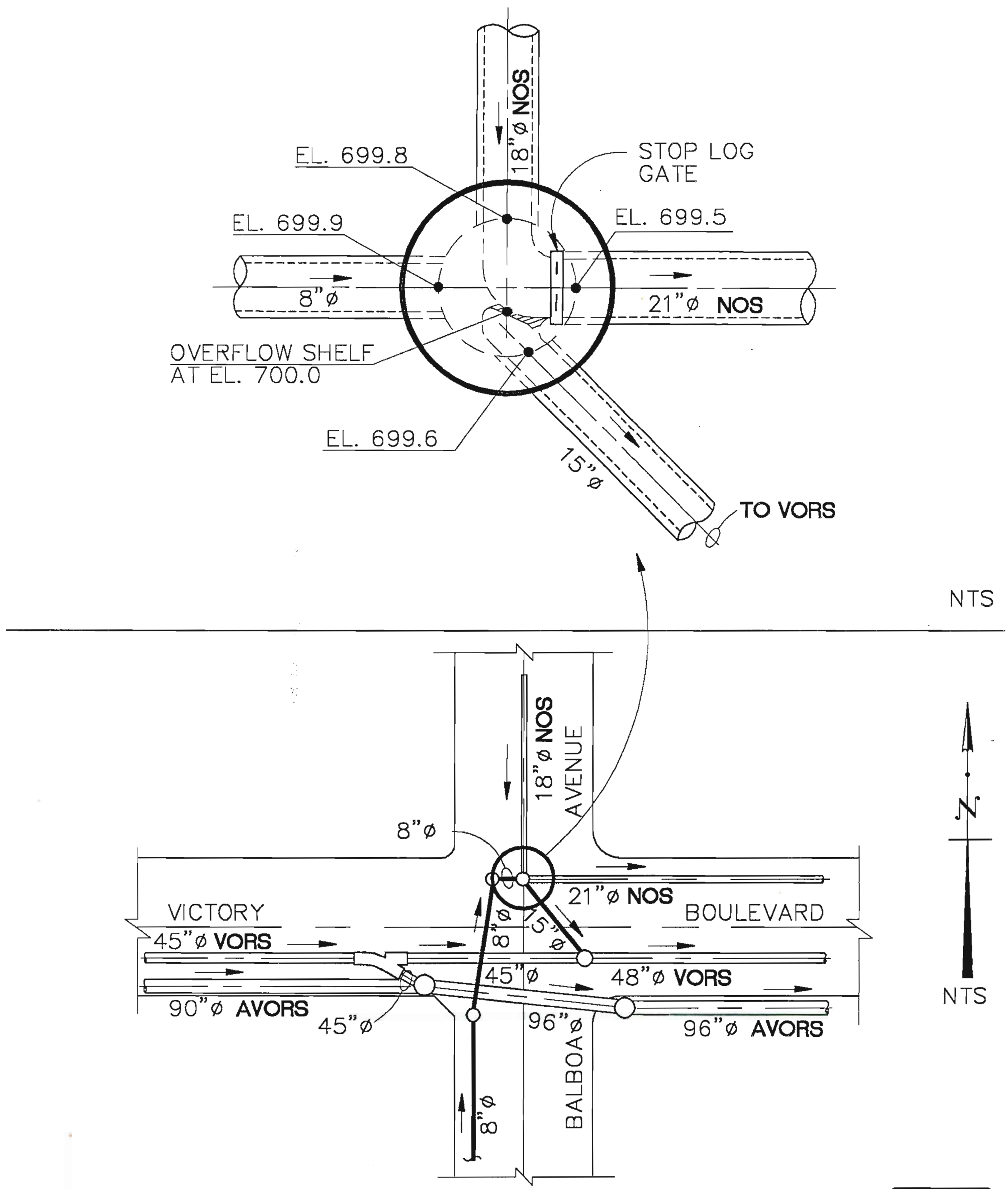

FIGURE 3K-C48
VICTORY BOULEVARD AT BALBOA AVENUE #2
DIVERSION STRUCTURE

