TO: BOARD OF DIRECTORS

FROM: BRUCE BUEL

DATE: OCTOBER 3, 2008

AGENDA ITEM
E-3
OCTOBER 8, 2008

SALTS MANAGEMENT

ITEM

Consider draft Salts Management Report and discuss options to minimize salt discharge into Town and Blacklake Sewer Systems [PROVIDE POLICY GUIDANCE].

BACKGROUND

Attached are two draft Boyle Reports entitled "Salts Minimization Plan for Southland" and "Salts Minimization Plan for Blacklake". As documented in the draft reports, the volume of salts discharged into NCSD's Town and Blacklake Sewer systems is resulting in high salts levels in the treated wastewater discharged from our two treatment facilities. Although the salt loading will decrease when NCSD switches to Santa Maria Water as our primary supply, we will still experience violations in regards to the levels of salts in the treated wastewater produced at Southland and Blacklake. As further detailed in the Report, the salts discharged from self-regenerative water softeners (SRWS) are a significant contributor to the salt loading and elimination of these self regenerative water softeners would assist in resolving this problem.

Given the veto of AB2270, it is very difficult to compel private property owners to convert from SRWS to canister style systems. Even if free installation can be arranged, the annual cost of a canister style system is usually higher than SRWS. A vital component of a voluntary replacement program will be an aggressive education outreach, however, it is likely that some form of rebate will be necessary to overcome the financial disadvantage to the customer. It should be noted that the capital cost to either remove the salts from the source supply or to treat the wastewater are extremely large compared to the cost of encouraging voluntary swap-out.

Mike Nunley from Boyle Engineering is scheduled to present the report at the meeting.

RECOMMENDATION

Staff recommends that the Board review the draft reports, ask questions of Boyle Engineering, and discuss options to replace self regenerative water softeners with canister style water softeners. Further, staff recommends that the Board authorize staff to develop a detailed salts management program for subsequent Board consideration including an ordinance banning the installation of new SRWS systems in new housing, an education program aimed at encouraging customers to swap-out, some type of financial incentive and arrangements with one or more canister style softener companies to swap-out SRWS systems with canister systems.

ATTACHMENTS

- Boyle Draft "Salts Minimization Plan for Southland"
- Boyle Draft "Salts Minimization Plan for Blacklake"

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Memorandum

Date:	October 1, 2008
To:	Bruce Buel
From:	Michael Nunley, PE
	Kirk Gonzalez
Subject:	DRAFT Salts Minimization Plan - Southland WWTF

Dear Bruce,

As requested, Boyle Engineering has developed a Salts Minimization Plan to analyze and provide recommendations for reduction of salts discharged from the District's Southland Wastewater Treatment Facility (WWTF). One of the District's goals in their 2007 Strategic Plan was to develop a salts management strategy. This Memorandum contains a characterization of salt in source water supply and wastewater, an estimation of salts contribution from water softeners, estimation of salt reduction as a result of using supplemental water from the City of Santa Maria, and prediction of salt reduction that could result from limiting or banning water softeners.

Characterization of Source Water Supply and Wastewater Quality

Salt concentrations in water and wastewater are typically measured as concentrations of total dissolved solids (TDS) as shown below, or are measured indirectly as conductivity. Higher conductivity is positively correlated with dissolved solids concentrations. Constituent ions of the dissolved salts are also measured, including the cations (positively charged ions) calcium (Ca^{2+}), magnesium (Mg^{2+}), Sodium (Na^{+}) potassium (K^{+}) and the anions (negatively charged ions) sulfate (SO_4^{2-}), carbonates (CO_3^{-}), phosphates (PO_4^{3-}), and chloride (Cl^{-}).

The discharge permit for the Southland WWTF limits allowable effluent concentrations of constituents, including dissolved salts. Pertinent effluent limits are summarized in Table 1.

Table 1. Southland WWTF Effluent Discharge Limits

Constituent	Southland WWTF Effluent Limit	Blacklake WWTF Effluent Limit	Groundwater concentration[1,2]		Basin Plan Objective
			Southland	Blacklake	
TDS (mg/L)	see note 2	Water supply + 250	260	373	710
Sodium (mg/L)	see note 2	Water supply + 70	36	48	90
Chloride (mg/L)	see note 2	Water supply + 65	36	57	95
Nitrate (mg/L)	see note 2	see note 2	11	2.7	5.7
Sulfate (mg/L)	see note 2	see note 2	--	--	22

1. Groundwater concentration in the vicinity of discharge, as reported in WWTP discharge permit.
2. The discharge permit requires that effluent not cause nitrate concentration in receiving groundwater to exceed 10 mg/L or cause a significant increase of constituent mineral concentrations in downgradient groundwater.
3. The Basin Plan objective is from the Central Coast Basin Plan. It is used to guide RWQCB staff in developing discharge limits that are appropriate for receiving water.

Existing Water Quality Data

Salt concentration data for NCSD's existing water source (a blend of waters from several different wells on the Nipomo Mesa) and the Southland WWTF are summarized below.

Wastewater in the Southland WWTF comes from customers served by two water suppliers (NCSD and Golden State Water Company [GSW]) and a small number of private wells. GSW serves the Galaxy Park and People's Self-Help Housing areas. The 2007 Water and Sewer Master Plan update estimates that these areas contribute 125,000 gallons per day (gpd), or approximately 20% of the total flow to the Southland WWTF. The salts content of the NCSD and GSW sources (individually and combined) are summarized below:

Table 2. NCSD Town Division Drinking Water Quality

Data Source	Consumer Confidence Report (CCR) 2007			Used in this Analysis
Data type	**average**	**min**	**max**	**average**
Specific Conductance (uS/cm)	862	316	1400	**862**
TDS (mg/l)	571	270	860	**571**
Sodium (mg/L)	63	41	125	**63**
Calcium (mg/L)	*			**73***
Magnesium (mg/L)	*			**31***
Chloride (mg/L)	65	42	128	**65**
Sulfate (mg/L)	186	7	342	**186**
Hardness (mg/L as $CaCO_3$)	311	46	516	**311**

*Average values were taken from Nipomo CCR average value, except calcium and magnesium which were estimated from Nipomo CCR hardness value using Ca:hardness and Mg:hardness ratio in GSW 2007 CCR.

Table 3. Golden State Water Company Drinking Water Quality

Data Source	Consumer Confidence Report (CCR) 2007			Used in this Analysis*
Data type	**average**	**min**	**max**	**average**
Specific Conductance (uS/cm)	676	300	930	**676**
TDS (mg/l)	451	200	670	**451**
Sodium (mg/L)	52	22	79	**52**
Calcium (mg/L)	50	18	78	**50**
Magnesium (mg/L)	22	7.8	30	**22**
Chloride (mg/L)	55	30	94	**55**
Sulfate (mg/L)	117	31	240	**117**
Hardness (mg/L as $CaCO_3$)	213	78	320	**213**

*Average values taken from CCR average value.

Table 4. Combined Source Water Quality

Water Source	NCSD	GSW	Mix
Fraction	**80%**	**20%**	**100%**
Specific Conductance (uS/cm)	862	676	825
TDS (mg/l)	571	451	547
Sodium (mg/L)	63	52	61
Calcium (mg/L)	73	50	68
Magnesium (mg/L)	31	22	30
Chloride (mg/L)	65	55	63
Sulfate (mg/L)	186	117	172
Hardness (mg/ L as CaCO3)	311	213	291

Mass balance for salts loading to the treatment plant

Wastewater customers contribute dissolved solids to the collection system through a number of mechanisms, including the use of self-regenerative water softeners (See Figure 1 for an illustration.). Their total contribution, in terms of daily mass loading, is estimated below.

