FINAL REPORT
CITY OF EL PASO DE ROBLES
WATER & WASTEWATER QUALITY CONCERNS – WATER QUALITY STRATEGY

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AF/yr	acre-feet per year
AWWA	American Water Works Association
BOD_5	Biochemical Oxygen Demand
CADHS	California Department of Health Services
DBP	disinfection by-product
EIR	Environmental Impact Report
GAC	granular activated carbon
gpm	gallons per minute
HAA	haloacetic acids
MF	microfiltration
MGD	million gallons per day
mg/L	milligrams per liter
NPDES	National Pollutant Discharge Elimination System
PVC	polyvinyl chloride
RAS	return activated sludge
RO	reverse osmosis
RWQCB	Regional Water Quality Control Board
SCVWD	Santa Clara Valley Water District
SDWA	Safe Drinking Water Act
SFPUC	San Francisco Public Utilities Commission
SLO County	San Luis Obispo County
TDS	Total Dissolved Solids
TOC	Total Organic Carbon
TTHM	Total Trihalomethanes
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
UV	ultraviolet
VFD	variable frequency drive
WAS	waste activated sludge
WTP	water treatment plant
WWTP	wastewater treatment plant

EXECUTIVE SUMMARY

The City of El Paso de Robles faces two important wastewater discharge challenges. Specifically, the City's wastewater effluent to the Salinas River does not consistently comply with numerical permit limits for Total Dissolved Solids (TDS) and the individual constituents chloride, sodium, and sulfate. The Regional Water Quality Control Board (RWQCB) has also indicated that ceasing discharge to the river altogether will likely become a future permit requirement. In addition, the City faces a long-term water supply problem. It currently relies completely on local groundwater for its water supply, but localized overdrafting of the groundwater basin has been documented. The City's population and water demand are expected to grow by roughly 80% over the next twenty years. These factors indicate that the City would be prudent to secure a new source of water to preserve the local groundwater basin and increase long-term water supply reliability. The City realized that these wastewater quality/discharge and water supply issues were interrelated, but had only been partially studied, individually in response to particular regulatory requirements. The City commissioned Malcolm Pirnie to develop a water/wastewater strategy to provide the City with direction to address its multiple, interrelated issues related to wastewater quality and discharge compliance, water supply, and drinking water quality.

We first reviewed individual reports and documents pertinent to the City's wastewater discharge and water supply issues. These included regular City water and wastewater quantity and quality reports, and reports prepared by others addressing previous individual regulatory requirements (e.g., recycled water, urban water management). We prepared a summary of this available information for the City's use and to provide a foundation for the subsequent phases of this project. We next considered the potential benefits and impacts of importing surface water, both in terms of City drinking water and wastewater effluent quality. The final and key task of this project was the development and relative ranking of over a dozen alternatives the City could implement to address its interrelated water and wastewater issues. For comparative purposes, well and wastewater desalination alternatives were evaluated on an equal TDS basis; that is, target TDS values in the City's water and wastewater system were set equivalent to the levels that would result from importing surface water.

Our evaluation indicated that importing surface water would provide drinking water quality benefits with respect to hardness and salinity, as well as not pose any water quality problems related to blending, as long as the new water is introduced to the City's system gradually and common treatment steps such as pH adjustment and disinfectant matching are taken. The City has a wide variety of potential alternatives to consider to address its wastewater compliance and related water supply issues. These include reducing salt load from industrial/commercial facilities, importing surface water, desalinating City wells, and desalinating wastewater effluent to either meet immediate river discharge standards or future recharge/reuse applications. Capital costs for the alternatives requiring new facilities range from under $10 million to over $50 million, and each alternative has its pros and cons related to other important considerations for the City (e.g., water supply reliability, customer/stakeholder acceptance). We provided a comparison matrix that allowed ranking of all the alternatives under consideration. Each was first considered against the two primary project criteria, namely, whether it would (1) solve the City's immediate TDS problem and (2) allow the City to cease discharge to the Salinas River. Alternatives were further ranked against the ten other criteria of importance to the City. Those alternatives involving importing surface water earned the highest overall scores, despite their relatively high costs, for providing a unique combination of benefits, including increased water supply reliability, improved drinking water quality, relief from local groundwater overdraft, and salt reduction across all TDS sources to the City's wastewater treatment plant.

The City must take action to address its immediate wastewater discharge concern – its current inability to regularly meet its numerical NPDES permit effluent limits for TDS and related constituents (chloride, sodium, and sulfate). Currently the City is at high risk for continuing to exceed its permit limits, which is not an acceptable situation. Malcolm Pirnie provided the City with recommendations to implement to address this high priority concern, as well as realize benefits relative to longer-term National Pollutant Discharge Elimination System (NPDES)/wastewater concerns and the City's long-range plans. These three specific recommendations were based on the comparative evaluation of alternatives discussed above, and were designed to be considered as a group of three complementary alternatives to most efficiently address the City's immediate TDS compliance need, as well as provide the foundation for future ceasing of discharge to the Salinas River and for ensuring adequate water supply for future growth. These recommendations are briefly summarized here.

