WEST YOST ASSOCIATES
Consulting Engineers

TECHNICAL MEMORANDUM

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TO: SRWA Technical Advisory Committee

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SUBJECT: Summary of Life Cycle Cost Analysis Tool for the SRWA Regional Surface Water Supply Project

INTRODUCTION

This Technical Memorandum (TM) summarizes a life cycle cost analysis (LCCA) tool developed for the Stanislaus Regional Water Authority (SRWA) Regional Surface Water Supply Project (Project). The TM is organized as follows:

- Purpose
- LCCA Tool Overview
- Summary of LCCA Calculations
- Summary of LCCA Tool Inputs
- Potential Adjustments to LCCA Tool Inputs to Facilitate Sensitivity Analyses
- Estimated Life Cycle Costs for Reference Project
- Recommended Next Steps

PURPOSE

The purpose of the LCCA tool is to allow SRWA to:

- Develop an estimate of annual operations and maintenance (O&M) and life cycle costs for the Project facilities for which SRWA has previously developed preliminary designs (referred to herein as the Reference Project)

- Evaluate and compare the life cycle costs associated with design-build (DB) proposals for the design and construction of the Project using a consistent method
- Compare the annual O&M and life cycle costs of the Reference Project to the costs of the DB proposals

LCCA TOOL OVERVIEW

The LCCA tool is designed to incorporate a variety of Project cost inputs, including those established by SRWA and those derived from DB proposals, and produce the following results for each proposal:

- Monthly and annual O&M costs over the duration of the analysis period
- Net present value (NPV) of capital and O&M costs

The LCCA tool considers the following elements of the total Project cost:

- Design and construction costs during the DB procurement phase
- Energy (i.e., electricity) costs for the operation of the raw water pump station (RWPS), the water treatment plant (WTP), and finished water pump stations (FWPS) for the Cities of Ceres and Turlock (Cities)
- Costs for chemicals used at the WTP
- Costs for O&M labor at regional Project facilities
- Costs for repair and rehabilitation/replacement (R&R) of major equipment at regional Project facilities

Although the LCCA tool does not currently account for offsite waste disposal costs, versions of the tool specific to individual DB proposals will be modified, if necessary, to account for such costs associated with the respective proposals. Any necessary modifications will be made following presentations of initial concept submittals by the DB teams, and prior to teams submitting priced DB proposals, in order to inform the proposers about how the proposals will be evaluated.

The LCCA tool accounts for inflation of O&M costs over time and considers the time value of money by converting all future cash flows to current values using discount rates.

The analysis period is 30 years, covering the period from 2022 to 2052, with SRWA assumed to begin operating the Project facilities after completion of acceptance testing in November 2022. Plant start-up is expected to occur in February 2022 and the date of substantial completion is expected to be July 2022. Because the DB team will be responsible for operations costs through completion of acceptance testing, the LCCA tool does not begin to capture energy, chemical, labor, and R&R costs until December 2022.

The tool relies on a number of inputs that will be established by SRWA:

- Surface water demand projections
- Electrical rates
- Chemical unit costs
- Minimum O&M staffing
- O&M staff compensation rates
- Inflation and discount rates

In turn, a number of LCCA tool inputs will be derived from DB proposals received by SRWA:

- Design and construction costs
- Energy demand and utilization
- Chemical consumption
- O&M labor requirements (above a certain minimum established by SRWA)
- Equipment R&R requirements
- Offsite waste disposal requirements (for disposal of wastes other than dewatered solids, if applicable)

In advance of receipt of priced DB proposals, the LCCA tool includes placeholder values for the inputs that DB proposals will provide. These placeholder values are derived from preliminary designs of Reference Project facilities developed by SRWA.

SUMMARY OF LCCA CALCULATIONS

This section broadly summarizes the calculation procedures for the following components of the Project costs:

- Capital expenditures
- Consumables (i.e., energy and chemicals)
- O&M labor
- Major Equipment R&R expenditures
- Offsite waste disposal (if applicable)
- Time value of money (i.e., inflation and discount rates)

The LCCA tool calculates the costs for energy, chemicals, labor, and R&R on a monthly and annual basis throughout the 30-year life cycle period (i.e., 2022 to 2052). The LCCA tool does not currently account for offsite waste disposal costs, but versions of the tool specific to individual DB proposal will be modified, if necessary to account for disposal costs as described below. The tool accounts for inflation in future cost calculations and for the time value of money in the NPV calculations.