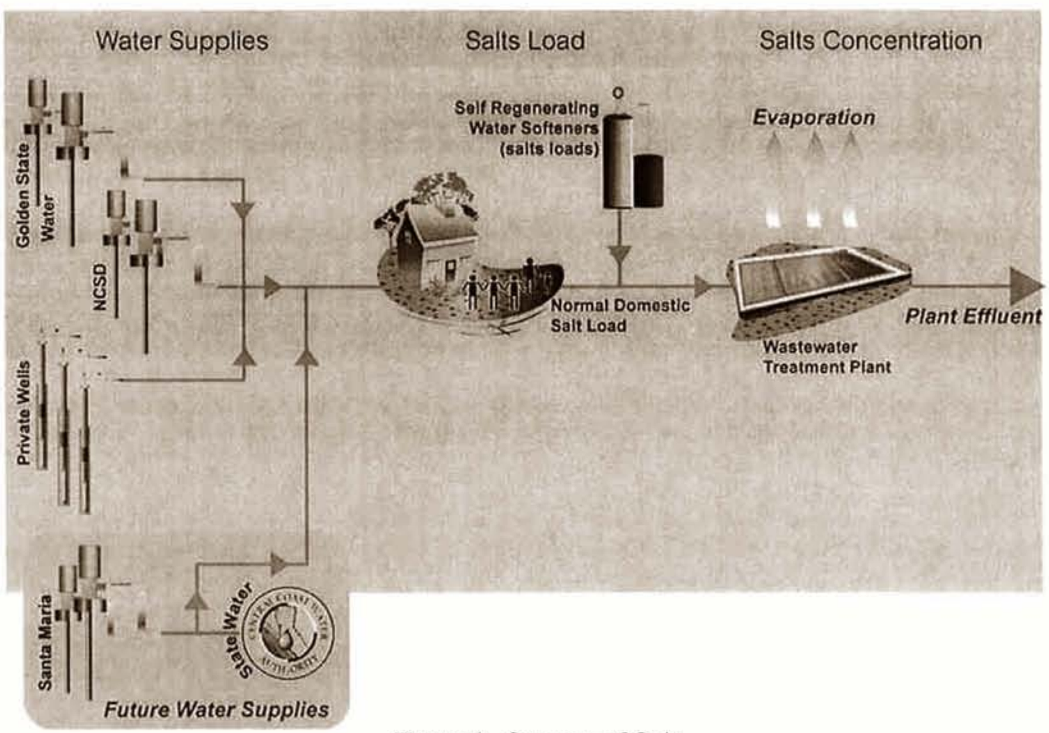

Figure 1. Sources of Salt

Table 4. Estimated Salts Contribution from Southland WWTF Users

Constituent	Water Supply (mg/L)	WWTF Influent [a] (estimated) (mg/L)	Contributed by Users	
			Concentration (mg/L)	Mass Load (lb/day)
TDS	547	1035 [b]	+488[b]	2,562
Sodium	61	188	+127	656
Calcium	68	86	+18	62
Magnesium	30	37	+7	22
Chloride	63	223	+160	819
Sulfate	172	261	+89	366
Hardness (as $CaCO_3$)	291	365	+74	246

a.The approach for estimating these concentrations is described later in this Memorandum.

b. July and August 2008 sampling resulted in average influent TDS concentration of 887 mg/L, or 341 mg/L contribution from users. A higher concentration was used in this report to reflect a higher, long-term average that more closely matches historical effluent monitoring data.

Examination of this table shows relatively minor increases in calcium and magnesium concentrations with significant increases in sodium and chloride. These differences may be indicative of self regenerating water softener use in the collection area.

Estimation of Contribution from Water Softeners

Water Hardness and Softeners

Hard water has a high mineral content, typically consisting of calcium and magnesium cations, and sometimes other dissolved compounds such as bicarbonates and sulfates. Measurements of "water hardness" account for the total concentrations of calcium and magnesium (the two most prevalent, divalent metal ions) and are read as mg/L (or parts per million - ppm) of calcium carbonate ($CaCO_3$). Hardness is also measured as "grains/gallon" (1 gr/gal = 17.1 mg/L as $CaCO_3$).

Water softeners work by passing hard water through a bed of beads which are made from an exchange media. The surface of the exchange media is saturated with positively charged sodium ions (Na^+). During the softening process positively charged calcium (Ca^{2+}) and magnesium (Mg^{2+}) ions in the hard water exchange places with the sodium ions on the exchange media. Virtually all the calcium and magnesium is removed from the water and replaced with sodium.

The softening process continues until the exchange media is exhausted, at which time a strong solution of sodium chloride ("salt") is applied. The highly concentrated solution reverses the earlier process, driving calcium and magnesium off the media and into the brine (or salt solution), which is disposed.

Canister type water softeners are collected from the user's location and regenerated at a central facility resulting in no brine discharge at the point of use. Self regenerating water softeners (SRWS) are regenerated at point-of-use resulting in a brine discharge.

Contribution of Softeners to TDS in Municipal Wastewater

When a self regenerating water softener (SRWS) is used, the net result to the wastewater system is an increase in sodium and chloride ions. Typical "salt efficiency" for these appliances is approximately 2,500 grains of hardness removed per pound of salt used (Phillips, 2008). The salts contribution of a typical SRWS in Nipomo to the Southland WWTF is estimated below.

Table 5. Estimated Salts Contribution from a Typical Self Regenerating Water Softener in Nipomo

Flow (3.5 people @ 75 gpcd)	262 gallons per day
Hardness of Untreated Water	291 mg/L as $CaCO_3$
Hardness of Untreated Water (1 gr/gal = 17.1 mg/L)	17.0 grains/gallon
Hardness removed	4472 grains per day
Hardness removed (1 pound = 7000 grains)	0.639 lb/day
Softener efficiency (grains of hardness per pound of salt)	2500 gr/lb
Salt Added	**1.79 lb/day**
Sodium (Na^+) Added	0.70 lb/day
Chloride (Cl^-) Added	1.09 lb/day

When a canister water softener is used, the net result to the wastewater system is a small increase in sodium ions, the magnitude of which is dependent on the hardness of the applied water, and a decrease in calcium and magnesium. 7.866 mg/L of sodium is added to the water for every grain per gallon of hardness in the untreated water. The salts contribution of a typical canister water softener in Nipomo to the Southland WWTF is estimated below.

Table 6. Estimated Salts Contribution from a Typical Canister Type Water Softener in Nipomo

Flow (3.5 people @ 75 gpcd)	262 gallons per day
Hardness of Untreated Water	291 mg/L as $CaCO_3$
Hardness of Untreated Water (1 gr/gal = 17.1 mg/L)	17.0 grains/gallon
Sodium Concentration Added (7.866 mg/l per grain/gal)	134 mg/L
Sodium Added	0.293 lb/day
Calcium Concentration Removed	68 mg/L
Calcium Removed	0.149 lb/day
Magnesium Concentration Removed	30 mg/L
Magnesium Removed	0.065 lb/day
Net Solids Load	**+ 0.079 lb/day**

Anticipated TDS Increase Without Softeners

Some data is available from other agencies for predicting the typical range of TDS contributed to municipal wastewater without onsite-regenerating softeners.

Besides water softening, other uses of water (such as laundry, sanitary uses, showers, and kitchen sinks) add dissolved solids to municipal wastewater. This increase has been estimated to be between 150 mg/L and 380 mg/L on a nationwide basis (Metcalf & Eddy, 3rd ed.), and between 150 mg/L and 250 mg/L in the Chino Basin of California (Wildermuth Environmental, 1999.)

The City of Lompoc is one of the few agencies on the Central Coast with low occurrence of water softeners. Supply water in Lompoc is softened before distribution to the community, eliminating a need for customers to operate individual softeners. By assuming that none of Lompoc's water customers use water softeners, contribution of dissolved solids from typical municipal users can be estimated.

On average, Lompoc's delivered water contains 815 mg/L TDS (City of Lompoc 2007 CCR). Effluent from the Lompoc Regional Wastewater Treatment Plant contains 1,119 mg/L TDS. If all influent to the WWTP originated from the softened Lompoc supply, a TDS increase of 304 mg/L could be attributed to normal municipal uses. However, 28% of Lompoc's WWTP influent originates from other sources including Vandenberg AFB, and Vandenberg Village CSD.

Since it is likely that some users from these communities use individual water softeners, municipal contributions of < 304 mg/ L should be assumed. According to a report on high chloride concentrations in Santa Clarita Valley wastewater, prepared by the Los Angeles County Sanitation District, chloride concentration typically increases between 30 and 50 mg/ L as water is used and discharged to the wastewater system. In the Fillmore area, the study indicated that chloride concentration increases by 31 mg/ L for "normal" water use.

For this analysis, a typical contribution of 250 mg/L for TDS was assumed.

Contribution of Self Regenerating Water Softeners to TDS in Southland

The table below indicates the mass fraction of sodium and chlorine to sodium chloride, in order to indicate whether the source water, effluent, and user contributions (Effluent – source water) resemble the mass fraction of sodium chloride. As shown, the ratio is fairly close and indicates sodium chloride could be the primary form of both sodium and chloride.