1. ***Desalinate WWTP Effluent.*** This alternative is the most cost-efficient way for the City to meet its current numerical TDS and related constituent effluent limits, and is also a necessary step for the City to take to prepare for ceasing discharge to the Salinas River. Leasing desalination equipment may be desirable if the City's current TDS limit (1,100 milligrams per liter [mg/L]) remains in effect with its upcoming NPDES permit renewal, because either wastewater desalination or surface water imports alone (discussed below) would bring the TDS of the City's effluent comfortably below that level. If the RWQCB reduces the City's effluent limit to 900 mg/L or lower, it is recommended that the City purchase permanent desalination capability.

2. ***Import Lake Nacimiento Water.*** Whether the City accomplishes this via the raw or treated water options of the Nacimiento Project (or on its own), this alternative offers a unique set of benefits among the alternatives considered in this report. In addition to bringing the City's effluent into compliance with its current TDS limit, it would provide increased water supply reliability, improved drinking water quality, relief from local groundwater overdraft, and salt reduction across all TDS sources to the City's wastewater treatment plant. The benefits of the regional treated water option are that the City could rely on the regional system for its treated water and it would require the least degree of variation from current City operations. However, significant cost savings are possible if the City participates in the raw water option of the Nacimiento Project and treats its own water with a package plant. With its own plant, the City also gains control over staffing and operation of the plant, and may have the opportunity to sell water to other agencies during periods of low demand. This alternative can be implemented in conjunction with wastewater desalination if necessary to meet a more stringent TDS effluent limit if put into place by the RWQCB. Various treatment options are available for either a regional or City-dedicated treatment plant to produce high-quality water, and phasing in the new water source gradually in conjunction

with taking common treatment steps such as pH and disinfectant matching are recommended.

3. ***Achieve Greater Industrial and Commercial Discharge Quality Control.*** Although the mass salt loading from industrial/commercial facilities (and thus the potential benefit of this alternative) cannot yet be quantified based on available data, this alternative represents a relatively low-cost measure that the City can take in addition to others to further reduce the TDS loading to its wastewater treatment plant. This alternative may well provide a worthwhile incremental TDS reduction, and therefore (1) a greater margin of safety against future TDS violations, as well as (2) decreased operating costs and brine disposal for a future City wastewater desalination system. We recommend that the City perform an industrial/commercial wastewater flow monitoring program and collect flow-weighted composite wastewater quality samples to complement the City's existing salt monitoring data. Following these steps, mass loading of salt from these facilities in the City's wastewater service area can be quantified, and the City can begin more active cooperation and/or Sewer Code enforcement for those facilities responsible for the most significant salt loadings to the City system.