Capital Costs

Capital cost inputs will ultimately be derived from DB proposals. In the interim, capital costs for the Reference Project facilities are taken from preliminary estimates previously developed for SRWA. Because SRWA intends to finance the DB costs with a State Revolving Fund (SRF) loan, capital cost expenditures by SRWA are represented in the LCCA tool as a series of amortized, equal annual payments which begin upon completion of each calendar year in which DB work is completed.

Consumables and O&M Labor

The information used to calculate monthly and annual consumables (i.e., energy and chemicals) and O&M labor costs is summarized in Table 1.

Table 1. Inputs for Calculation of Consumables and O&M Labor Costs

Component	Inputs
Energy	• Water demand projections • Guaranteed maximum electrical demands and utilizations (GMEDs and GMEUs) from DB proposals (or preliminary estimated GMEDs and GMEUs for the Reference Project facilities as placeholders) • TID electrical rate structures
Chemicals	• Water demand projections • Annual average chemical doses from DB proposals (or preliminary estimated average chemical doses for the Reference WTP as placeholders) • Unit costs of bulk chemicals (with the same or similar concentrations as those needed at the Reference WTP) from other treatment plants and chemical suppliers
O&M and Administrative Labor	• Minimum required O&M staffing envisioned by SRWA, as developed based on staffing requirements for the Reference RWPS and WTP facilities • Modifications to SRWA's minimum staffing requirements from DB proposals with SRWA review and approval • Estimated SRWA staff compensation packages, including salaries and benefits

Major Equipment Repair and Rehabilitation (R&R)

Major equipment R&R expenditures are intended to account for the costs of future repair and replacement of major equipment, and reflect SRWA's plans to set aside funds annually to finance these expenses. In this instance, major equipment is defined as any equipment with a replacement cost equal to or greater than $25,000. Each DB proposal will include a list of the replacement costs and anticipated manufacturer lifespans of all major equipment items. The SRWA will utilize this information to estimate periodic R&R costs associated with each type of major equipment and sum all anticipated R&R costs during the 30-year lifecycle period. The annual R&R cost will then be calculated as the cumulative R&R cost over the entire analysis period divided by the length of the analysis period (i.e., 30 years). The resulting annual R&R cost will reflect SRWA's necessary annual contributions to an "escrow" account to finance future R&R expenses. Prior to the receipt of DB proposals, the LCCA tool will use an estimated annual R&R cost based on information for recent, similar projects.

Offsite Waste Disposal Costs

The placeholder inputs for the LCCA tool do not include offsite waste disposal costs, as the Reference Project would not require any offsite waste disposal other than the disposal of dewatered solids. However, versions of the tool specific to individual DB proposals will be modified as needed to account for wastes beyond periodic dewatered solids disposal. Any such versions of the tool would calculate the monthly disposal costs based on the estimated weight or volume of material requiring disposal, the distance to a suitable disposal facility, and the estimated trucking cost per mile. Information regarding materials requiring offsite disposal, including estimated weights or volumes of the material(s) to dispose, would be derived from DB proposals. SRWA would identify suitable disposal facilities, determine the distances to these facilities, and establish the trucking costs per mile.

Inflation and Discount Rates

The estimated life cycle costs of the Project include cost items which are expected to be subject to inflation over time. Similarly, future costs occurring within the life cycle analysis period must be discounted to account for the time value of money, namely the notion that the amount of money that could be invested today to pay for future costs will generally be less than the amount of the future costs. Thus, inflation rates are used to capture the rate of change of prices over time and the discount rate is used to find the present value of future cash flows. The NPV is calculated as the sum of the present value of amortized capital costs and the present worth of all future costs for consumables, O&M labor and R&R.