Table 7. Sodium Chloride Proportions

	Sodium Chloride		Supply Water		WWTP Effluent		Use contribution	
	mg/ mole	Proportion	mg/ L	Proportion	mg/ L	Proportion	mg/ L	Proportion
Na (mg/ L)	23	40%	61	49%	194	46%	133	44%
Cl (mg/L)	35	60%	63	51%	230	54%	167	56%

A local water softening company representative has estimated that on the order of "several hundred" canister type water softeners, and approximately "twice as many" self regenerating water softeners (SRWS), may be operating in the area where collected wastewater discharges to Southland WWTF (Phillips, 2008.) The following mass-balance estimation verifies that this "ballpark" estimate agrees with observed water supply and effluent values, and with estimates of typical increases of TDS from municipal use.

Using the values discussed above, we estimate 680 SRWS and 340 canister-type water softeners are in operation in the area where collected wastewater discharges to Southland WWTF. This estimated number of SRWS was estimated to result in an estimated TDS load from NCSD users to equal 250 mg/L.

Table 8. Estimated Solids Loading from Water Softeners and Other Sources

	Water Supply (measured)		Load from 680 SRWS units (assumed)	Load from 340 canister water softeners (assumed)	Load from Other Uses (calculated here)		Load to WWTP (measured)	
units	**mg/L**	**lb/day**	**lb/day**	**lb/day**	**lb/day**	**mg/L**	**lb/day**	**mg/L**
TDS	547	2,856	1,216	27	1,303	249	5,402	1,035
Sodium	61	317	478	100	86	16	981	188
Calcium	68	356	-	-51	144	28	449	86
Magnesium	30	154	-	-22	59	11	191	37
Chloride	63	329	738	0	95	18	1,163	223

This analysis suggests that the SRWS could contribute up to 1,200 pounds of dissolved solids per day, or 23% of the total salts load to the Southland WWTF.

Timing of Regeneration and Brine Discharge

Two methods are common for scheduling regeneration of water softeners, and therefore discharge of high-TDS brine solution. Simple models use an estimated daily flow rate to schedule how many days between regeneration cycles. More efficient models tabulate the volume of water processed and regenerate only when media exhaustion is predicted within 48 hours. Regardless of the scheduling method, virtually all self-regenerating water softeners regenerate at 2AM (Phillips, 2008) if installed by local vendors. However, those settings could vary widely.

Costs of Operation, Installation and Retrofit

The cost of installation and operation of the two types of water softener discussed above are compared below. The estimated installation costs for the canister system ($45 to $65) are also the estimated costs for retrofitting a self regenerating model to a canister system.

Table 9. Estimated Costs of Water Softeners in Typical Installation

Water Softener Type	Self Regenerating		Canister	
Cost Estimate Type (high/low)	Low	High	Low	High
Equipment Purchase	$479	$1,000		
Installation	$300	$500	$45	$65
Total Capital Cost	$779	$1,500	$45	$65
Monthly Capital Cost (amortized 10 years @ 6%)	$9	$17	$0.50	$0.72
Salt Use (lb/day)	1.79	1.79		
Salt Use (lb/month)	54.4	54.4		
Monthly Salt Cost (@$8 per 40lb bag delivered)	$11	$11		
Monthly Service Cost			$35	$38
Total Monthly Cost	$20	$28	$36	$39
Total Annual Cost	$234	$330	$426	$464

Wastewater Process and Quality

The Southland WWTF consists of an influent flowmeter, comminutors, influent pump station, four (4) facultative ponds with surface aerators, and six (6) onsite percolation ponds for effluent disposal. Plant influent is sampled from the influent lift station and effluent is sampled downstream of the last two (2) facultative ponds but prior to discharge into the percolation ponds.

A number of water quality samples have been collected from the Southland WWTF effluent and analyzed for dissolved solids. Semi-annual sampling for TDS, sodium, and chlorides from 2004 to 2007 is summarized below, along with a more complete set of analyses run once in October 2004, twice in October 2007 and additional analyses conducted in July and August, 2008 as part of this study.

Table 10. Southland Effluent Water Quality

Constituent	Number of Observations	Average (used in this Analysis)	Min	Max
Specific Conductance (µS/cm)	2	**1900**	1900	1900
TDS (mg/l)	19	**1069**	940	1180
Sodium (mg/L)	19	**194**	183	210
Calcium (mg/L)	7	**89**	77	99
Magnesium (mg/L)	7	**38**	33	43
Chloride (mg/L)	18	**230**	199	264
Sulfate (mg/L)	7	**270**	250	330
Hardness (mg/L as $CaCO_3$)		**377***	328*	424*

*Effluent hardness calculated from calcium and magnesium results.

Treatment pond processes can contribute salts to effluent. Evaporation will not increase the mass of salt loading, but will increase salt concentration by removing water from the ponds. Various in-pond chemical reactions and biological processes will affect concentrations of dissolved solids, as well. We used two approaches to estimate the increase in salt loading and concentration across the treatment process:

1) Evaporation estimates using available irrigation records; and

2) Sampling of influent and effluent dissolved solids concentrations.

Because the Southland WWTF uses a pond treatment system, evaporation contributes to the increase in the concentration of dissolved solids in the effluent. During typical operations, 5.2 acres of water surface are exposed in the aeration basins. The average annual evaporation from a pond in Nipomo is approximately 68 inches (CIMIS, 2008), and the average annual precipitation is approximately 16 inches (SLO Co., 2006), giving a net evaporation of 52 inches. Average net evaporation from the aeration basins would total 20,000 gallons per day. Assuming no other wastewater treatment processes are significant to the increase in dissolved solids other than evaporation, dissolved solids concentrations in the Southland WWTF influent would be estimated as follows:

Table 11. Southland Effluent Water Quality, Mass Load, and Estimated Influent Water Quality

	Effluent		**Influent**
Flow Rate (MGD)	**0.597**		**0.626**
	Concentration (mg/L)	**Mass Load (lb/day)**	**Estimated Concentration (mg/L)**
TDS	1069	5,325	1035
Sodium	194	967	188
Calcium	89	442	86
Magnesium	38	188	37
Chloride	230	1,146	223
Sulfate	270	1,344	261
Hardness (mg/L as $CaCO_3$)	377	1,879	**365**

This table shows that evaporation within the Southland WWTF is estimated to increase solids concentrations by 3%.

Sampling and analysis of treatment plant influent and effluent (July through August, 2008) allow estimation of increase in TDS, sulfate, and nitrate from biological treatment at the plant and evaporation from treatment ponds. Results are summarized in Table 12.

Table 12. Increase in TDS, Sulfate, and Nitrate at WWTF for July through August 2008

	Average Concentrations		**Increase (mg/ L)**	**Percent Increase**
	Influent (mg/ L)	**Effluent (mg/ L)**		
TDS	888	1010	123	14%
Sulfate	248	283	35	14%
Nitrate	<0.4	66	>65.6	Not calculated

Salts Minimization Approaches

Management of salts in wastewater effluent can be accomplished several ways:

1) Direct treatment of plant effluent – Effluent from Southland Wastewater Treatment Facility could be treated by chemical softening, nanofiltration or reverse osmosis to directly reduce salts from plant effluent. The planned treatment plant process (Biolac) would be succeeded by coagulation, filtration, and either chemical softening through lime and/or alum addition, nanofiltration (often coupled with chemical softening), or reverse osmosis. Each of these processes results in a solid waste product (such as lime or alum sludge or nanofiltration waste) or brine in the case of reverse osmosis. Treatment plant effluent would be considered more difficult to treat than groundwater since there would be trace amounts of organics and solids. Cost has not been estimated for this process since it is not considered to be a feasible or cost effective approach to manage salts.

2) Direct treatment of groundwater - Less pretreatment would be required for salt removal from groundwater than from treatment plant effluent. In November 2007, Boyle completed a Technical Memorandum concerning costs for salt removal from District groundwater supplies (see Appendix). Several District wells could be routed to a central treatment facility. An option commonly used for removing TDS from groundwater is reverse osmosis (RO). However, a concentrated brine will be generated that will require disposal. It is assumed the treatment process would include a first RO stage, then a second RO stage followed by mechanical vapor compression and crystallization to recycle the brine and produce dry salt for offsite disposal

   The cost for combining these wells is not considered in this memorandum, but is likely to be a significant increase over treatment costs. A "salt removal cost", based on the assumptions stated above, would be approximately $7.7 M in capital cost and $700,000 per year in operations and maintenance costs in order to reduce TDS by 60 mg/L. This does not include costs to build pipelines to connect District wells to a central treatment facility. Those costs are expected to be substantial.