1.0 SUMMARY OF EXISTING WATER/WASTEWATER QUALITY INFORMATION

1.1 INTRODUCTION

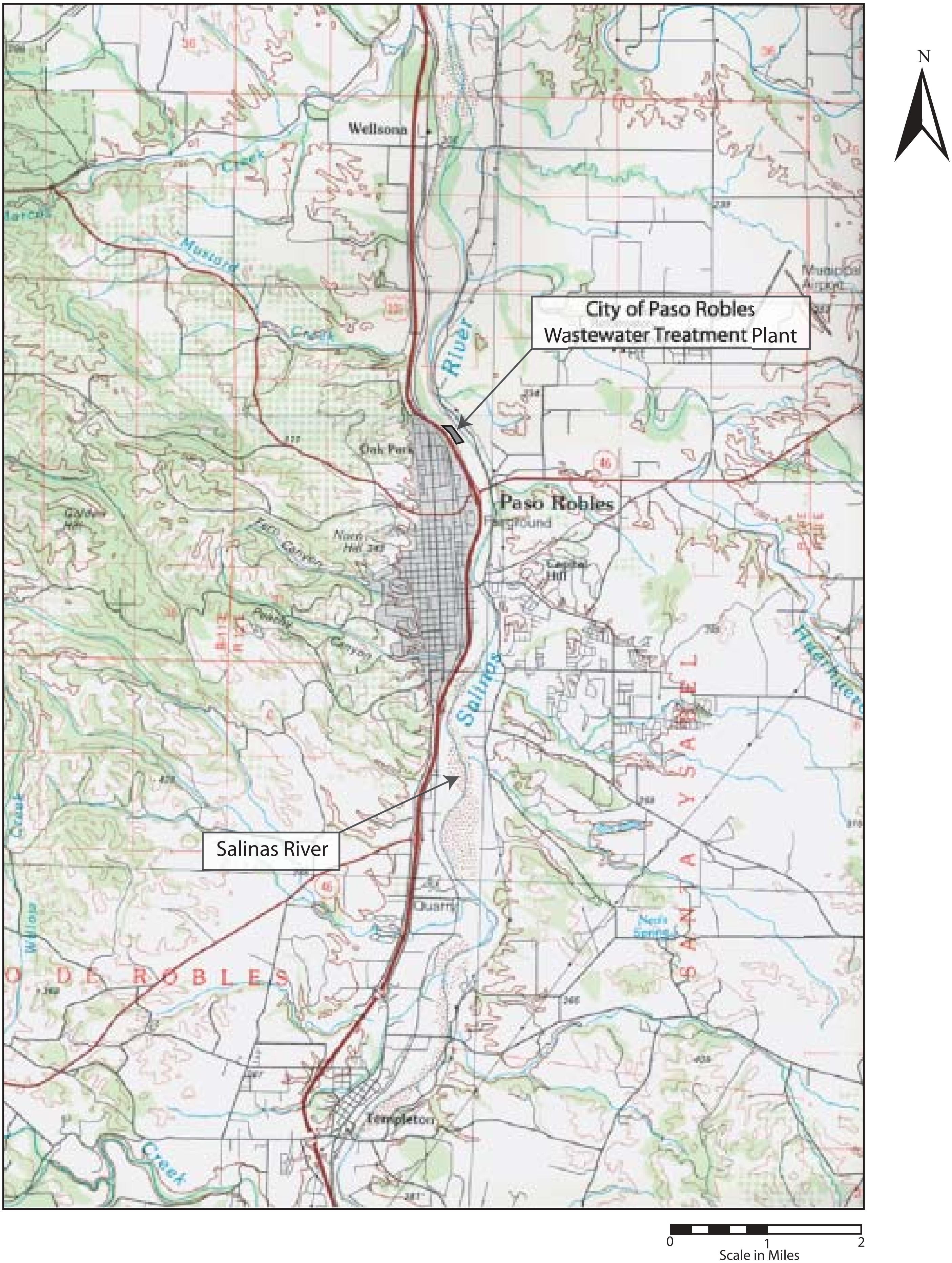
This section provides a condensed summary of available water and wastewater information pertinent to the development of a water/wastewater quality strategy for the City. A full version of the summary is provided as Appendix A of this report, and was used as the basis for the primary tasks of this project: evaluating potential water blending impacts and benefits, and evaluating water/wastewater quality strategy alternatives. The documents and other information sources reviewed by Malcolm Pirnie to understand the City's current water/wastewater quality condition are listed in the References section of this report. This summary focuses on the City's current status with respect to the key drivers of this project, wastewater compliance issues. This also summarizes City water quality, treated wastewater reuse, water supply, and water rights issues as they pertain to the development of a water/wastewater quality strategy. **Figure 1-1** is a location map of the study area.

1.2 EXISTING CITY WASTEWATER INFORMATION

The City provides secondary treatment of an average of 2.9 million gallons per day (MGD) of wastewater with effluent discharge to the Salinas River. The City continues to have difficulty complying with its numerical effluent limit for Total Dissolved Solids (TDS) of 1100 mg/L, as well as its limits for the individual constituents sodium, chloride, and sulfate. These limits are specified in the City's National Pollutant Discharge Elimination System (NPDES) permit administered by the Regional Water Quality Control Board (RWQCB). The increase in TDS concentration due to use by the City is higher than average, likely reflecting the widespread use of home water softeners as well as commercial/industrial inputs. This immediate wastewater regulatory issue is the primary reason for the City undertaking this project and developing compliance alternatives. The City wishes to consistently comply with its numerical effluent limitations with a reasonable (e.g., 20%) margin of safety.

The other regulatory directive facing the City is the RWQCB's encouragement to the City to find alternatives to discharging its treated wastewater to the Salinas River, and the RWQCB's favorable view of water reuse. Ceasing river discharge may become an NPDES permit requirement for the City, which would necessitate a significant undertaking. Specifically, it would require the City to desalinate its wastewater to a level suitable for either wastewater reuse or recharge, and to implement one of (or a combination of) those alternatives, including developing a recharge facility and/or identifying reuse customers, and designing and constructing the associated distribution infrastructure.