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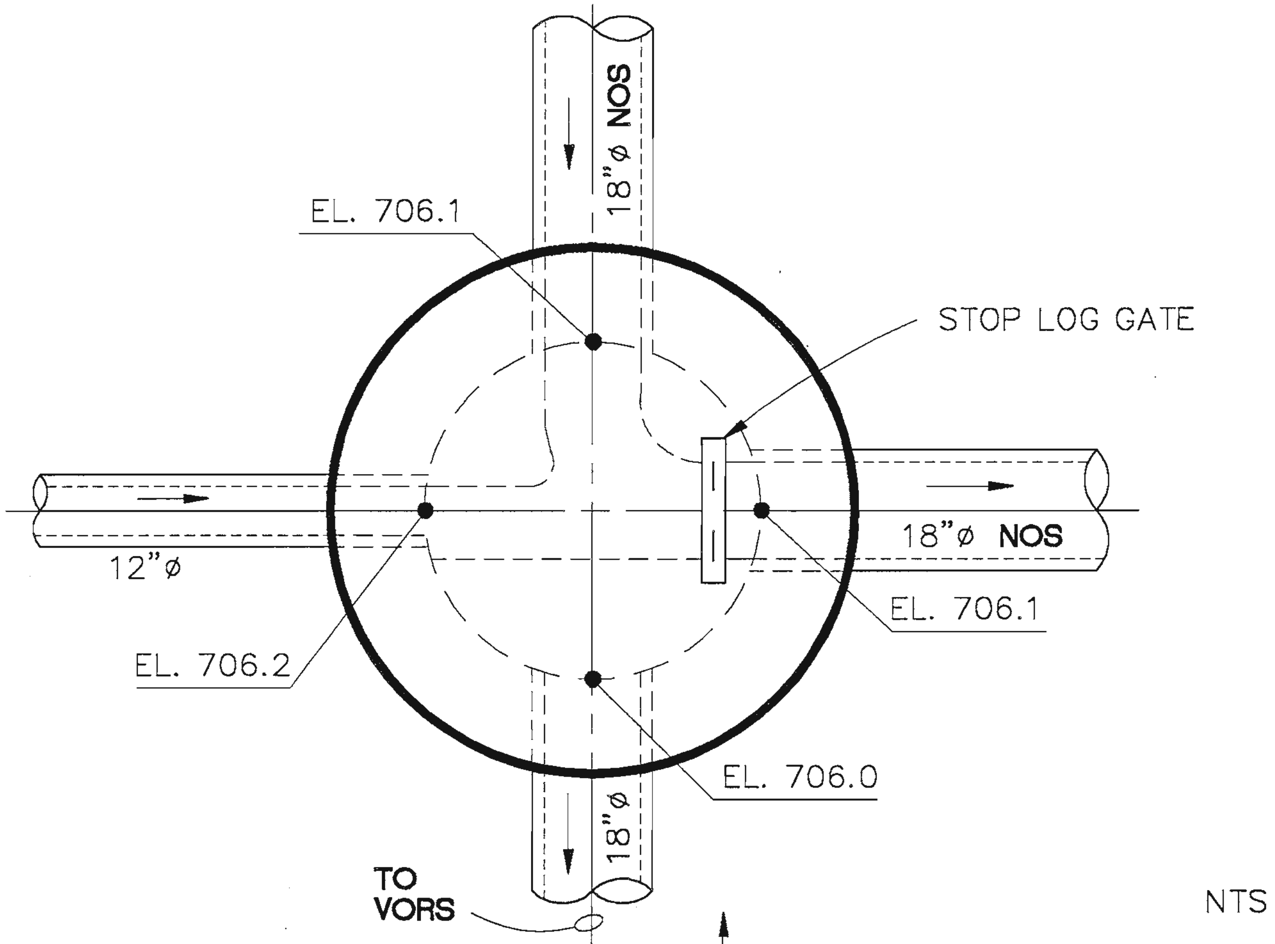