3) Import water supply with lower salts concentrations – The District is planning to import water from the City of Santa Maria, which currently delivers a "municipal mix" of water to its customers that is over 98% State Water and the remainder is Santa Maria Valley groundwater. State Water has considerably lower salts concentrations than local groundwater supplies, resulting in lower concentrations to the WWTF and from WWTF effluent.

4) Limit onsite-regenerating water softeners – Reducing the number of onsite-regenerating water softeners would eliminate the brine stream from entering the WWTF and elevating salts concentrations in WWTF effluent.

Importing water supply with lower salts concentrations and limiting onsite-regenerating water softeners would be effective salts reduction strategies and would result in the lowest implementation cost for the District. Importing water is already part of the District's water supply strategy and limiting water softeners could result in some increased cost for individuals (if offsite regenerating canister-type units are used instead) but is not likely to require significantly increased user charges or fees from the community as a whole.

Approach 1: Supplemental Water from the City of Santa Maria

Reported Water Quality from City of Santa Maria

The City of Santa Maria delivers water to its customers from two sources: a local well field and the CCWA pipeline. The water quality of these two sources is summarized below:

Table 13. City of Santa Maria Source Water Quality

Water Source	Well Fields (2007 CCR)			CCWA Pipeline at Polonio Pass (2007 CCR)		
Data type	**average**	**min**	**max**	**average**	**min**	**max**
TDS (mg/l)	874	650	1300	239	131	358
Sodium (mg/L)	60	44	96	53	53	53
Calcium (mg/L)	131*			50	28	74
Magnesium (mg/L)	57*			12	12	12
Chloride (mg/L)	49	23	89	65	21	125
Sulfate (mg/L)	364	240	560	58	58	58
Hardness (mg/L as $CaCO_3$)	562			101	72	130

*Calcium and magnesium values were estimated from CSM well field average hardness value using the Ca:hardness and Mg:hardness ratios from GSW well data.

According to the City's 2005 Urban Water Master Plan, the City will deliver a mixture of groundwater and CCWA pipeline water to its customers according to the following schedule:

Table 14. City of Santa Maria Predicted Groundwater Mix

Year	Percent of CSM Deliveries from Groundwater (2005 UWMP)
2005	1%
2010	4%
2015	7%
2020	9%
2025	11%
2030	14%

Assumed Delivery Schedule from City of Santa Maria

For the purposes of this analysis, we assume that the Waterline Intertie project (WIP) will become operational in the year 2010, and that system constraints will limit deliveries to 1,860 gallons per minute. The total water demand for the District was 3,009 acre-feet during 2007. Assuming this demand grows at 2.3% per year, and assuming the monthly variation in demand pattern remains constant, the amount of water delivered annually through the WIP has been estimated (Boyle, 2008) as shown below:

Table 15. Projected District Demands and Waterline Intertie Project Deliveries

Year	Demand (AFY) @ 2.3% Growth	Estimated Delivery (AFY)	Percent from WIP
2010	3221	2605	81%
2011	3296	2626	80%
2012	3371	2647	79%
2013	3449	2669	77%
2014	3528	2691	76%
2015	3609	2714	75%
2016	3692	2737	74%
2017	3777	2761	73%
2018	3864	2785	72%
2019	3953	2810	71%
2020	4044	2836	70%
2021	4137	2862	69%
2022	4232	2888	68%
2023	4329	2916	67%
2024	4429	2944	66%
2025	4531	2972	66%
2026	4635	3001	65%
2027	4742	3002	63%
2028	4851	3002	62%

Year	Demand (AFY) @ 2.3% Growth	Estimated Delivery (AFY)	Percent from WIP
2029	4962	3002	60%
2030	5076	3002	59%

Estimated Mixture in Combined Sources

Assuming the Golden State Water (GSW) contribution to Southland wastewater flows grows at the same rate as contribution from other portions of the Southland service area, and assuming the Waterline Intertie Project (WIP) is implemented as described above, then the source water reaching Southland WWTF will come from a mixture of sources as listed and illustrated below.

In the near future, the District is planning to operate Blacklake #4, Sundale, Eureka, and Via Concha with water from Santa Maria. The District will add other wells as they are upgraded from chlorination to chloramination in order to meet increasing system demands. Therefore, predicting the "long-term" TDS contributed by Nipomo's wells is challenging since the operation plan will change in the future. It is assumed the "long term" average salt concentration in District wells will closely resemble existing water quality.

Table 16. Projected Mixture of Sources Flowing to Southland WWTF

Year	NCSD Wells	GSW Wells	CSM Wells	CCWA Pipeline	Total
2005	80%	20%	0%	0%	100%
2010	15%	20%	3%	62%	100%
2015	20%	20%	4%	56%	100%
2020	24%	20%	5%	51%	100%
2025	28%	20%	6%	47%	100%
2030	33%	20%	7%	41%	100%

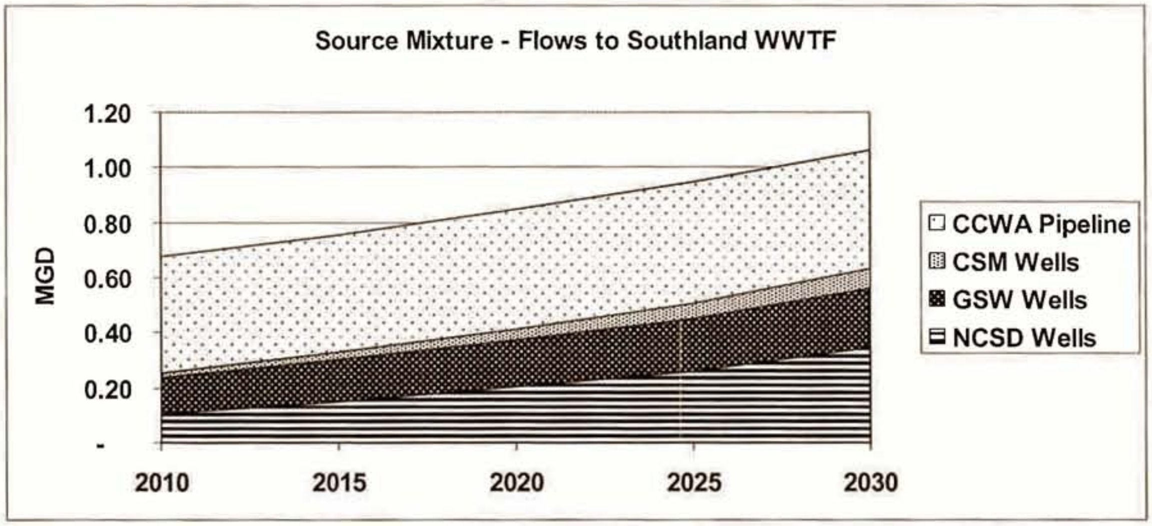

Figure 2. Projected Mixture of Water Sources to Southland Wastewater

Estimated Water Quality in Combined Sources

Assuming the average water quality of the various sources noted above remains constant, the water quality of the combined sources to users that discharge to the Southland WWTF will be as shown below.

Table 17. Projected Source Water Quality of Existing+WIP Mixture for Users that Discharge to Southland WWTF

Source Mixture Water Quality	2007 (existing)	2010	2015	2020	2025	2030
TDS (mg/l)	574	349	374	393	410	432
Sodium (mg/L)	61	55	55	56	56	57
Calcium (mg/L)	68	56	58	59	61	63
Magnesium (mg/L)	30	18	19	21	22	23
Chloride (mg/L)	63	63	62	62	62	62
Sulfate (mg/L)	172	97	108	116	123	132
Hardness (mg/L as $CaCO_3$)	291	167	184	197	208	223

Assuming no changes in use patterns (i.e., the same fraction of water customers will use SWRS), these changes in source water quality are estimated to result in improved water quality for Southland WWTF at the influent as shown below.

Table 18. Projected Water Quality in Southland WWTF Influent with Existing+WIP Mixture

Influent Water Quality	2007 (existing)	2010	2015	2020	2025	2030
TDS (mg/l)	1035	836	862	881	897	920
Sodium (mg/L)	188	182	182	183	183	184
Calcium (mg/L)	86	73	76	77	79	81
Magnesium (mg/L)	37	25	27	28	29	30
Chloride (mg/L)	223	222	222	222	222	222

Assuming a 5% increase in these solids concentrations due to evaporation in the plant (as was projected above in Table 5), these changes in influent water quality are estimated to result in improved water quality for Southland WWTF effluent, as shown below.

