Water Supply Advisory Committee Portfolio Building Block Information

3. Purified Recycled Water for Direct Potable Reuse (DPR)

working draft of 20 July 2015

1. Objectives

The technical team prepared this document as part of a series that provides our latest assessment of the anticipated costs, supply production, yields, timelines, and other relevant information for the various water supply enhancement alternatives that may serve as key components ("building blocks") in a future portfolio. Each of the major potential water supply components is now being considered individually so that each of these "building blocks" can be more carefully compared side by side. The objective is to provide WSAC with our best current assessment for each building block, so that the Committee can better evaluate its potential choices as they build portfolios for future consideration.

Disclaimer/Context

The material provided herein reflects the technical team's best assessment given currently available information. At this stage, all estimates are preliminary and suitable only for high level planning: cost estimates are prepared to a "planning level," we have included a 50-percent contingency to address "known and 'unknown' unknowns," and the estimated capital and operating costs are intended to be used for comparison purposes, as Class 5 estimates with an accuracy range of -30% to +50%.[1]

As we continue to review and refine underlying assumptions and data, and as new information becomes available, our estimates will likely evolve. More extensive analysis ultimately will need to be conducted to develop more precise estimates – including site-specific field evaluations beyond the scope and timeline for WSAC activities.

Also, please note that the total portfolio yield is not equal to the sum of the individual building block yields. This is because the components operate interactively at a system level (as captured in *Confluence* modeling).

2. Purified Recycled Water for Direct Potable Reuse -- Overview

In this document, a direct potable reuse (DPR) approach is envisioned generally as:

1. The City applying "Complete Advanced Treatment" (CAT) to produce purified recycled water of potable quality.

2. Building a pipe and pumping system to blend the CAT-produced water into the North Coast water main near the Bay Street Tank site, and blending further with San Lorenzo River (SLR) water at the

[1] Per the Association for the Advancement of Cost Engineering (AACE), *Standard Cost Estimating Guidelines*. Note too that these are considered "Class 5" planning-level estimates, which include a 50 percent contingency factor, and should also be accompanied by an accuracy range of -30% to +50%. For example, a project presented with a $100M cost including contingency allowance ($66.7 million plus $33.3 million = $100 million) likely would have a final cost between $70 million and $150 million.

SLR pump station.

3. Treating the blended source waters for potable supply at the Graham Hill Water Treatment Plant (GHWTP).

4. The additional supply provided would help meet water demands for Santa Cruz Water Department (SCWD).

5. Once SCWD needs are met, and Loch Lomond storage targets are achieved, any additional available supply could be made available to help meet demands in areas served by the Scotts Valley Water District (SVWD) and Soquel Creek Water District (SqCWD). Such transfers would help restore groundwater levels in the depleted regional aquifers (by enabling passive [in-lieu] recharge), reduce seawater intrusion potential into the Purisima formation, and provide stored waters that could be tapped in dry periods (including the possible return of some waters from neighboring Districts to the City).

There are numerous specific details and variations on how this DPR approach might be structured and implemented. These include, for example, whether any excess water might be made available to SVWD and SqCWD for in-lieu recharge. If these transfers are included, issues arise regarding the scale and location of any new infrastructure (e.g., interties, pumps, wells) that may be necessary to implement the approach, and the forms of the institutional arrangements negotiated between the City and SVWD and SqCWD regarding sharing water, costs, and risks. The latter issue impacts when and how much water may be transferred to and from SVWD and SqCWD, the associated improvements in yields and system reliability, how much the approach would cost, and what an equitable allocation of costs might look like.

In this paper, we aim to be as explicit as possible about the underlying assumptions and constraints that are included in our analysis and findings. Where feasible, we provide preliminary indications of the impact of some of the possible variations. If the City pursues this building block further, the information provided in this document will need to be vetted and developed in more detail to confirm assumptions and refine cost estimates.

3. Base Case Configuration and Assumptions

1. CAT-produced potable quality water would be provided at a scale of 4.7 MGD, for a total annual supply of 1,715 MG per year. This is based on the volume of City-owned wastewater effluent entering the City's wastewater treatment plant of 5.5 MGD, with little seasonal variation (driven by indoor water use).[2]

2. It is envisioned that the membrane process would operate continuously. Membrane processes work best when the flow is relatively steady; large diurnal variations are particularly undesirable. An equalization basin is included upstream of the treatment train to help moderate changes in flow rate. If you need to operate a facility with membrane systems such as RO at a reduced output, one approach, besides going through a shutdown and preservation process, is to rotate operation among modules. For example, you have four sets/banks of membranes and you operate each set one week in four. Thus, no set of modules sits idle for an extended period.

[2] The 5.5 –MGD flow does not include any effluent flow from the City of Scotts Valley

3. Newell Creek Dam height and Loch Lomond operational rules remain as they currently exist.

4. Purified recycled water is blended first into the North Coast raw water main near the Bay Street Tank site, then with other source waters entering the Graham Hill Water Treatment Plant (GHWTP) for additional treatment before distribution to SCWD customers.