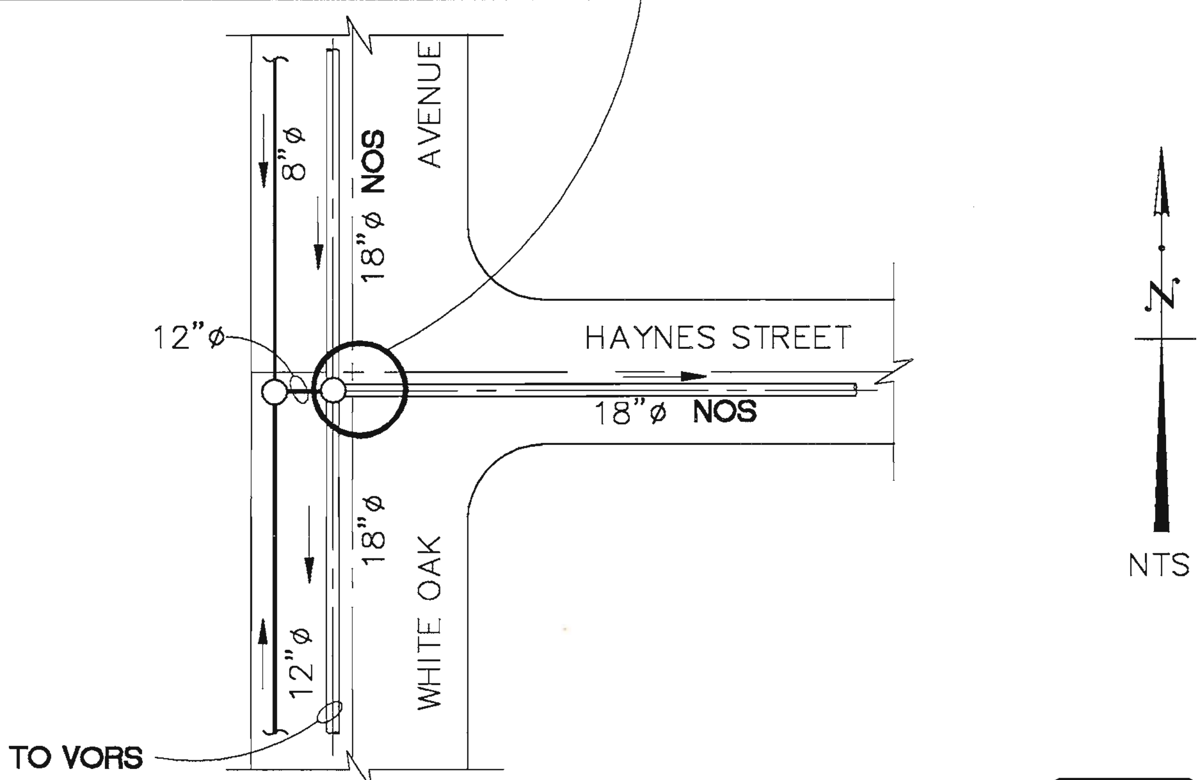

FIGURE 3K–C49
HAYNES STREET AT WHITE OAK AVENUE
DIVERSION STRUCTURE

CLEAN WATER PROGRAM
City of Los Angeles

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