SUMMARY OF LCCA TOOL INPUTS

This section discusses the following inputs to the LCCA tool:

- Inputs established by SRWA
- Summary of placeholder values for inputs to be taken or derived from DB proposals
- Potential adjustments to inputs to facilitate sensitivity analyses

LCCA Tool Inputs Established by SRWA

As previously mentioned, the tool requires SRWA to establish the following inputs, each of which are described in further detail in the following subsections:

- Surface water demand projections
- Electricity rates
- Chemical unit costs
- Minimum administrative and O&M staffing requirements
- Administrative and O&M staff compensation
- Inflation and discount rates
- Placeholder LCCA tool inputs

Surface Water Demand Projections

Monthly water demands were projected for the duration of the analysis period to facilitate the calculation of power demand and chemical consumption, each of which is a function of the amount of water treated and delivered by the Project. The projections rely on supply and demand information reviewed as part of the Project's preliminary phasing and treatment plant sizing analyses (West Yost Associates, 2016), which included demand projections for each City at five-year intervals through 2040 (in Turlock's case) and 2035 (in Ceres' case). The approach for projecting monthly surface water demands over the 30-year analysis period relies on the following assumptions:

- Demand Growth Assumptions:
  - Demand growth rate is constant between the five-year intervals (e.g., between 2025 and 2030) for which each City's demand projections are available
  - Monthly surface water demands for each year from 2022 to 2025 are equal to the previously established monthly projections for calendar year 2025
  - The demand growth rate for Turlock between 2040 and the end of the LCCA analysis period (2052) is equal to the rate between 2035 and 2040; for Ceres, the growth rate between 2035 and 2052 is equal to the rate between 2030 and 2035
- Project Phasing and Capacity Assumptions:
  - During Phase 1 of the Project, which is assumed to end in 2030, surface water demands are limited to five mgd for Ceres and 10 mgd for Turlock
  - During Phase 2 of the Project, from 2031 to 2040, surface water demands are limited to 10 mgd for Ceres and 20 mgd for Turlock
  - After Project build-out, which is assumed to occur in 2040, surface water demands are limited to 15 and 30 mgd for Ceres and Turlock, respectively
  - If the demand reaches its limit (e.g., five mgd for Ceres) during any month of a given Project phase, the demand during that month is capped at that limit for the remainder of the given phase, regardless of the actual demand growth rate

Figure 1 shows the projected monthly surface water demands for Ceres and Turlock.

Electrical Rates

Electrical rates are based on electricity utilization and demand rates published by the local electric utility provider, Turlock Irrigation District (TID), effective January 1, 2015. GMED and GMEU values for the RWPS are used to determine which rate schedules apply. The LCCA tool utilizes TID's Schedule IT rate tariff, which is applicable for demands up to 500 kW. After maximum power demands of the RWPS reach 500 kW during a single month, the LCCA uses TID's Schedule HT rate tariff, which is applicable for demands between 500 and 2,999 kW, for the RWPS throughout the remainder of the analysis period. The LCCA tool uses TID's Schedule HT rate tariff for the WTP and both FWPS facilities, given that the entire WTP facility is expected to exert a demand greater than 500 but less than 2,999 kW. Charges related to time-of-use are calculated in accordance with the usage periods defined by TID. Electricity utilization and demand rates are inflated over time according to projected inflation rates described below.

Chemical Unit Costs

A list of required chemicals was developed based on chemicals needed for the Reference WTP (Trussell Technologies, 2018). Although corrosion control chemicals will ultimately be selected by the Cities based on the results of their respective system integration studies, the use of phosphoric acid (e.g., orthophosphate) is assumed in this TM and the LCCA tool. Chemical unit costs have been estimated using information from existing treatment plants and quotes from chemical suppliers (where no other information was available). A sales tax of 8.25 percent is applied to all chemical costs and the prices are inflated over time according to inflation rates described below. Table 2 summarizes the pre-tax unit cost and the purpose of each chemical.

Table 2. Chemical Unit Costs

Chemical	Pre-Tax Unit Cost	Purpose of Chemical
Hydrated Lime Slurry[(a)]	$0.16/lb	Alkalinity addition for finished water stabilization
Sodium Permanganate Solution[(b)]	$1.03/gal	Pre-oxidation for manganese removal
Aluminum Sulfate Solution[(c)]	$0.62/gal	Coagulation
Dry Cationic Polymer[(d)]	$5.51 gal	Flocculation and improved particle settling
Dry Anionic or Nonionic Polymer[(d)]	$5.51/gal	Flocculation aid and particle destabilization
Liquid Oxygen[(e)]	$0.05/lb	Ozone generation for primary disinfection and treatment of total organic carbon and organic contaminants via ozonation
Hydrogen Peroxide Solution[(f)]	$2.11/gal	As-needed, advanced oxidation for organic contaminant removal
Calcium Thiosulfate Solution[(g)]	$2.49/gal	Quenching of residual ozone
Sodium Hypochlorite Solution[(h)]	$0.66/gal	Final disinfection and chlorine residual management
Carbon Dioxide[(i)]	$0.06/ b	pH adjustment for finished water stabilization
Sodium Hydroxide Slurry[(h)]	$0.32/lb	pH adjustment for finished water pH specific to each City's distribution system
Phosphoric Acid Slurry[(j)]	$0.55/gal	Corrosion control