5. If in-lieu recharge is considered part of this building block, then the costs, yields, and issues associated with the in-lieu component will depend on several factors, as described in the summary paper for Building Block #1.

6. Yield estimates for DPR reflect the assumption that SCWD realizes water savings from Program C Rec (i.e., that C Rec is anticipated to be part of the portfolio along with DPR). For purposes of this building block, the assumed peak season demand reduction attained is 150 MG. If additional changes in peak season demands are agreed upon by WSAC, then associated modifications to the yields in this portfolio will be derived.

4. Necessary Capital Improvements and Related Costs[3]

Table 3.1 provides an overview of the major capital investments and other upfront costs associated with developing and operationalizing the DPR program.

Table 3.1 DPR capital improvement needs and costs (millions of 2015$)

Capital improvement item	Hard capital cost	Soft capital cost*	Total capital cost
DPR			
a. Nitrification (6.1 MGD)	2.25	0.70	2.95
b. Equalization basin (0.5 MG)	0.75	0.24	0.99
c. Ozone/BAC filters (6.1 MGD)	13.50	4.19	17.69
d. Microfiltration (6.1 MGD)	21.00	6.51	27.51
e. Reverse osmosis (5.5 MGD)	30.00	9.30	39.30
f. Advanced oxidation (UV + Peroxide) (4.7 MGD)	4.88	1.52	6.39
g. Conditioning facilities (4.7 MGD)	2.15	0.67	2.82
h. Effluent diffuser modification	1.50	0.47	1.97
i. Pumping system (WWTP to CAT)	2.58	0.80	3.38
j. Pipeline installation (WWTP to CAT)	0.18	0.06	0.24
k. Pumping system (CAT to Bay St. Tank Site)	1.92	0.60	2.52
l. Pipeline installation (CAT to Bay St. Tank Site)	3.96	1.23	5.19
m. Line maintenance facility relocation	N/A	N/A	5.20
Totals	**84.67**	**26.29**	**116.15**

[3] Note that at this stage of the evaluation process, all cost estimates are highly preliminary, "Planning Level" estimates reflecting a range of –30% to + 50% (per AACE Guidelines), and subject to modification as additional information emerges.

Table 3.1 DPR capital improvement needs and costs (millions of 2015$)

Capital improvement item	Hard capital cost	Soft capital cost*	Total capital cost

NOTES:

* Soft costs include engineering, construction management, permitting, City contract administration and legal.

a. Modify existing wastewater treatment plant (WWTP) processes to achieve full nitrification.
b. Part of the Complete Advanced Treatment (CAT) water purification process: a 0.5-MG basin at the beginning of the CAT process to keep the flow rate relatively stable over time.
c. Part of the CAT water purification process: install ozonation with biologically active filtration to provide microbial and organic contaminant destruction.
d. Part of the CAT water purification process: install low-pressure membrane filtration to remove solids and some microorganisms; pretreatment for the reverse osmosis (RO) process. The concentrate (10% of the flow) is recycled back to the head of the plant.
e. Part of the CAT water purification process: add high-pressure membrane filtration to further purify the microfiltration product stream.
f. Part of the CAT water purification process: install advanced oxidation with high-dose UV light plus peroxide to oxidize any remaining organic contaminants and provide an additional disinfection barrier.
g. Construct de-carbonation and lime addition systems to modify the pH and add alkalinity to stabilize the highly purified RO effluent for corrosion control in the distribution system.
h. Modify the Santa Cruz wastewater outfall to properly diffuse the RO concentrate stream into the ocean.
i. Install a 4,300-gpm pumping system to move WWTP effluent to the CAT process train.
j. Build a 200-foot, 20-inch diameter pipeline to convey an average of 6.1 MGD of WWTP effluent to the CAT process train. Costs use 6.1 MGD, not 5.5 MGD, because of the ability to capture recycle streams within the WWTP.
k. Install a 3,200-gpm pumping system to move WWTP effluent to North Coast raw water main at the Bay Street Tank site.
l. Build a 1.1-mile, 20-inch diameter pipeline to convey an average of 4.7 MGD of CAT-purified water to the Bay Street Tank site for blending into the North Coast raw water main.
m. Relocate the existing line maintenance facility to make room for addition of the CAT process train. Includes purchase of property for new facilities on the west side of the City.

If an in-lieu component is linked to the DPR approach, additional capital costs would be incurred, as outlined in Building Block summary paper #1.

5. Annual Operation and Maintenance (O&M) Costs and Energy Requirements

Table 3.2 provides additional cost and energy use information, including annual O&M costs, annualized capital costs, total annualized and present value costs, and energy requirements for the DPR approach. Note that water quality testing would be performed at the CAT plant and there is a cost component for water quality testing contained in the O&M. There are a few direct reuse plants operating in the United States, including several implemented by small utilities in Texas, that are researching and documenting performance. In addition, CAT-based IPR projects are running in Orange County, San Jose, West Basin and elsewhere that are benchmarking reliable performance. Verifying performance, and using existing information, will be a central part of the regulations and guidance that are being developed in the state and will come out in 2016.