Previous studies performed in response to individual regulatory requirements evaluated recycled water implementation options and identified alternatives for reducing salt input into the City's wastewater collection system (Carollo, 2001a and 2001b, respectively). In response to the study regarding salt input, the City performed wastewater quality monitoring in its collection system and has reported TDS concentration data representing both residential and industrial areas (City of El Paso De Robles, 2003b). The City's monitoring confirmed TDS concentrations in the system in excess of Sewer Code limits, but without flow data, does not enable quantification of mass loading to the wastewater treatment plant from each type of source.



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MALCOLM PIRNIE

Location Map
Paso Robles, California

MALCOLM PIRNIE, INC

Figure 1-1

1.3 EXISTING CITY WATER SYSTEM INFORMATION

The City currently serves approximately 26,000 customers and relies on groundwater for 100% of its water supply. The population and associated water demand are expected to grow by roughly 3% per year, mostly on the east side of the City, to a build-out population of approximately 42,000. The City's water system is divided into the West and East Zones, which typically operate independently. The City owns and operates 18 wells completed in two major aquifer units – the relatively shallow Salinas River Underflow unit and the deeper Paso Robles Formation – and provides disinfection of its groundwater with free chlorine. The City has water rights to a specific quantity of water from the Salinas River Underflow unit, but withdrawals from the deeper Paso Robles Formation are currently not limited by water rights. Localized areas of groundwater table decline were noted in a recent study commissioned by the County.

Wells completed in the Salinas River Underflow unit produce water with TDS concentrations ranging from 300 to 800 mg/L, averaging roughly 540 mg/L. A wider range (300 to 1000 mg/L) of TDS concentrations has been observed in the deeper Paso Robles Formation wells, although the average TDS from these deeper wells is generally lower (approximately 450 mg/L). The water delivered to City customers averages about 510 mg/L of TDS according to City water quality reports and consistent with the blend of these two sources.

1.4 RECYCLED WATER

In response to a RWQCB directive to study alternatives to discharging to the Salinas River, the City commissioned a Comprehensive Recycled Water Study (Carollo, 2001a). This study evaluated potential alternative effluent disposal options and recycled water customers, and developed five reuse/disposal scenarios for the City's consideration. Three of these five scenarios featured water reuse, with only one of the three enabling the City to cease river discharge year-round. The other two options featured either evaporating or percolating treated wastewater, and outlined the siting drawbacks associated with each. The study concluded that there were no traditional reasons in place for the City to implement a reuse program. For example, Carollo noted that the cost for reuse water exceeded the cost of other water supply options. However, the increasing importance of the wastewater regulatory requirements noted earlier in this section, in particular, the RWQCB's encouragement to the City to cease discharge to the Salinas River, indicates that the City needs to consider treated wastewater reuse and recharge despite the cost or other potential drawbacks.

1.5 SURFACE WATER

The City has been considering importing surface water, specifically, water from Lake Nacimiento, for a number of years. City staff are active participants in the Nacimiento Participants Advisory Committee, a group of municipalities who are potential participants in a regional program to deliver and/or treat Nacimiento water for municipal use in San Luis Obispo County. There are several benefits noted by previous authors (e.g., Todd, 2000) associated with importing surface water to Paso Robles. These include: decreased TDS concentration of wastewater effluent, improved drinking water quality, conservation of local groundwater, and improved water supply reliability. There are 16,200 acre-feet per year (AF/yr) allocated for San

Luis Obispo County water purveyors, and the City's current request is for 4,000 AF/yr of this amount.