(a) Unit cost based on 2018 quote from Lhoist North America.
(b) Unit cost based on 2017 price paid by Calaveras County Water District's Jenny Lind Water Treatment Plant.
(c) Unit cost based on quote from ChemTrade Chemicals US LLC presented in the BACC 2018 Bid for Sacramento region.
(d) Unit cost based on 2018 price paid by Modesto Irrigation District (MID) to Nalco.
(e) Unit cost based on 2018 price paid by Davis-Woodland Water Treatment Plant to Air Products.
(f) Unit cost based on 2018 quote from USP Technologies.
(g) Unit cost based on 2018 price paid by MID to Tessenderlo Kerley.
(h) Unit cost based on quote from Univar USA Inc. presented in the BACC 2018 Bid for Central Valley region.
(i) Unit cost based on 2018 price paid by MID to Matheson Tri-gas.
(j) Unit cost based on 2018 price paid by MID to Brenntag Pacific.

Minimum Administrative and O&M Staffing Requirements

Table 3 lists the minimum numbers and types of staff expected to be needed to operate the regional Project facilities, as well as a hiring schedule. O&M staffing requirements were estimated for the Reference WTP based on staffing patterns at the Modesto Regional Water Treatment Plant (operated by MID). The staffing plan shown in Table 3 is considered a minimum, and will be the basis of O&M labor costs assigned to all DB proposals; the staffing plan may be adjusted by SRWA, however, if SRWA determines that the labor requirements of any DB proposal are substantially greater or less than the established minimum requirements.

Table 3. Minimum Staffing Requirements

Position	Number of Full-Time Equivalents
Plant Manager	1
Secretary	1
Maintenance Supervisor	1
Water Quality Supervisor	1
Senior Operator	5
Operator	2
Apprentice Operator	2
Instrumentation and Controls Technician	1
Maintenance II Worker	1
Maintenance I Worker	1
Laboratory Technician	1

Administrative and O&M Staff Compensation

Annual salaries for administrative and O&M staff for the regional Project facilities have been estimated based on MID's salary schedule. For the positions for which salary ranges are available, the midpoint of the range is used, as shown in Table 4. The cost of benefits is estimated as 70 percent of salaries, based on the City of Turlock's typical multiplier for benefits. In the LCCA tool, salaries and benefits are inflated over time according to inflation rates described below.

Table 4. Estimated SRWA Staff Compensation

Position	Annual Salary Range, $	Average Annual Salary, $	Average Annual Benefits, $	Average Annual Total Compensation, $
Plant Manager	129,000 – 166,000	147,000	103,000	251,000
Secretary	52,000 – 66,000	59,000	41,000	101,000
Maintenance Supervisor	96,000 – 123,000	110,000	77,000	186,000
Water Quality Supervisor	106,000 – 136,000	121,000	85,000	206,000
Senior Operator	72,000 – 92,000	82,000	57,000	139,000
Operator	83,000	82,000	58,000	141,000
Apprentice Operator	59,000 – 75,000	67,000	47,000	114,000
Instrumentation and Controls Technician	106,000	106,000	74,000	180,000
Maintenance II Worker	94,000	94,000	66,000	159,000
Maintenance I Worker	66,000 – 85,000	76,000	53,000	129,000
Laboratory Technician	64,000 – 82,000	73,000	51,000	124,000

Inflation and Discount Rates

This section describes several potential approaches which may be used to estimate the inflation and discount rates to be used in the LCCA tool. The approaches are based on information obtained from the following sources:

- Office of Management and Budget (OMB)
- United States Energy Information Administration (EIA)
- Engineering News-Record (ENR)

Information Derived from the Office of Management and Budget

The OMB publishes Budget Circular No. A-94, which includes a regularly revised forecast of real and nominal interest rates for U.S. Treasury notes and bonds of specified maturities, and can be used to estimate inflation and discount rates which are generally applicable to most projects. Inflation rates from 2018 to 2048 are calculated by subtracting the real interest rates from the nominal interest rates published by OMB. Linear regression on the resulting inflation rates determines the inflation values for each year of the Project's analysis period, as shown in Table 5 below. Inflation rates are calculated starting in 2018 to allow estimation of future costs from current 2018 costs, but the LCCA tool accounts only for costs during the analysis period from 2022 to 2052.