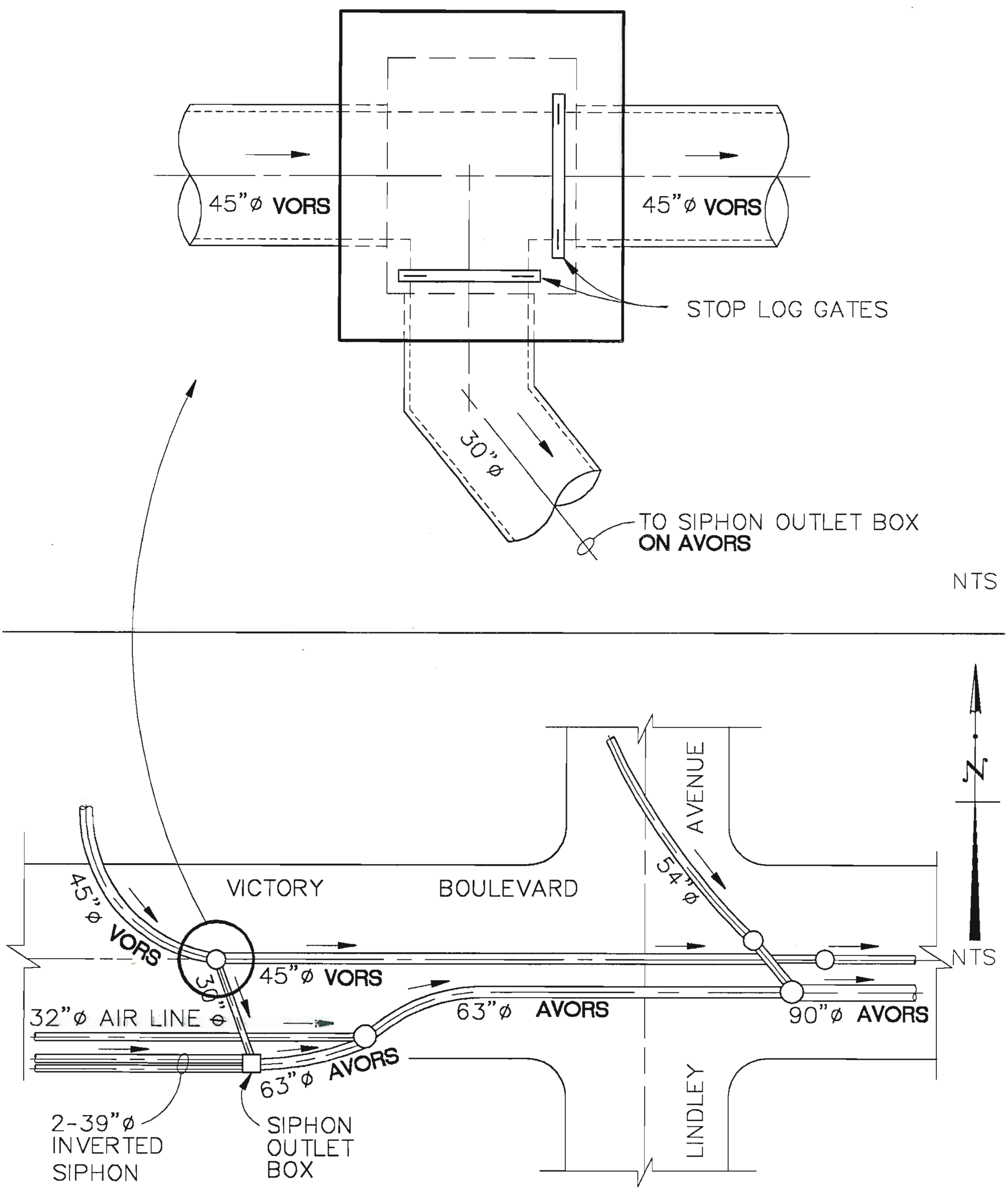

FIGURE 3K–C50
VICTORY BOULEVARD AT LINDLEY AVENUE
DIVERSION STRUCTURE

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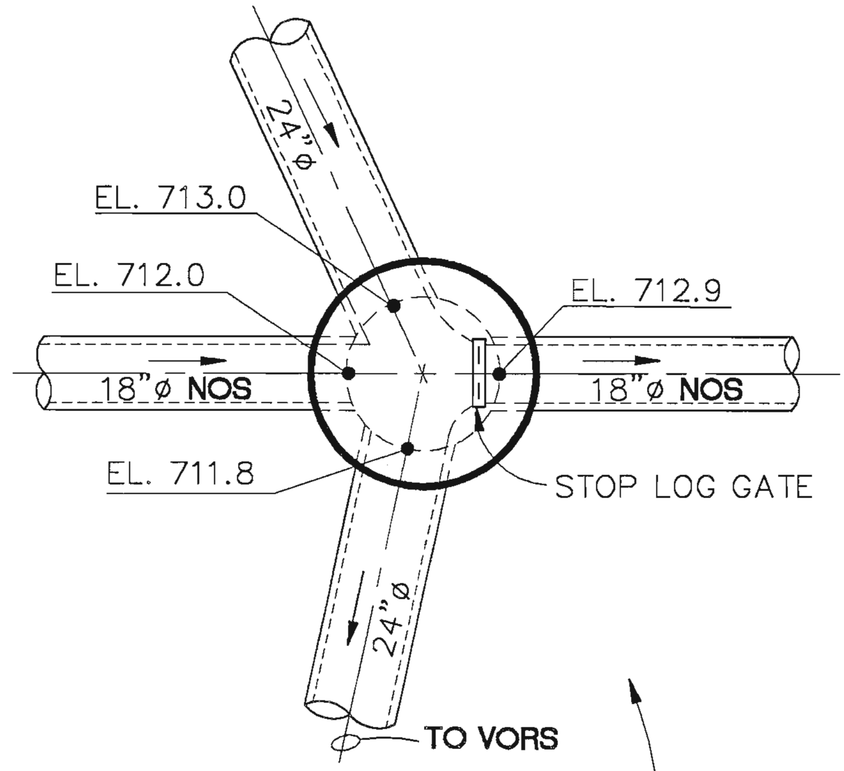