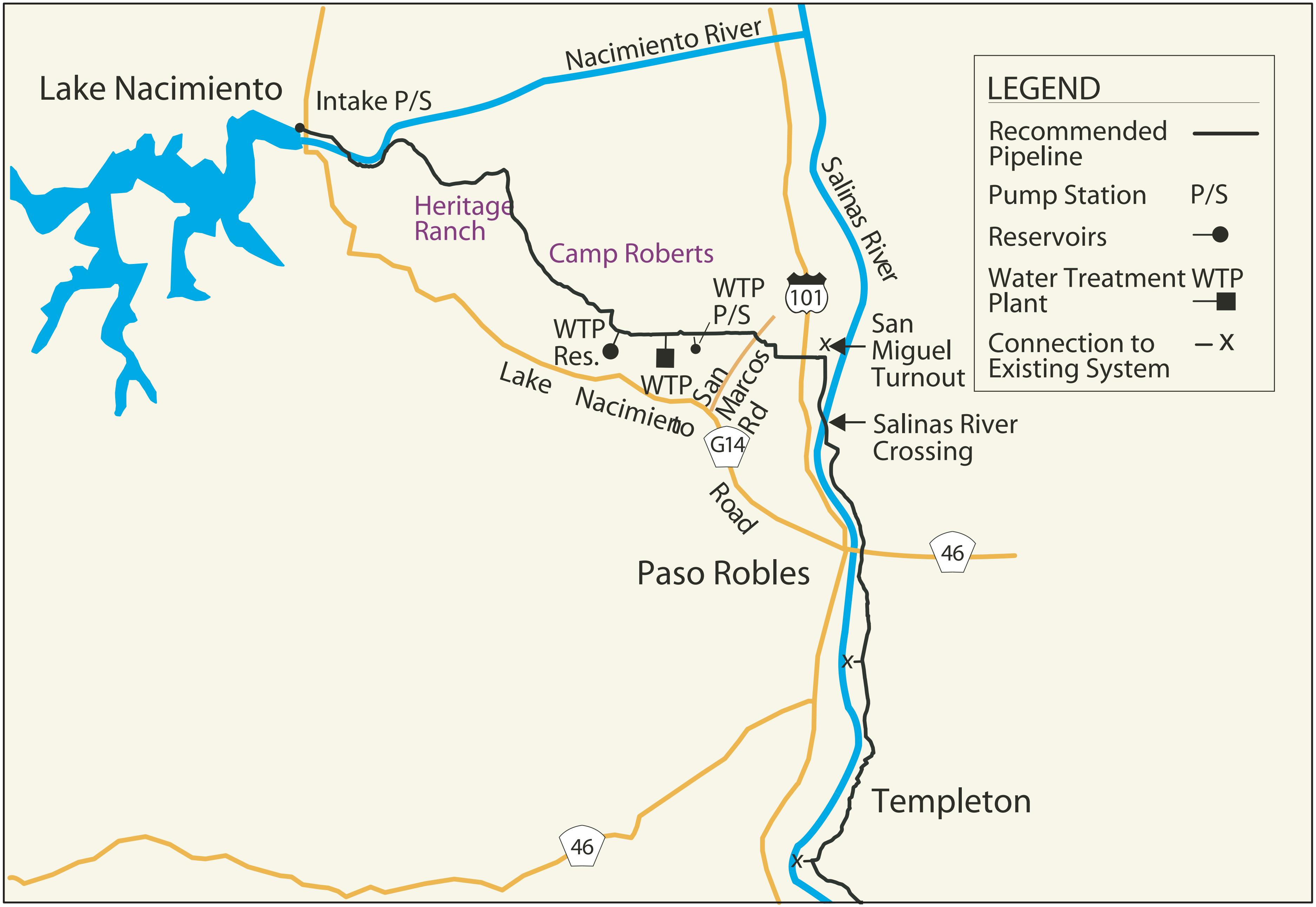
The Nacimiento Project has been conceived as two basic alternatives, and planning-level costs have been developed for each. One would deliver raw lake water to the participants, who would treat, recharge, or otherwise use the water. The second of the two alternatives includes a regional water treatment plant, probably located roughly halfway between the lake and Paso Robles, and delivery of treated water to the project participants. This treated water alternative is shown in **Figure 1-2**. The raw water alternative would follow the same alignment but not include a water treatment plant, and would feature river/recharge discharge or raw water turnout locations for the participating municipalities instead of treated water turnouts.

The water quality and treatability of Lake Nacimiento water has been previously investigated (Boyle, 2002) and found to be generally favorable. However, the evaluation does not directly address such topics as synthetic organic compounds, algal concentrations, other potential taste-and-odor issues, seasonal stratification, or finished water disinfection by-product (DBP) concentrations and the relationship between DBP formation and project participant distance from the regional water treatment plant. A variety of treatment technologies were determined to be viable options for treating Lake Nacimiento water to drinking water regulatory standards.

1.6 SUMMARY

In summary, the City has previously investigated many aspects of its wastewater and water supply/quality issues. However, because each has generally been performed individually, in response to specific regulatory requirements, a comprehensive solution to the City's interrelated water and wastewater issues had not been developed until now.

The remaining chapters build on the available information summarized briefly above (and more thoroughly in Appendix A) and develop a strategy for the City to best address their interrelated challenges. Specifically, the potential water quality impacts and benefits of the City importing surface water are discussed in Chapter 2 of this report, and Chapter 3 develops and ranks a number of alternatives to solve the City's compliance and related issues strategically. Chapter 4 presents the recommended groups of alternatives for the City to implement to most efficiently address its wastewater regulatory requirements and also provide water supply and other benefits consistent with the City's long-term plan.



SOURCE: EIR Preparation Phase Engineering Report - Nacimiento Project (Updated Draft), prepared by Carollo Engineers for County of San Luis Obispo, April 2002.

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Northern Segment of Nacimiento Project
Treated Water Alternative

MALCOLM PIRNIE, INC.