Table 5. Projected Inflation Rates Based on OMB Circular A-94	
Year	Inflation Rate, percent
2018	1.80
2019	1.80
2020	1.80
2021	1.80
2022	1.85
2023	1.90
2024	1.90
2025	1.90
2026	1.90
2027	1.90
2028	1.90
2029	1.91
2030	1.92
2031	1.93
2032	1.94
2033	1.95
2034	1.96
2035	1.97
2036	1.98
2037	1.99
2038	2.00
2039	2.00
2040	2.00
2041	2.00
2042	2.00
2043	2.00
2044	2.00
2045	2.00
2046	2.00
2047	2.00
2048	2.00
2049	2.00
2050	2.00
2051	2.00
2052	2.00

For this analysis, projected discount rates from 2018 to 2048 are taken to be equal to the nominal interest rates published by OMB, which by definition do not account for inflation. As for inflation rates, a linear regression on projected discount rates is used to determine discount rates during each

year of the Project's analysis period, as shown in Table 6 below. Discount rates are calculated starting in 2018 to allow determination of the present worth (in 2018 dollars) of future costs, but the LCCA tool accounts only for costs during the analysis period from 2022 to 2052.

Table 6. Projected Discount Rates Based on OMB Circular A-94

Year	Discount Rate, percent
2018	1.00
2019	1.00
2020	1.00
2021	1.00
2022	1.15
2023	1.30
2024	1.45
2025	1.60
2026	1.67
2027	1.73
2028	1.80
2029	1.84
2030	1.88
2031	1.92
2032	1.96
2033	2.00
2034	2.04
2035	2.08
2036	2.12
2037	2.16
2038	1.20
2039	2.24
2040	2.28
2041	2.32
2042	2.36
2043	2.40
2044	2.44
2045	2.48
2046	2.52
2047	2.56
2048	2.60
2049	2.64
2050	2.68
2051	2.68
2052	2.68

Information Derived from the United States Energy Information Administration (EIA)

The EIA publishes the Annual Energy Outlook, which includes electricity price growth forecasts for various types of end-use customers, and can be used to estimate inflation rates that are specific to electricity prices. A linear regression on EIA-projected electricity prices through 2050 determines the present value of electricity prices for each year of the EIA analysis period. By applying the inflation values shown in Table 5 to the present values of the electricity prices, future values of the electricity prices are determined, and these values are used to determine the effective annual electricity price inflation rates.

Information Derived from Engineering News-Record (ENR)

ENR publishes a Construction Cost Index (CCI) reflecting the costs of construction materials and labor components. The CCI is based on data from 20 cities nationwide, and can be used to estimate construction cost inflation over time, in lieu of the OMB-based approach described above. For purposes of comparison to the OMB-based approach, the ENR-based inflation rate for capital costs is assumed to equal the 10-year average inflation rate based on CCI data. Year-to-year inflation of the CCI reported by ENR from 2008 to 2017 is calculated for each month. The 10-year average year-to-year inflation is determined as the average of the monthly values, yielding an inflation rate of 3.0 percent.

Summary of Placeholder Values for LCCA Tool Inputs to be Taken or Derived from DB proposals

This section provides a summary of placeholder inputs used in the LCCA tool in the absence of completed, priced DB proposals. Such inputs are derived from various Reference Project preliminary design documents, and will be replaced with information from the DB proposals when they are received. The placeholder inputs include:

- Capital Costs
- Electrical Power Demands
- Chemical Consumption Rates
- R&R Costs

Capital Costs

West Yost has previously prepared preliminary estimates for the design and construction costs for the regional Project facilities, and these estimates have been used as placeholder values in the LCCA tool. For purposes of estimating SRF loan repayment costs, the LCCA tool treats each of four fiscal year's estimated capital expenditures (specifically, the progress payments made to the DB contractor during a given fiscal year) as a separate loan, as shown in Table 7, and begins repayment for each "loan" at the end of the preceding fiscal year. To determine the NPV of the individual annual payments on the resulting SRF loan amounts, the LCCA tool assumes a financing period of 30-years and discount rates based on OMB information, as described in Table 6.