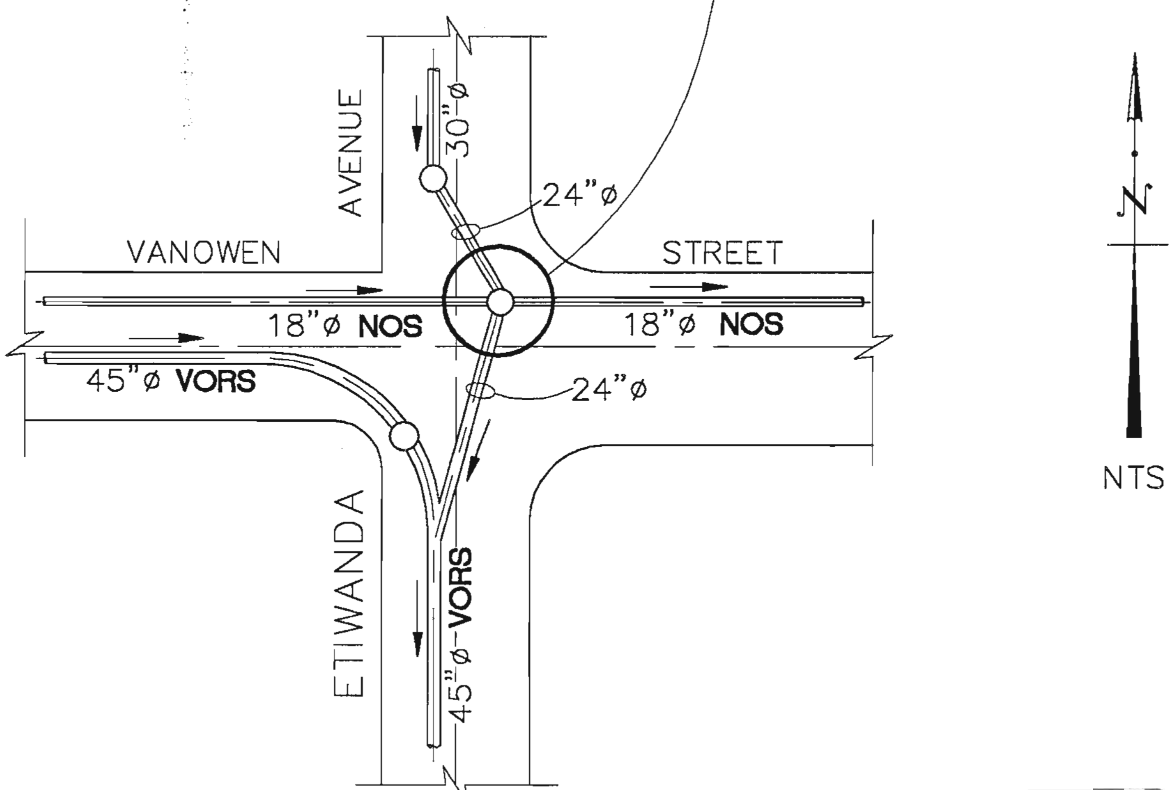

FIGURE 3K-C52
VANOWEN STREET AT ETIWANDA AVENUE
DIVERSION STRUCTURE