Table 3.2 DPR for Regional Demands	
Estimates	**DPR for City and Regional Use**
Annual O&M costs ($M/yr)	$4.7 M
Total Annualized Cost ($M/Yr)	$14.0 M
PV Costs (30 years) ($M)[1]	$317M
Power Consumption (MWh/MG)[2]	6.3

NOTES:
1. Discount rate = 2.5%; bond interest rate = 5.5%; interest on reserve = 3%, bond issuance cost = 3%.
2. Existing SCWD water production requires 1.6 MWH/MG.

If an in-lieu component is linked to the DPR approach, then additional O&M and other costs and energy requirements would be incurred, as outlined in Building Block #1.

6. Water Supply and Yield Implications

Table 3.3 provides the water supply production and yield estimates for the DPR option. The availability of this supply of 1,715 MGY (in combination with conservation Program C Rec) addresses all anticipated future demands (no shortfalls) for SCWD, and also offers an opportunity to provide in-lieu recharge for SVWD and SqCWD as well (at levels of more than half of their combined winter demands).

Table 3.3. DPR: Estimated yields, peak season shortages, and in-lieu demands met for SVWD and SqCWD (MG)

	Santa Cruz yields		**Remaining peak-season shortages (% shortfall)**		**Average annual combined SV and SqC demand served in-lieu of groundwater draw (% met)**	**Average annual separate SV and SqC demand served in-lieu of groundwater draw**
	Worst-year yield	**Average-year yield**	**Worst-year**	**Average-year**		
DPR	1,110	340	0 (0%)	0 (0%)	870 (57%)	250 to SV 620 to SqC

The total annual supply produced by the DPR approach is 1715 MG, and given the total annualized cost of $14.0 million, the average annualized cost per unit of production is approximately $8,160 per MG.

Note that the yield estimates shown in Table 3.3 for DPR reflect an assumption that Program C Rec is part of the Portfolio with DPR, such that some yield also is attributed to the water savings associated with conservation component.[4]

If an in-lieu component is linked to the DPR approach, additional water supply production and yields would be realized, as outlined in Building Block summary paper #1.

7. Timeline for Implementation and Realizing Water Supply Benefits

The timeline for the DPR approach could be 9 or 13 years, consisting of the following key elements:

- Permitting, right of way acquisition, and construction of CAT facilities and pipelines and pump stations to develop the purified recycled water and deliver it to GHWTP. (2-3 years). Similar requirements for in-lieu-related interties and any additional well development in SVWD and SqCWD could occur concurrently, if in-lieu is part of the DPR approach.

- Regulatory approval for DPR would likely occur prior to facility construction, but may occur concurrently with facility and pipeline right of way and permitting activities. State development of final DPR-specific regulations, and (or) approval of SCWD's DPR program (7-10 years but might be accelerated given current State-level priorities and initiatives to facilitate potable reuse).

8. Key Institutional Issues to Resolve

The City needs to resolve several critical institutional issues in order for a DPR program to proceed as envisioned here. Among these are the following:

- Regulatory approval from the State Water Resources Control Board, Division of Drinking Water (DDW), for DPR.

- Public and political acceptability of purified recycled water as a blended part of the City's potable source waters.

- Agreements with SVWD, and perhaps the County, regarding the volume of effluent delivered to SCWD's wastewater treatment plant (as opposed to being extracted by SVWD for recycling elsewhere). The 5.5 MGD flow referred to above does <u>not</u> include any raw sewage or effluent flow from the City of Scotts Valley.

- If an in-lieu component is linked to the DPR approach, then all the institutional issues associated with that approach (including the need for clear agreements between the City and SVWD and

[4] Please recall that "yields" refer to the ability of a portfolio to meet peak season gaps between supply and demand. Based on *Confluence* model runs reflecting climate change and DFG-5 fish flow requirements, the worst-year peak season shortage amounts to 1,110 MG, given the existing SCWD system portfolio. The average-year peak season shortage is 340 MG. Thus, the maximum yields of a portfolio are 1110 MG and 340 MG for worst and average years, respectively.

SqCWD on water-, risk- and cost-sharing) would need to be realized, as outlined in Building Block summary paper #1.

- If DPR were pursued, a public information campaign would be strongly recommended to educate the public on the safety and benefits of potable reuse similar to those being conducted in San Diego, San José, and elsewhere.

9. Other Key Questions, Issues, and Observations

- Given the ability of the DPR option (when coupled with Program C Rec) to meet all of SCWD's anticipated supply needs, there is no apparent need for return flows from a potential in-lieu recharge component. Excess DPR water might thus be sold to SVWD and SqCWD (if the cost was competitive with other supply options the Districts are considering), without any obligation or agreement for return draws on their groundwater.

- The potential use of purified recycled water provides a production supply that is largely independent of rainfall.