Table 7. Estimated Design-Build Capital Expenditures by Fiscal Year	
Fiscal Year	Value, $
2019/2020	33,785,000
2020/2021	95,677,000
2021/2022	62,661,000
2022/2023	1,515,000
Total	**$193,638,000**

Electrical Power Demands

West Yost has previously prepared conceptual estimates of electrical power demands for the following regional Project facilities, over the range of flow scenarios shown:

- Reference raw water pump station (RWPS), at capacities between 5 and 65 mgd[1]
- Reference WTP, at capacities between 5 and 45 mgd
- Reference finished water pumping stations (FWPS) for Ceres and Turlock, at capacities between 1 and 15 mgd (for Ceres) and between 4 and 30 mgd (for Turlock)

The conceptual power demand estimates are summarized in Table 8. In the LCCA tool, monthly power demands are based on the actual projected monthly surface water demand and are calculated using linear interpolation between the power demands estimated for the two nearest surface water demand values.

[1] The RWPS will be designed to convey raw water to both the WTP and the TID Ceres Main Canal, with flow splitting achieved at flow splitting structure located along the raw water transmission main. Although the buildout capacity of the RWPS is expected to be 65 mgd, no more than 45 mgd would be delivered to the WTP at buildout.

Table 8. Estimated Power Demands for Reference Project Facilities	
Capacity, mgd	Estimated Power Demand, kW
RWPS	
5	129
7.5	193
10	257
12.5	321
15	370
65	1,739
WTP	
5	642
7.5	729
10	817
12.5	905
15	1,056
30	1,434
45	1,985
Ceres FWPS	
1	15
2	31
3	48
4	65
5	85
10	216
15	433
Turlock FWPS	
4	70
6	107
8	147
10	190
20	475
30	933

Chemical Consumption Rates

The Pre-Design Report of the Reference WTP (Trussell Technologies, 2018) identifies chemical requirements for the Reference WTP. For all chemicals except sodium hypochlorite, sodium hydroxide, and phosphoric acid which will be applied to finished water, chemical consumption estimates are based on the average doses specified in the Pre-Design Report and the projected surface water demand. Although each City will independently set doses of sodium hypochlorite, sodium hydroxide, and phosphoric acid to meet their individual needs for stabilization of their finished water, consumption estimates in the LCCA tool are based on estimated doses developed by Trussell Technologies. Table 9 summarizes the estimated bulk chemical doses and amounts required per volume of water treated.

Table 9. Estimated Bulk Chemical Consumption Rates

Chemical	Point of Application	Average Dose[(a)]	Amount Required per MG Finished Water Produced
Lime	Raw Water	7 mg/L as $Ca(OH)_2$	300 lbs
	Finished Water	29 mg/L as $Ca(OH)_2$	
Sodium Permanganate	Raw Water	0.2 mg/L as $NaMnO_4$	0.86 gal
Aluminum Sulfate	Flash Mix	15 mg/L as $Al_2(SO_4)_3 \cdot 14H_2O$	25.6 gal
Cationic Polymer	Flash Mix	0.5 mg/L	5.7 gal
	Gravity Thickener Influent	2.5 mg/L	
	Dewatering (Sludge Drying Bed)	2.5 mg/L	
Anionic or Nonionic Polymer	Flocculation	0.1 mg/L	0.33 gal
	Common Filter Influent	0.02 mg/L	
	Backwash Basin Influent	0.2 mg/L	
Liquid Oxygen	Ozone Generation / Primary Disinfection	1.0 mg/L at 10% O_3 by weight	83 lbs
Hydrogen Peroxide	Ozone Contactor Chamber	0.5 mg/L as H_2O_2	1.4 gal
Calcium Thiosulfate	Ozone Contactor Exit	0.16 mg/L as CaS_2O_3	0.53 gal
Sodium Hypochlorite	Chlorine Contact Basin Influent	2 mg/L as Cl_2	36.7 gal
	Finished Water	3.5 mg/L as Cl_2[(b)]	
Carbon Dioxide	Finished Water	26 mg/L as CO_2	217 lbs
Sodium Hydroxide	Finished Water	1 mg/L as NaOH[(c)]	8.3 lbs
Phosphoric Acid[(d)]	Finished Water	3.0 mg/L as PO_4	2.4 gal

(a) As determined for the Reference WTP by Trussell Technologies, unless otherwise specified.
(b) Placeholder for each City's specified dose for sodium hypochlorite to the finished water based on detention time in the distribution system to maintain an adequate residual.
(c) Placeholder for each City's specified sodium hydroxide dose to achieve an appropriate pH in the finished water for corrosion control in the distribution system.
(d) Phosphoric acid is a placeholder corrosion inhibitor until each City determines its corrosion control chemical.