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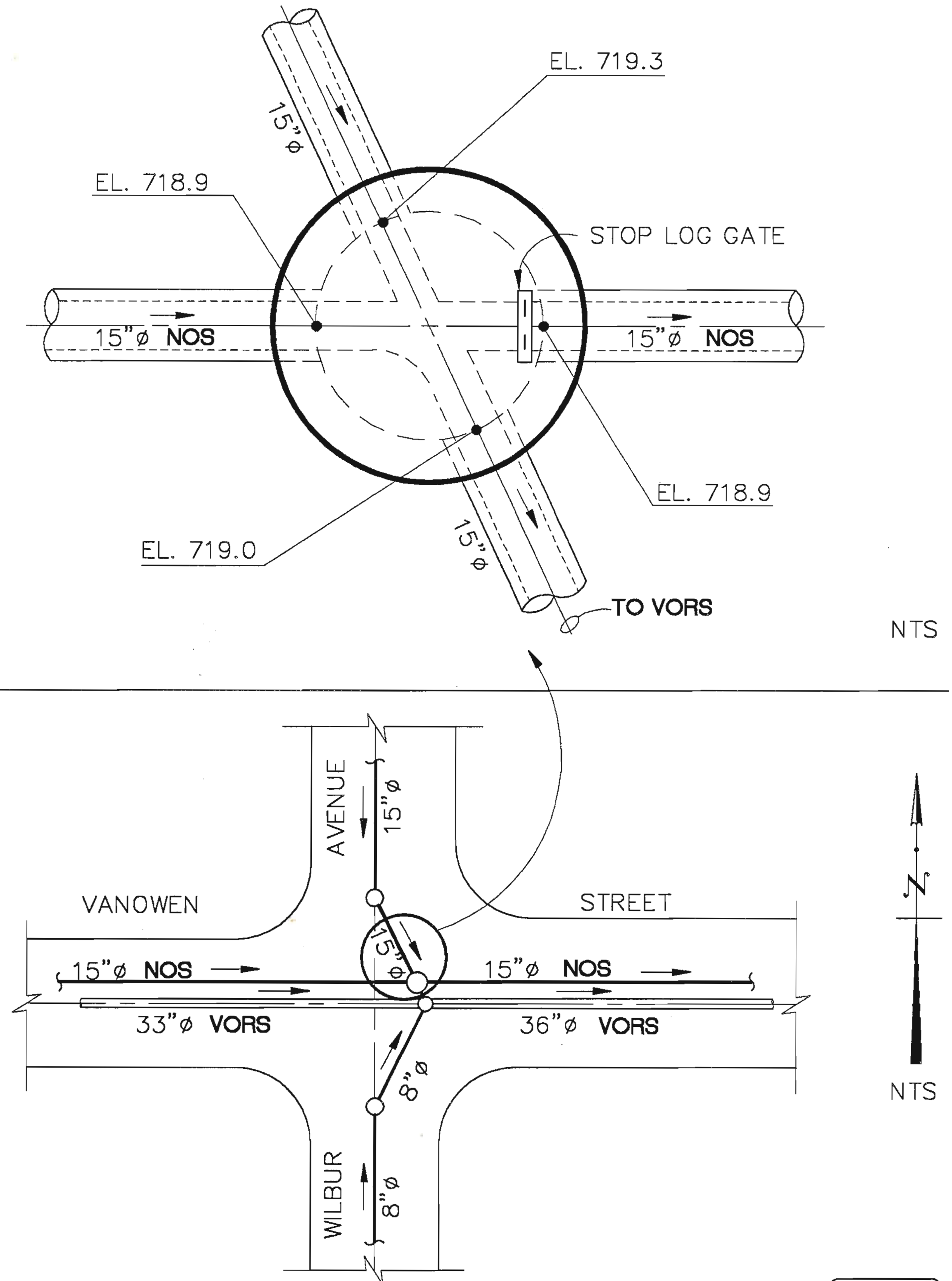