FIGURE 1-2

2.0 ANALYSIS OF IMPORTING SURFACE WATER: DRINKING WATER AND WASTEWATER QUALITY BENEFITS/IMPACTS

2.1 INTRODUCTION

The City of El Paso de Robles currently relies on groundwater for 100% of its water supply, as described in Chapter 1 of this report. The City has been considering importing surface water from Lake Nacimiento to improve the quality of the City's treated wastewater for regulatory compliance. This would also increase the City's water supply reliability. This chapter discusses two key aspects of this potential addition to the City's source of water:

- Possible water quality impacts in the City's distribution system
- Expected treated wastewater quality improvements

The analyses presented in this report were performed by Malcolm Pirnie based on available reports and other documents provided by the City for review, as well as discussions with City staff. The evaluations herein are at the planning level; that is, they were conducted at a level of detail appropriate for understanding potential water quality impacts and wastewater quality benefits, and their relevance to developing an overall water and wastewater quality strategy for the City. The information herein is incorporated into Chapter 3 of this report, which discusses the development and ranking of water/wastewater alternatives.

2.2 POTENTIAL WATER QUALITY IMPACTS OF INTRODUCING SURFACE WATER TO CITY SYSTEMS

This section discusses the water quality considerations associated with introducing a new source of water (specifically, treated Lake Nacimiento water) into the City's distribution system, which has historically been supplied exclusively by groundwater. Section 3 of this chapter focuses on another key aspect of introducing a new water source, namely, the resulting effect on the City's treated wastewater quality and regulatory compliance.

2.2.1 Pertinent Existing Water Quality Parameters

Chapter 1 of this report provided a brief summary of the City's existing water system and water quality, and a more complete description is provided in Appendix A. This section discusses those parameters of particular importance to the consideration of a new water source. Each of these parameters directly relates to the possible water quality impacts of introducing a new water source, potential wastewater quality benefits of doing so, or both.

- Total Dissolved Solids (TDS): The TDS content of the City's water is fairly high, averaging about 510 mg/L in the system. This is the result of the generally high TDS content of the City's two groundwater sources, the Salinas River Underflow unit and the Paso Robles Formation.

- Hardness: The City's water is hard, with hardness values ranging from 250 to 300 mg/L (as $CaCO_3$). A "moderate" range for hardness is 75-150 mg/L, with water between 150 and 300 mg/L classified as "hard." (AWWA, 1999). There is a corresponding widespread use of water softeners among City residents (pers. comm., Columbo, 2003).

- pH: The City's water is neutral to slightly basic, with an average pH of about 7.5.

- Chlorine residual: The City chlorinates all of its well water to achieve a system free chlorine residual target of 0.8 to 1.1 mg/L. There have historically been no problems with loss of residual in the City system. Similarly, there have been no problems with high coliform counts, which are usually associated with insufficient chlorine residuals (pers. comm., Dunham, 2002).

- Total Trihalomethanes (TTHM): TTHMs are disinfection by-products (DBP) that are found at relatively low concentrations (10 to 25 µg/L) in the City's system, as would be expected from chlorination of groundwater. Groundwater typically has low concentrations of DBP precursors, which can be measured as Total Organic Carbon (TOC). TOC data is not available for the City's water, but the reported TTHM range suggests an average TOC content in the City's groundwater sources of approximately 1 mg/L

- Lead and copper: The City has conducted monitoring at the tap per the federal Lead and Copper Rule and no action level exceedances for either parameter have been recorded based on the annual Water Quality Reports reviewed. The 90th percentile value for the 1998-2000 data sets for copper monitoring was 1.1 mg/L as compared to the corresponding action level of 1.3 mg/L. This suggests some corrosion of household copper plumbing, given the non-detect or otherwise very low copper results associated with the City's source water per Water Quality Reports from the early 1990s.

2.2.2 Water Supply Scenario with Nacimiento Imports

As discussed in Chapter 1, the City is considering participating in the Nacimiento Project and receiving imported water deliveries of 4,000 acre-feet per year (AF/yr). (It is understood that this allocation may change depending on decisions made by the Nacimiento Participants Advisory Committee members and/or other agencies.) It is envisioned that the City will receive its full allocation of 4,000 AF/yr when the Project is implemented, and use its groundwater sources to meet its remaining demand. Initially, this scenario will represent a significant decrease in groundwater production as compared to current conditions. Over time, however, assuming the City's Nacimiento allocation remains at 4,000 AF/yr, groundwater production will have to again steadily increase to meet the City's growing population and associated water demand.