Repair and Rehabilitation (R&R) Costs

This section summarizes an approach for estimating R&R costs for major equipment at regional Project facilities in advance of obtaining detailed R&R cost information from DB proposers. For this approach, West Yost has utilized available construction and R&R cost data for recent, similar projects in the development of the following ratios:

- The estimated ratio of major equipment costs to total regional Project facility costs
- The estimated ratio of annual R&R costs to major equipment costs

Based on available data from recent, similar projects, annual R&R costs are expected to be equal to approximately 1.25 percent of the initial capital costs for major equipment. Costs for major equipment, which in this instance is defined as any equipment item with a replacement cost of $25,000 or more, are expected to be approximately 25 percent of total WTP design and construction costs. The estimated major equipment and annual R&R costs are shown in Table 10.

Table 10. Estimated Costs for Major Equipment, and R&R Costs for Reference Regional Project Facilities

Element	Value, $
WTP Design and Construction Costs[(a)]	114,046,000
Initial Capital Costs for Major Equipment[(b)]	28,512,000
Annual Major Equipment R&R[(c)]	356,000

(a) Includes design, construction management, and inflation to midpoint of construction. Based on cost information presented in *Addendum to November 2016 TM Basis and Comparison of SRWA Surface Water Supply Project Costs* (West Yost Associates, November 2017).
(b) 25 percent of WTP design and construction costs. Major equipment refers to all equipment with a replacement cost equal to or greater than $25,000.
(c) 1.25 percent of major equipment

POTENTIAL ADJUSTMENTS TO LCCA TOOL INPUTS TO FACILITATE SENSITIVITY ANALYSES

Sensitivity analyses related to inputs are recommended to assess the impacts of certain key assumptions on the results of the LCCA evaluation. Such analyses will increase confidence in comparisons between DB proposals and will inform SRWA about the economics of the Project if certain assumptions do not hold. Possible factors and scenarios to assess with respect to inputs established by SRWA include:

- Increasing and decreasing projected discount rates by up to 10 percent
- Increasing and decreasing projected inflation rates by up to 10 percent
- Increasing and decreasing projected water demands by up to 10 percent
- Increasing and decreasing chemical unit costs by up to 10 percent
- Increasing and decreasing O&M staff total compensation by up to 10 percent

Potential factors and scenarios to assess with respect to inputs from DB proposals include:

- Increasing and decreasing energy demands by up to 10 percent
- Increasing and decreasing chemical consumption by up to 10 percent
- Increasing and decreasing equipment R&R requirements by up to 10 percent
- Increasing and decreasing offsite waste disposal costs (if applicable) by up to 10 percent

ESTIMATED LIFE CYCLE COSTS FOR REFERENCE PROJECT

The estimated annual O&M costs for the first year of full operation (2023) of the Reference Project, as well as the total O&M costs over the 30-year analysis period, are summarized in Table 11.

Table 11. Present Worth of Reference Project O&M Costs (2018 Dollars)

Component	2023	Over 30 Years (2022-2052)
Energy	1,141,000	43,157,000
Chemicals	706,000	21,735,000
O&M and Administrative Labor	2,606,000	70,993,000
R&R	366,000	9,936,000
Total	**4,819,000**	**145,821,000**

With total capital costs for design and construction of $193,638,000, the combined NPV of the Reference Project is $350,045,000.

RECOMMENDED NEXT STEPS

West Yost recommends the following steps:

- West Yost Associates will conduct a sensitivity analysis on key assumptions of the LCCA tool and provide results to the SRWA TAC for review.
- A copy of the model and this TM describing the methodology will be provided to DB proposers.
- When the Cities determine required doses for sodium hypochlorite, sodium hydroxide, and corrosion inhibitor applied to finished water, this information will be incorporated into the LCCA tool.
- Any additional adjustments made to the LCCA tool based on the proposals received will be documented in a revised TM.

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Figure 1. Projected Surface Water Demands