Table 19. Projected Water Quality in Southland WWTF Effluent with Existing+WIP Mixture

Effluent Water Quality	2007 (existing)	2010	2015	2020	2025	2030
TDS (mg/l)	1069	865	891	910	927	951
Sodium (mg/L)	194	188	188	189	189	190
Calcium (mg/L)	89	76	78	80	81	83
Magnesium (mg/L)	38	26	28	29	30	31
Chloride (mg/L)	230	230	230	229	229	229

Approach 2: Control Self-Regenerating Water Softeners

The following estimates of water quality are based on the assumption that 680 self regenerating water softeners now exist and contribute dissolved solids to Southland WWTF, that all of these SRWS are replaced with canister type water softeners, and that the average water quality of the various sources noted above remains constant. The mass load impact of SRWS control is shown below.

Table 20. Projected Mass Load Impact of Changing 680 SRWS to Canister Systems

	Removing 680 SRWS	Adding 680 canister systems	Net Mass Load Impact
TDS (lb/day)	-1,216	54	-1,162
Sodium (lb/day)	-478	200	-279
Calcium (lb/day)	0	-101	-101
Magnesium (lb/day)	0	-44	-44
Chloride (lb/day)	-738	0	-738

These mass load impacts of SRWS control are estimated to produce changes in the quality of the source water which ultimately used and discharged to Southland WWTF as shown below.

Table 20. Projected Source Water Quality Impact of SRWS Control

Year	**2010**	**2015**	**2020**	**2025**	**2030**
1Water Use (MGD)	**0.67**	**0.76**	**0.85**	**0.95**	**1.06**
Projected Change in Source Water Quality					
TDS (mg/L)	-207	-184	-165	-147	-131
Sodium (mg/L)	-50	-44	-39	-35	-31
Calcium (mg/L)	-18	-16	-14	-13	-11
Magnesium (mg/L)	-8	-7	-6	-6	-5
Chloride (mg/L)	-131	-117	-105	-93	-83

Combined Approach: Estimation of TDS Reduction by Controlling Self-Regenerative Water Softeners and using Supplemental Water from City of Santa Maria

The combined program of changing source water and controlling water softeners are estimated to result in improved water quality for Southland WWTF influent as shown below.

Table 22. Projected Water Quality in Southland WWTF Influent with Existing + WIP Mixture + SRWS Control

Projected Influent Water Quality	2007 (existing)	2010	2015	2020	2025	2030
TDS (mg/l)	1035	630	677	716	750	789
Sodium (mg/L)	188	132	138	143	148	152
Calcium (mg/L)	86	55	60	63	66	69
Magnesium (mg/L)	37	17	20	22	23	25
Chloride (mg/L)	223	91	105	117	129	138

Assuming a 3% increase in these solids concentrations due to evaporation in the plant (as was projected above in Table 21), these changes in influent water quality are estimated to result in improved water quality for Southland WWTF effluent, as shown below.

Table 23. Projected Water Quality in Southland WWTF Effluent with Existing + WIP Mixture + SRWS Control

Projected Effluent Water Quality	2007 (existi ng)	201 0	201 5	202 0	202 5	203 0	Basin Plan Objecti ve
TDS (mg/l)	1069	651	700	740	775	815	710
Sodium (mg/L)	194	137	143	148	153	157	90
Calcium (mg/L)	89	57	62	65	68	71	na
Magnesium (mg/L)	38	18	20	22	24	26	na
Chloride (mg/L)	230	94	108	121	133	143	95

The projected solids concentrations (TDS) in Southland WWTF effluent with the City of Santa Maria Waterline Intertie Project (WIP) and with and without control of self regenerating water softeners (SRWS) are graphically compared below. Also shown is the median groundwater water quality objective for TDS published in the Central Coast Regional Water Quality Control Board Basin Plan for the Lower Nipomo Mesa. Published median groundwater water quality objectives are intended to serve as a baseline for evaluating water quality management, and for establishing limits for discharge permits (RWQCB, 2001).

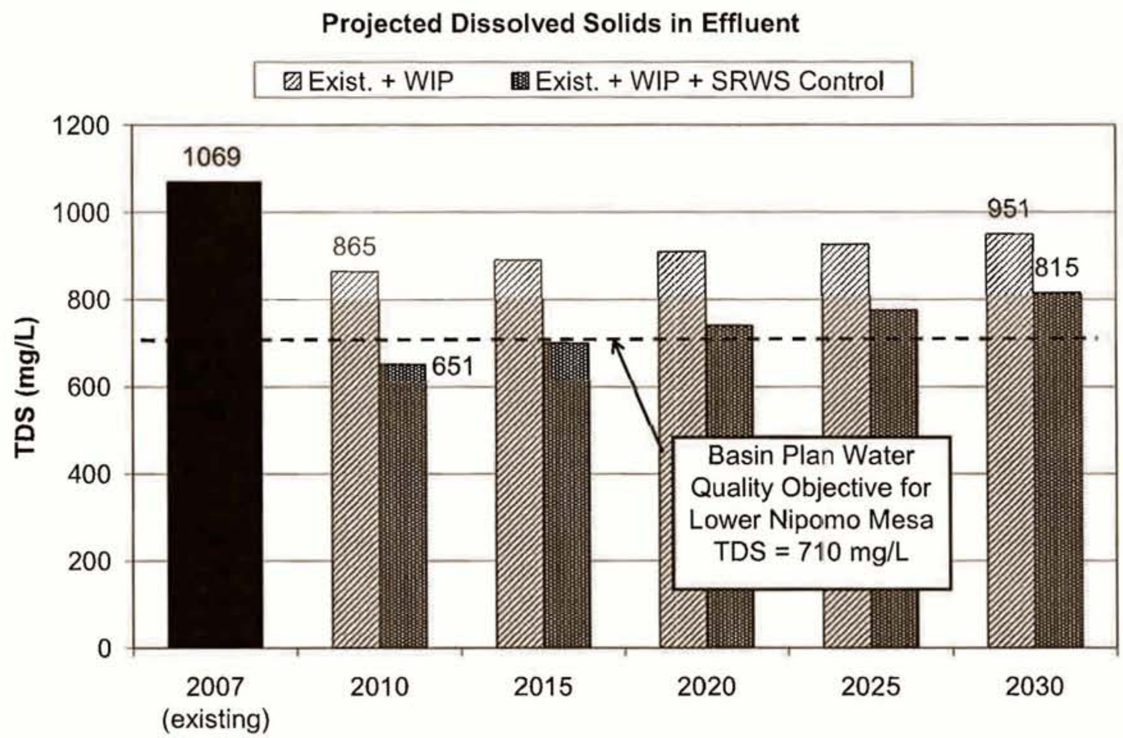

Figure 3 Projected Effluent Water Quality

Conclusions

- Our preliminary calculations, based on limited water quality data and anecdotal estimates of the number of appliances in operation, show that there may be approximately 600-700 self regenerating water softeners (SRWS) operating in the area where wastewater discharges to the Southland WWTF.
- Our estimates indicate that these SWRS may contribute up to one-quarter of the salts load in the Southland WWTF effluent.
- Use of supplemental water from the City of Santa Maria will decrease TDS concentrations in Southland WWTF effluent. This effect will be reduced in the future as the City blends more of its groundwater sources with CCWA pipeline water.
- Our calculations show that use of supplemental water from the City of Santa Maria and eliminating 600-700 SRWS in the area where wastewater discharges to Southland WWTF could decrease TDS concentrations in Southland WWTF effluent to levels near or below the Regional Board Basin Plan objective for TDS. As noted above, this effect will diminish in the future as the proportion of imported water to local groundwater decreases.
- If community members replaced their self-regenerating softeners with canister systems, expected annual costs would increase from a range of $230-$330 to $420-$410. However, this would require almost no capital investment or fees from the District for a 20%-30% reduction in salts from WWTF effluent.

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Attachments: Appendix
Boyle Engineering Corporation, November, 2007. "Salt Removal Allowance."