As noted in Chapter 1 and discussed more fully in Appendix A, previous authors have developed a number of estimates of future City population and water demand. For the purposes of investigating the expected proportions of City water sources over time, we used a current population of 26,000 (City of El Paso de Robles, 2003a) and estimated a current water demand of 7,300 AF/yr based on available 2001 and 2002 water production records (City of El Paso de Robles, 2002). An average annual increase in both of 3% was used (Todd, 2000), which brings the population in 20 years to approximately 47,000. This is a reasonable and conservative estimate of the City's build-out population, given the estimate of 42,000 as presented in Appendix A and the possibility of additional annexation. The water demand associated with a population of 47,000 in 2023 would be approximately 13,200 AF/yr, given current consumption rates. This is generally consistent with the 2020 demand estimates of 10,600 and 11,130 AF/yr presented in the 2000 Urban Water Management Plan (Todd, 2000).

Table 2-1 summarizes the growth in the City's water demand and expected reliance on surface water and groundwater sources from the present (2003) to 2023, based on the assumptions outlined above. This population, demand, and water supply analysis is also shown graphically in **Figure 2-1**.

The distribution of water between the East and West Zones indicated in the table reflects that most of the future growth is expected to take place in the East Zone, as discussed in the Water Master Plan (Boyle, 1995), and that the percentage of the City's population that resides in the East Zone will increase with time. As noted in the table, the distribution of groundwater and imported surface water between the West and East Zones was estimated based on (1) a faster rate of population growth in the East Zone over the coming decades and (2) equitable distribution of surface water between the two zones over time; that is, as the imported surface water amount stays fixed at 4,000 AF/yr while the demand grows, the surface water is assumed to be distributed between the West and East Zones according to their proportional population. The water quality and customer equity issues associated with this assumption are discussed later in this report.

As illustrated by **Figure 2-1**, the introduction of surface water in the near future (e.g., 2007) would reduce the use of City groundwater by roughly one-half. Under this scenario, in 2007, both imported surface water and groundwater would contribute approximately 4,000 AF/yr to meet the City's projected demand at that time of just over 8,000 AF/yr. As the population continues to grow, the City's groundwater production would steadily increase to make up the difference between the growing water demand and the 4,000 AF/yr surface water allocation.

As seen in **Figure 2-1**, under this scenario, by 2014, the City's wells will be producing 1.5 times the imported surface water amount (i.e., approximately 6,000 AF/yr), and by 2018, the City's wells will again be producing as much water per year as they are now. That is, for the first 10 years or so of importing water from Lake Nacimiento, the City's wells can be operated at lower production rates than they are now. After about 10 years (in 2018 in our scenario), however, the imported supply no longer offsets the expected growth in demand, and City groundwater production will have to increase over its current 7,000 to 8,000 AF/yr to meet the City demand.

A key consideration related to importing surface water and reducing groundwater production in the near-term is maintenance of the City's water rights to Salinas River Underflow water. City wells completed in the Underflow include the Thunderbird wells, the Borcherdt well, and the off-line Ronconi wells. As discussed in Appendix A, the City currently has water rights to produce either 4,600 or 5,800 AF/yr from the Underflow (according to two different sources). Following the introduction of surface water, City pumping from the Underflow will decrease significantly, as shown in the "Groundwater Supply to West Zone" column in **Table 2-1.**