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FIGURE 3K–C53
VANOWEN STREET AT WILBUR AVENUE
DIVERSION STRUCTURE

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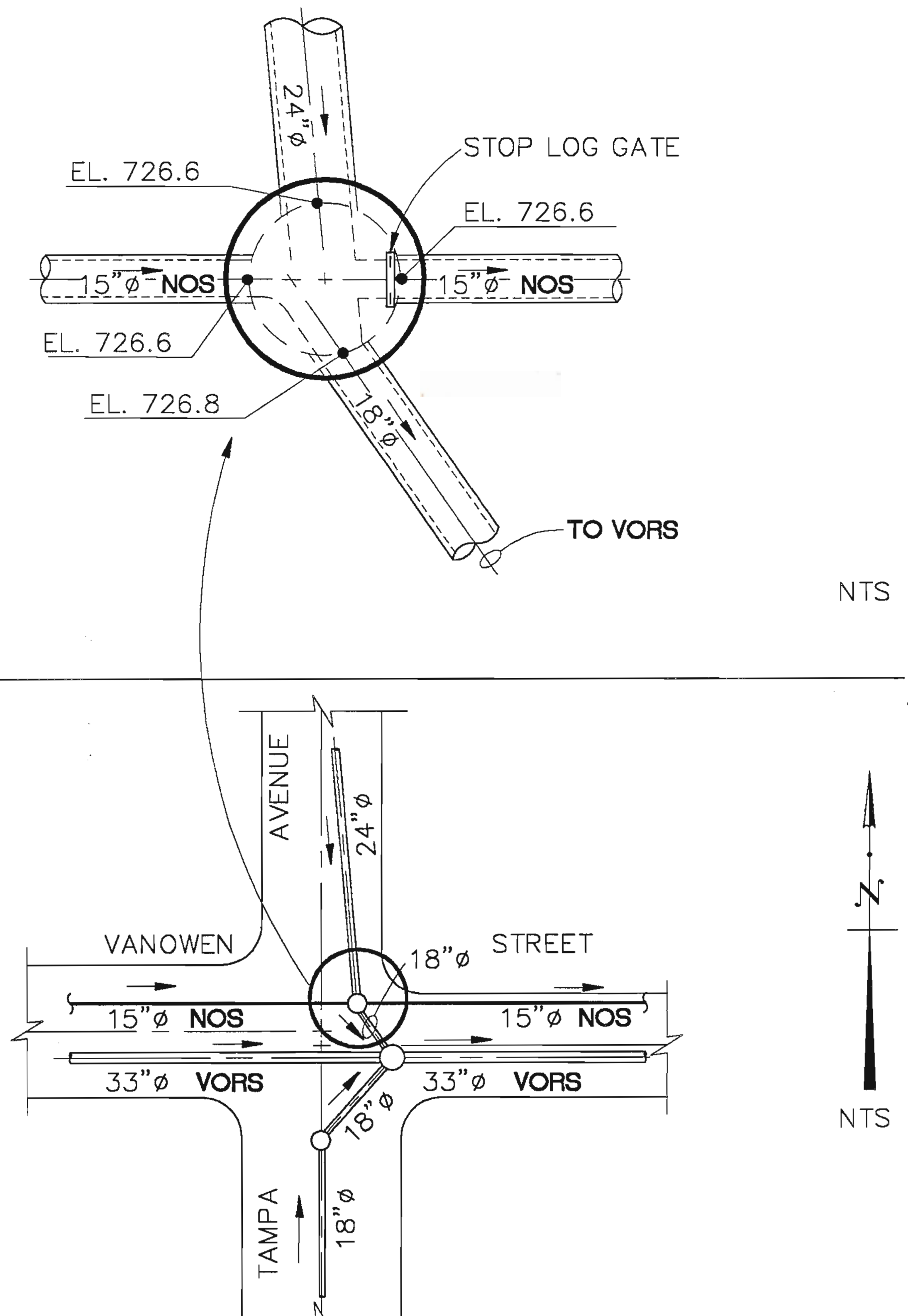