MEMORANDUM

TO: Bruce Buel, Peter Sevcik, PE   November 9, 2007

FROM: Mike Nunley, PE

SUBJECT: Salt Removal Allowance

Salt management has become a significant concern for wastewater treatment agencies around California. Nipomo Community Services District directed Boyle to provide a planning-level opinion of cost to remove salt from the District's groundwater supply, in an attempt to determine the "value" of discontinuing use of onsite-regenerating water softeners within the District service area. In order to perform this analysis, we relied on the following information :

1) 2007 Water Production for Town System = 3008 acre-feet per year (AFY)

2) Maximum Day Demand (MDD) for 2007 = 4.6 million gallons per day (MGD)

3) The Town System water supply had an average total dissolved solids (TDS) concentration of 666 mg/L according to the 2006 Consumer Confidence Report (CCR).

4) According to data from the District's 2005 Salt Study and Self-Monitoring Reports at the Blacklake Wastewater Treatment Facility (WWTF), increase in total dissolved solids (TDS) between well water and WWTF plant influent was approximately 261 mg/L. This increase was assumed for the Town System as well.

5) 200 mg/L is a typical increase in TDS for water systems without onsite-regenerating water softeners. Therefore, it is assumed the source water TDS should be reduced by approximately 60 mg/L to account for contribution of brine from these softeners.

Treatment Approach

Salts could either be removed at the Southland WWTF or at District wells. Less pretreatment would be required for salt removal from groundwater than from treatment plant effluent. Therefore, it is assumed TDS would be removed from District groundwater. Several District wells could be routed to a central treatment facility. The cost for combining these wells is not considered in this memorandum, but is likely to be a significant increase over treatment costs.

An option commonly used for removing TDS from groundwater is reverse osmosis (RO). However, a concentrated brine will be generated that will require disposal. Recovery of 75% is expected from the treatment system. Assuming the RO system will reduce TDS from 666 to 100 mg/L in the groundwater supply, a ratio of 1:8 (permeate to groundwater) would produce a TDS of 600 mg/L. Therefore, during a maximum day, approximately 0.5 MGD of permeate and 4.1 MGD of raw groundwater would be required. Assuming 75% recovery, the RO system would be sized for approximately 0.67 MGD. The system would would require 500 AFY of raw water to yield 375 AFY of permeate to meet water quality goals.

Not including brine disposal costs, the cost for this facility (at $3/gpd for groundwater RO) would be approximately $2M with an additional 40% for contingency and engineering costs, or $2.8M planning-level project cost. Operation and maintenance costs for a groundwater RO system would be approximately $400/AF ($270,000 per year) based on similar systems.

Brine Disposal

Brine disposal will be a challenge, since the TDS concentration will be over 2000 mg/L and the Basin Plan objective for the Nipomo groundwater basin is 710 mg/L. Assuming a second RO stage followed by mechanical vapor compression and crystallization are used to recycle the brine and produce dry salt for offsite disposal, the cost for these stages would be approximately 1.5 times the RO cost listed above ($4.2M) including construction, contingencies, and engineering, and another $600/AF of total plant inflow ($430,000 per year) for operation and maintenance.[1] Nearly all water entering the RO facility would be available for use to customers, if this alternative is pursued, and no discharge of brine would be required. Conceptually, this disposal option would provide the same benefits as eliminating onsite-regenerating water softeners. Other options for brine disposal may be pursued, such as deep injection or ocean discharge.

Summary

Therefore, a "salt removal cost", based on the assumptions stated above, would be approximately $7.5M in capital cost and $700,000 per year in operations and maintenance costs in order to reduce TDS by 60 mg/L, as opposed to eliminating onsite-regenerating water softeners. This does not include costs to build pipelines to connect District wells to a central treatment facility. Those costs are expected to be substantial.

This study is not intended to be a detailed treatment evaluation. Other treatment approaches should be explored if source water treatment is desired, but this analysis is considered adequate for a "planning-level" opinion of the "value" of eliminating these types of softeners.

REGISTERED PROFESSIONAL ENGINEER
MICHAEL K. NUNLEY
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[1] Cost Estimates Derived in Water Source Evaluation, City of El Paso de Robles (September, 2006) by Boyle

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Memorandum

Date:	October 2, 2008
To:	Bruce Buel
From:	Michael Nunley, PE Kirk Gonzalez
Subject:	Salts Minimization Plan – Blacklake WWTF
Distribution:	Peter Sevcik, PE

Dear Bruce,

As requested, Boyle Engineering has developed a Salts Minimization Plan to analyze and provide recommendations for reduction of salts discharged to the Blacklake Wastewater Treatment Facility (WWTF). One of the District's goals in their 2007 Strategic Plan was to develop a salts management strategy. This memorandum contains a characterization of salts in source water supply and wastewater, an estimation of salt loads from water softeners, an estimation of salts reduction using supplemental water from the City of Santa Maria, and salts reduction that could result from controlling self-regenerating water softeners (SRWS).

Characterization of Source Water Supply and Wastewater Quality

Salts concentrations in water and wastewater are typically measured as concentrations of total dissolved solids (TDS) as shown below, or are measured indirectly as conductivity. Higher conductivity is positively correlated with dissolved solids concentrations. Constituent ions of the dissolved salts are also measured, including the cations (positively charged ions) calcium (Ca^{2+}), magnesium (Mg^{2+}), Sodium (Na^{+}) potassium (K^{+}) and the anions (negatively charged ions) sulfate (SO_4^{2-}), carbonates (CO_3^{-}), phosphates (PO_4^{3-}), and chloride (Cl^{-}).

The discharge permit for the Blacklake WWTF limits allowable effluent concentrations of constituents. Pertinent effluent limits are summarized in Table 1.

Table 1. Blacklake WWTF Effluent Discharge Limits

Constituent	Blacklake WWTF Effluent Limit	Groundwater concentration[1,2]	Basin Plan Objective
TDS (mg/L)	Water supply + 250	373	710
Sodium (mg/L)	Water supply + 70	48	90
Chloride (mg/L)	Water supply + 65	57	95
Nitrate (mg/L)	see note 2	2.7	5.7
Sulfate (mg/L)	see note 2	--	22

1. Groundwater concentration in the vicinity of discharge, as reported in WWTF discharge permit.
2. The discharge permit requires that effluent not cause nitrate concentration in receiving groundwater to exceed 10 mg/L or cause a significant increase of constituent mineral concentrations in down-gradient groundwater.

Source Water Quality

Blacklake water customers, historically served by only the Blacklake wells, have recently been connected to the NCSD Town Division distribution system and currently receive a blend of water from both sources. Specific amounts of water received from each source are difficult to determine or predict due to system configuration, fluctuations in demand, and system operation. For analyses in this report, it is assumed that 50% of water ultimately reaches the Blacklake WWTF from each source. Salts data for each supply and water quality resulting from a 50:50 blend are tabulated in Table 2.

Table 2. Blacklake, NCSD, and Combined Drinking Water Quality

Water Source	NCSD 2007 CCR Average	Blacklake 2006 CCR Average	Estimated Blacklake Supply (50:50 Blend)
TDS (mg/l)	**571**	**464**	**518**
Sodium (mg/L)	**63**	**50**	**57**
Calcium (mg/L)	**73***	**53***	**63**
Magnesium (mg/L)	**31***	**21***	**26**
Chloride (mg/L)	**65**	**54**	**60**
Sulfate (mg/L)	**186**	**141**	**164**
Hardness (mg/ L as CaCO3)	**311**	**214**	**263**
Specific Conductance (uS/cm)	**862**	**706**	**784**

Refer to Southland Salts Minimization Report for NCSD CCR data. Blacklake 2007 CCR was not available.

* Calcium and magnesium estimated based on hardness and ratio of Ca:Mg in Town Water.

Mass balance for salts loading to the treatment plant

Wastewater customers contribute dissolved solids to the collection system through a number of mechanisms, including the use of self-regenerative water softeners. Their total contributions, in terms of daily mass loading, are estimated below.

Table 3. Estimated Salts Contribution from Blacklake WWTF Users

Constituent	Water Supply (mg/L)	WWTF Influent [a] (estimated) (mg/L)	Contributed by Users	
			Concentration (mg/L)	Mass Load (lb/day)
TDS	518	795 [b]	+277 [b]	242
Sodium	57	175	+119	104
Calcium	63	47	-16	--
Magnesium	26	25	-1	--
Chloride	60	133	+74	64
Sulfate	164	231	+68	59
Hardness (as $CaCO_3$)	263	220	-42	--

a The approach for estimating these concentrations is described later in this memorandum

b July and August 2008 sampling resulted in average influent TDS concentration of 695 mg/L, or 178 mg/L contribution from users

Examination of this table shows net losses in calcium, magnesium, and hardness concentrations with increases in sodium, chloride, TDS. These differences may be indicative of self regenerating water softener use in the community.

Hardness and Dissolved Solids from Water Softeners

Hard water has a high mineral content, typically consisting of calcium and magnesium cations, and sometimes other dissolved compounds such as bicarbonates and sulfates. Measurements of "water hardness" account for the total concentrations of calcium and magnesium (the two most prevalent, divalent metal ions) and are read as mg/L (or parts per million - ppm) of calcium carbonate ($CaCO_3$). Hardness is also measured as "grains/gallon" (1 gr/gal = 17.1 mg/L as $CaCO_3$).

Water softeners pass hard water through an ion exchange media. The surface of the exchange media is saturated with positively charged sodium ions (Na^+). During the softening process, positively charged calcium (Ca^{2+}) and magnesium (Mg^{2+}) ions in the hard water exchange places with the sodium ions on the exchange media. Virtually all the calcium and magnesium is removed from the water and replaced with sodium.

The softening process continues until the exchange media is exhausted, at which time a strong solution of sodium chloride is applied. The highly concentrated solution reverses the earlier process, driving calcium and magnesium off the media and into the brine, which is disposed.

Canister type water softeners are collected from the user's location and regenerated at a central facility. Self regenerating water softeners (SRWS) are regenerated at point-of-use and typically discharge a concentrated brine solution to the wastewater collection system.

Estimated TDS Increase from Softeners in Blacklake Wastewater

The use of self regenerating water softeners (SRWS) results in an increase in sodium and chloride ions in processed water. Typical "salt efficiency" for these appliances is approximately 2,500 grains of hardness removed per pound of salt used (Phillips, 2008). The salts contribution of a typical SRWS in Nipomo to the Blacklake WWTF is estimated below.

Table 4. Estimated Salts Contribution from a Typical Self Regenerating Water Softener for Blacklake Supply Water

Flow (3.5 people @ 75 gpcd)	262 gallons per day
Hardness of Untreated Water	263 mg/L as $CaCO_3$
Hardness of Untreated Water (1 gr/gal = 17.1 mg/L)	15.4 grains/gallon
Hardness removed	4029 grains per day
Hardness removed (1 pound = 7000 grains)	0.576 lb/day
Softener efficiency (grains of hardness per pound of salt)	2500 gr/lb
Salt Added	**1.61 lb/day**
Sodium (Na^+) Added	0.63 lb/day
Chloride (Cl^-) Added	1.98 lb/day

The use of a canister water softeners results in a small increase in sodium ions (dependent on the hardness of the applied water) and a decrease in calcium and magnesium. 7.866 mg/L of sodium is added to processed water for every grain per gallon of hardness in the untreated water. The salts contribution of a typical canister water softener in Nipomo to the Blacklake WWTF is estimated below.

Table 5. Estimated Salts Contribution from a Typical Canister Type Water Softener for Blacklake Supply Water

Flow (3.5 people @ 75 gpcd)	262 gallons per day
Hardness of Untreated Water	263 mg/L as $CaCO_3$
Hardness of Untreated Water (1 gr/gal = 17.1 mg/L)	15.4 grains/gallon
Sodium Concentration Added (7.866 mg/l per grain/gal)	121 mg/L
Sodium Added	0.264 lb/day
Calcium Concentration Removed	63 mg/L
Calcium Removed	0.138 lb/day
Magnesium Concentration Removed	26 mg/L
Magnesium Removed	0.057 lb/day
Net Solids Load	**+ 0.069 lb/day**

Anticipated TDS Increase from Other Municipal Sources

Apart from water softening, a number of municipal uses add dissolved solids to municipal wastewater. This increase in dissolved solids has been estimated to be between 150 mg/L and 380 mg/L nationwide (Metcalf & Eddy, 3rd ed.), and between 150 mg/L and 250 mg/L in the Chino Basin of California (Wildermuth Environmental, 1999.)

The average municipal increase in TDS in the City of Lompoc, one of few agencies on the Central Coast with low occurrence of water softeners, is estimated to be less than 304 mg/L. In the Santa Clarita Valley, chloride concentration typically increases between 30 and 50 mg/ L as a result of municipal use. In the Fillmore area, chloride is reported to increase by 31 mg/L. Additional discussion of reported salts contributions from municipal sources is provided in the Southland Salts Minimization Plan.

For this analysis, a typical TDS contribution of 250 mg/L was assumed.

Contribution of Self Regenerating Water Softeners to Blacklake Effluent TDS

The table below indicates the mass fraction of sodium and chlorine to sodium chloride, in order to indicate whether the source water, effluent, and user contributions (effluent – source water) resemble the mass fraction of sodium chloride. As shown, the ratio suggests that an additional source of sodium may be impacting effluent.

Table 6. Sodium Chloride Proportions

	Sodium Chloride		Supply Water		WWTP Effluent		Use contribution	
	mg/ mole	Proportion	mg/ L	Proportion	mg/ L	Proportion	mg/ L	Proportion
Na (mg/ L)	23	40%	57	49%	184	57%	127	61%
Cl (mg/L)	35	60%	60	51%	140	43%	80	39%

Timing of Regeneration and Brine Discharge

Two methods are common for scheduling regeneration of water softeners, and therefore discharge of high-TDS brine solution. Simple models use an estimated daily flow rate to schedule how many days between regeneration cycles. More efficient models tabulate the volume of water processed and regenerate only when media exhaustion is predicted within 48 hours. Regardless of the scheduling method, most all self-regenerating water softeners regenerate at 2AM (Phillips, 2008) unless timing is modified by the owners.

Costs of Operation, Installation and Retrofit

The cost of installation and operation of the two types of water softener discussed above are compared below. The estimated installation costs for the canister system ($45 to $65) are also the estimated costs for retrofitting a self regenerating model to a canister system.

Table 7. Estimated Costs of Water Softeners in Typical Installation

Water Softener Type	Self Regenerating		Canister	
Cost Estimate Type (high/low)	Low	High	Low	High
Equipment Purchase	$479.00	$1,000.00		
Installation	$300.00	$500.00	$45.00	$65.00
Total Capital Cost	$779.00	$1,500.00	$45.00	$65.00
Monthly Capital Cost (amortized 10 years @ 6%)	$8.65	$16.65	$0.50	$0.72
Blacklake Estimated Salt Use (lb/day)	1.61	1.61		
Salt Use (lb/month)	49.0	49.0		
Monthly Salt Cost (@$8 per 40lb bag delivered)	$9.80	$9.80		
Monthly Service Cost			$35.00	$37.95
Total Monthly Cost	$18.45	$26.46	$35.50	$38.67
Total Annual Cost	$211.42	$317.48	$426.00	$464.06

Wastewater

A number of water quality samples have been collected from the Blacklake WWTF effluent and analyzed for dissolved solids. Available semi-annual sampling results for TDS, sodium, and chlorides from 2006 to 2008 are summarized below, along with additional analyses conducted as part of this study in July and August, 2008.

Table 8. Blacklake Effluent Water Quality

Constituent	Number of Observations	Average (used in this Analysis)	Min	Max
TDS (mg/l)	14	833	650	940
Sodium (mg/L)	14	184	148	212
Calcium (mg/L)	4	50	46	52
Magnesium (mg/L)	4	26	24	28
Chloride (mg/L)	14	140	97	174
Sulfate (mg/L)	4	243	210	280
Hardness (mg/L as $CaCO_3$)	4	231	214	245

Treatment pond processes can contribute salts to effluent. Evaporation will not increase the mass of salt loading, but will increase salt concentration by removing water from the ponds. Various in-pond chemical reactions and biological processes will affect concentrations of dissolved solids, as well. We used two approaches to estimate the increase in salt loading and concentration across the treatment process:

1) Evaporation estimates using local evapotranspiration and precipitation records; and

2) Sampling of influent and effluent dissolved solids concentrations.

Because the Blacklake WWTF uses aerated lagoons for treatment, evaporation contributes to the increase in the concentration of dissolved solids in the effluent. During typical operations, approximately 1.2 acres of water surface are exposed in the aerated lagoons. The average annual evaporation from a pond in Nipomo is approximately 68 inches (CIMIS, 2008), and the average annual precipitation is approximately 16 inches (SLO Co., 2006), giving a net evaporation of 52 inches. Average net evaporation from the aeration basins would total 4,800 gallons per day. Assuming no wastewater treatment processes significantly increase dissolved solids and only the effects of evaporation are considered, dissolved solved solids concentrations in the Blacklake WWTF influent would be estimated as summarized in Table 9.