FIGURE 3K-C54
VANOWEN STREET AT TAMPA AVENUE
DIVERSION STRUCTURE

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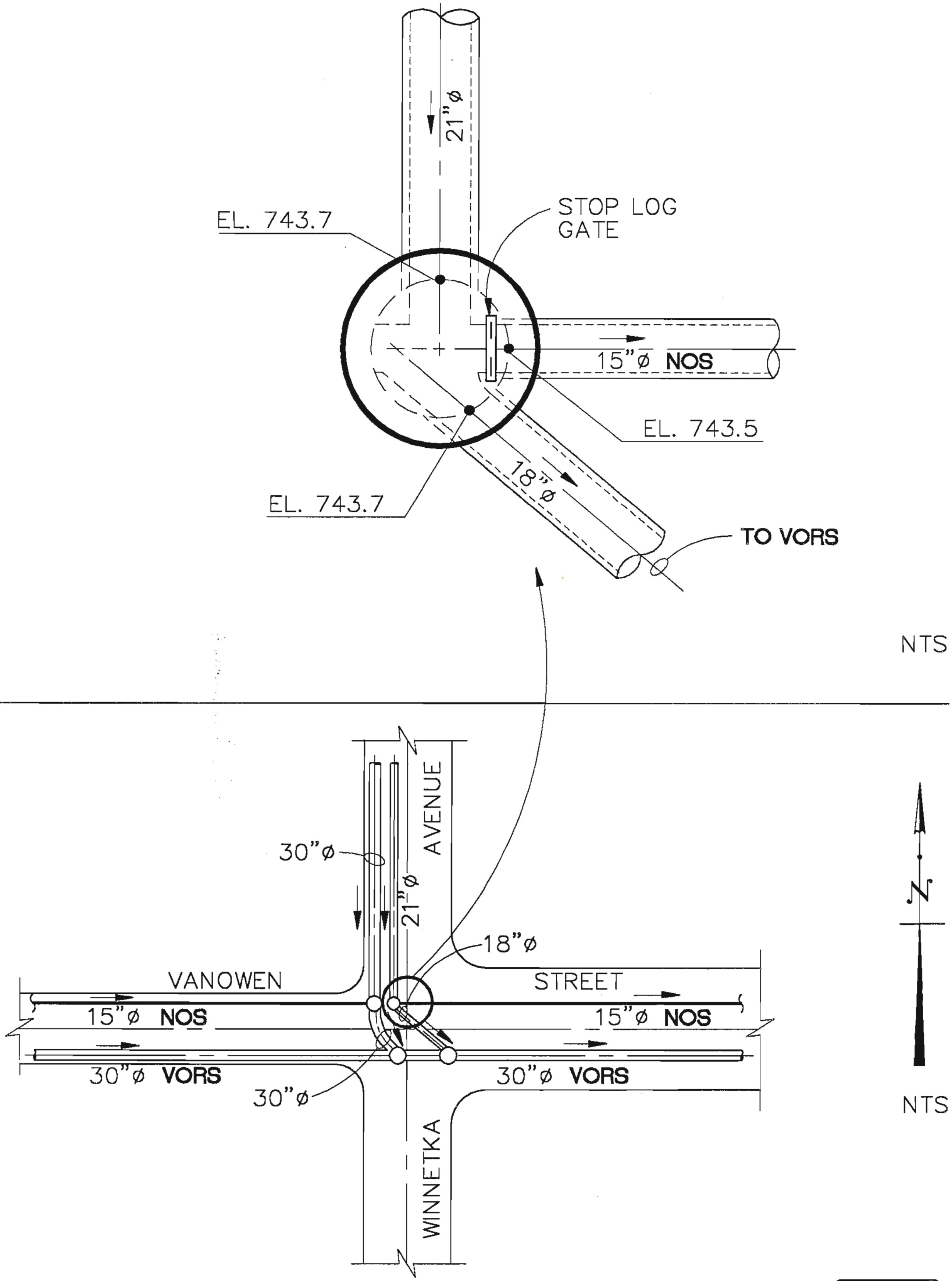

FIGURE 3K–C55
VANOWEN STREET AT WINNETKA AVENUE
DIVERSION STRUCTURE

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Los Angeles Department of Water & Power

City of Los Angeles Sanitation Department of Public Works

Bureau of Engineering

City of Los Angeles Founded 1781