Table 9. Blacklake Effluent Water Quality, Mass Load, and Estimated Influent Water Quality

	Effluent		Influent
Flow Rate (MGD)	**0.100**		**0.105**
	Concentration (mg/L)	**Mass Load (lb/day)**	**Estimated Concentration (mg/L)**
TDS	833	695	795
Sodium	184	153	175
Calcium	50	41	47
Magnesium	26	22	25
Chloride	140	116	133
Sulfate	243	202	231
Hardness (mg/L as $CaCO_3$)	231	192	220

Evaporation estimates show that evaporation within the Blacklake WWTF is estimated to increase solids concentrations by 5%.

Sampling and analysis of treatment plant influent and effluent (July through August, 2008) allow estimation of increase in TDS, sulfate, and nitrate from biological treatment at the plant and evaporation from aerated lagoons. Results are summarized in Table 10.

Table 10. Increase in TDS, Sulfate, and Nitrate at WWTF (July – August 2008)

	Average Concentrations		Increase (mg/ L)	Percent Increase
	Influent (mg/ L)	**Effluent (mg/ L)**		
TDS	695	888	193	28%
Sulfate	228	243	15	7%
Nitrate	--	99	>99	Not Calculated

Salts Minimization Approaches for the Blacklake Community

Management of salts in effluent from the Blacklake WWTF can be accomplished several ways.

- Direct treatment of groundwater supply

- Import water supplies with lower salts concentrations

- Direct treatment of WWTP effluent

- Limit onsite regenerating water softeners

Considering the existing configuration of the NCSD distribution system and connections to supply wells, direct treatment of groundwater sources was not considered feasible due to the high anticipated cost of combining the existing wells and isolating them from the distribution system. Direct treatment of plant effluent is considered to be prohibitively expensive.

The District is planning to import water from the City of Santa Maria, which currently over 98% State Water and the remainder, Santa Maria Valley groundwater. State Water has considerably lower salts concentrations than local groundwater supplies, and would result in lower concentrations to the WWTF and from WWTF effluent.

Direct treatment of Blacklake WWTF effluent would require significant plant upgrades for coagulation, filtration, and either chemical softening through lime and/or alum addition, nanofiltration (often coupled with chemical softening), or reverse osmosis. Each of these processes results in production of solid waste products (such as lime or alum sludge) or wastes rejected from filtration processes. Plant effluent is considered more difficult to treat than groundwater since wastewater would contain trace amounts of organics and solids. Cost has not been estimated for these process upgrades since this approach to salts management is not considered cost effective or feasible at this time.

Reducing the number of onsite-regenerating water softeners would eliminate the brine stream from entering the WWTF and elevating salts concentrations in WWTF effluents. Salts discharge to the WWTF would be reduced by replacing any existing self-regenerating onsite water softeners with canister-type softeners.

Of these salts management approaches, importing water with lower salts concentrations and limiting onsite-regenerating water softeners would be effective salts reduction strategies and would result in the lowest implementation cost for the District. Importing water is already part of the District's water supply strategy and limiting water softeners could result in some increased cost for individuals (if canister-type units are used instead), but not likely to require fees from the community as a whole. These approaches are also recommended for the Southland WWTF.

Approach 1: Imported Water Supply

Sources and water quality characteristics of the future imported water supply is discussed in detail in the Southland Salts Minimization Plan. For estimating future improvements in Blacklake WWTF effluent resulting from the imported water supply, it is assumed that water supplied to the Blacklake community will be a 50:50 blend of the District's future water supply, and the Blacklake well supply.

Estimated Mixture in Combined Sources

Assuming the Waterline Intertie Project (WIP) is implemented as described in the Southland Salts Minimization Plan, water supplied to the Blacklake WWTF will be a mixture of sources in the amounts tabulated in Table 15.

Table 11. Projected Mixture of Sources Flowing to Blacklake WWTF

Year	Blacklake Wells	NCSD Town Wells*	CSM Wells*	CCWA Pipeline*	Total
Current	50%	50%	0%	0%	100%
2010	50%	10%	2%	39%	100%
2015	50%	12%	3%	35%	100%
2020	50%	15%	3%	32%	100%
2025	50%	17%	4%	29%	100%
2030	50%	20%	4%	26%	100%

*Refer to Southland Salts Minimization Plan for discussion on future water deliveries

Estimated Water Quality in Combined Sources

Assuming the average water quality of the various sources noted above remains constant, the water quality of the combined sources to Blacklake users will be as shown below in Table 12.

Table 12. Projected Source Water Quality of Existing + WIP Mixture for Users that Discharge to Blacklake WWTF

Source Mixture Water Quality	2007 (existing)	2010	2015	2020	2025	2030
TDS (mg/l)	518	394	409	421	432	446
Sodium (mg/L)	57	53	53	53	53	54
Calcium (mg/L)	63	55	56	57	58	60
Magnesium (mg/L)	26	19	20	21	21	22
Chloride (mg/L)	60	59	59	59	59	59
Sulfate (mg/L)	164	117	123	128	133	138
Hardness (mg/L as $CaCO_3$)	263	185	196	203	210	219

The current contribution to effluent salts from the Blacklake Community's use, and wastewater treatment processes (including evaporation) can be estimated by comparing source water quality with effluent water quality as summarized in Table 13.

Table 13. Current increase in salt constituents

	Blacklake Source Water	Blacklake WWTF Effluent	Increase or (Decrease)
TDS (mg/l)	518	833	315
Na (mg/L)	57	184	127
Ca (mg/L)	63	50	(13)
Mg (mg/L)	26	26	0
Cl (mg/L)	60	140	80
SO4 (mg/L)	164	243	79
Hardness (mg/L as CaCO3)	263	231	(32)

Assuming similar increases in concentration will be applied by the community and WWTF processes in the future, effluent concentrations for the Blacklake WWTF can be projected. Projected concentrations of salts constituents in effluent are summarized in Table 14.

Table 14. Projected Blacklake WWTF Effluent Water Quality with Existing + WIP Mixture

WWTF Effluent Water Quality	Current	2010	2015	2020	2025	2030	Basin Plan Objective
TDS (mg/l)	833	709	725	736	747	761	710
Sodium (mg/L)	184	180	180	180	181	181	90
Calcium (mg/L)	50	42	43	44	45	46	--
Magnesium (mg/L)	26	19	20	21	21	22	--
Chloride (mg/L)	140	139	139	139	139	139	95
Sulfate (mg/L)	243	196	202	207	212	217	--
Hardness (mg/L as $CaCO_3$)	231	153	164	172	179	188	--

Approach 2: Control of Self-Regenerating Water Softeners

Since self-regenerating water softener data were not available for Blacklake at the time of this study, potential salts reductions are estimated assuming 40 self regenerating softeners are currently in use and will be converted to canister-type softeners. As noted in the Water and Sewer Master Plan Update (Cannon, 2007), the Blacklake community is near build-out and as a result, wastewater flow is not expected to significantly increase. Therefore, the assumed salt loads from 40 SRWS were deducted from the projected water quality estimates and loads from an assumed 40 canister-type replacement softeners were added. Results are summarized in Table 15.

Table 15. Projected Blacklake WWTF Effluent Water Quality with Existing + WIP Mixture and Self Regenerating Water softener Control Implemented

WWTF Effluent with SRWS Control	Net reduction (lb/ day)	Current	2010	2015	2020	2025	2030	Basin Plan Objective
TDS (mg/l)	-61.7	759	635	651	663	673	687	710
Sodium (mg/L)	-14.8	166	162	162	163	163	163	90
Chloride (mg/L)	-39.1	93	92	92	92	92	92	95

Conclusions

- Based on calculations summarized herein and data on calcium, magnesium, and hardness obtained at the WWTF, salts loads from water softeners could be significantly impacting WWTF effluent water quality.
- Use of supplemental water from the City of Santa Maria will decrease TDS concentrations in Blacklake WWTF effluent. This effect will be reduced in the future as the City blends more of its groundwater sources with CCWA pipeline water, and delivers this "municipal mix" to NCSD.
- Our calculations show that use of supplemental water from the City of Santa Maria and eliminating approximately 40 self-regenerating softeners in the Blacklake community would decrease TDS concentrations in Blacklake WWTF effluent between 18% - 24%, to levels below the Regional Board Basin Plan objective for TDS.

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