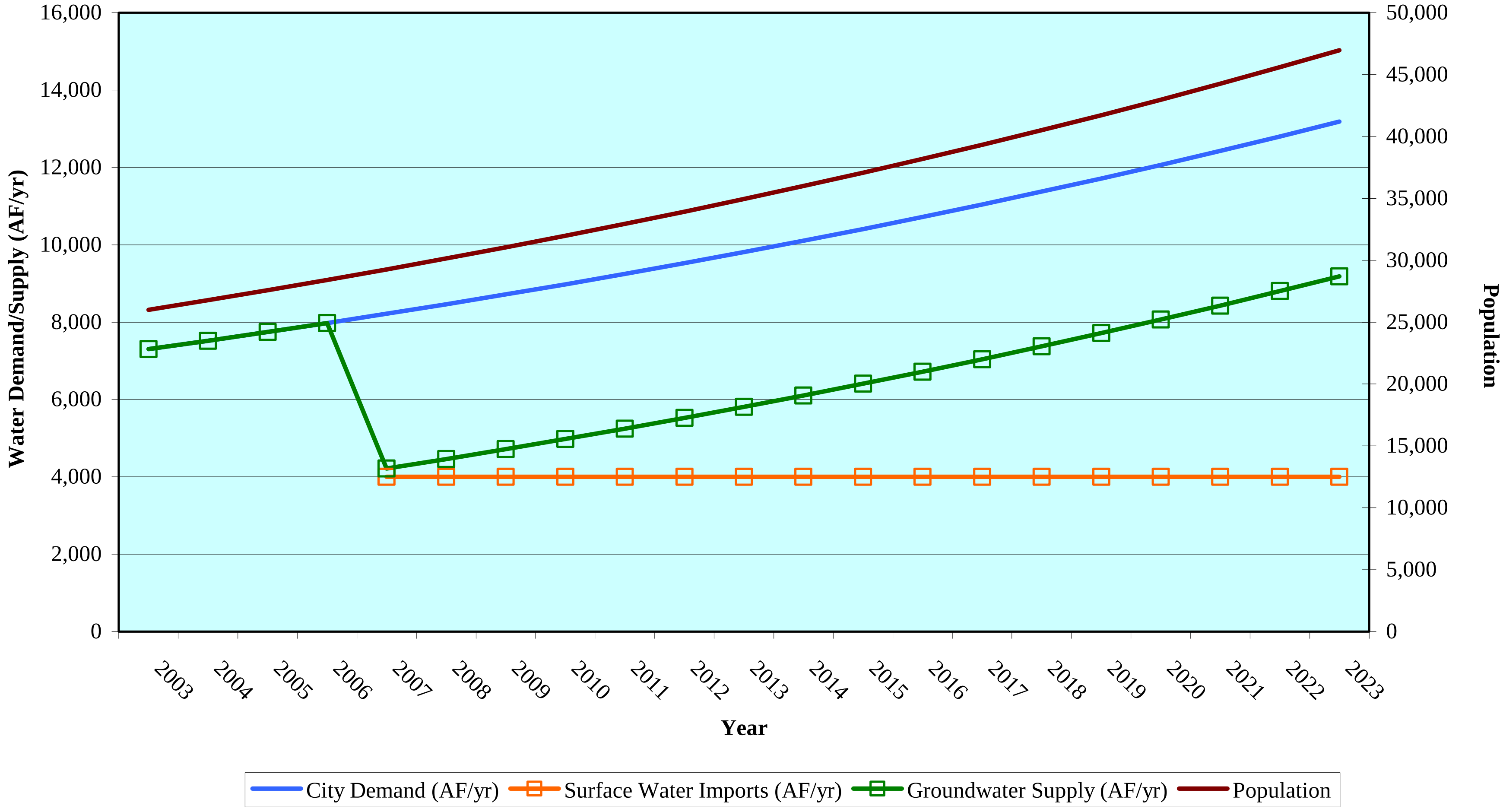
Table 2-1. Population, Water Demand, and Water Supply Sources Over Time

Year	Population	City Demand (AF/yr)	West Zone Demand (AF/yr)	East Zone Demand (AF/yr)	Surface Water Imports (AF/yr)	Surface Water Imports to West Zone (AF/yr)	Surface Water Imports to East Zone (AF/yr)	Groundwater Supply (AF/yr)	Groundwater Supply to West Zone (AF/yr)	Groundwater Supply to East Zone (AF/yr)
2003	26,000	7300	2920	4380	-	-	-	7300	2920	4380
2004	26,780	7519	2972	4547	-	-	-	7519	2972	4547
2005	27,583	7745	3024	4721	-	-	-	7745	3024	4721
2006	28,411	7977	3075	4902	-	-	-	7977	3075	4902
2007	29,263	8216	3127	5089	4000	1522	2478	4216	1605	2612
2008	30,141	8463	3179	5284	4000	1503	2497	4463	1676	2786
2009	31,045	8717	3231	5486	4000	1483	2517	4717	1748	2968
2010	31,977	8978	3282	5696	4000	1462	2538	4978	1820	3158
2011	32,936	9247	3334	5913	4000	1442	2558	5247	1892	3355
2012	33,924	9525	3386	6139	4000	1422	2578	5525	1964	3561
2013	34,942	9811	3438	6373	4000	1402	2598	5811	2036	3775
2014	35,990	10105	3489	6615	4000	1381	2619	6105	2108	3997
2015	37,070	10408	3541	6867	4000	1361	2639	6408	2180	4228
2016	38,182	10720	3593	7127	4000	1341	2659	6720	2252	4468
2017	39,327	11042	3645	7397	4000	1320	2680	7042	2324	4717
2018	40,507	11373	3697	7677	4000	1300	2700	7373	2396	4977
2019	41,722	11714	3748	7966	4000	1280	2720	7714	2468	5246
2020	42,974	12066	3800	8266	4000	1260	2740	8066	2540	5525
2021	44,263	12428	3852	8576	4000	1240	2760	8428	2612	5816
2022	45,591	12801	3904	8897	4000	1220	2780	8801	2684	6117
2023	46,959	13185	3955	9229	4000	1200	2800	9185	2755	6429

Notes and Assumptions

1. Current population of 26,000 is based on City website (City of El Paso de Robles, 2003a)
2. Growth in population is assumed to be 3% per year (Todd, 2000) to a build-out population of 47,000 (see population/build-out discussion in Appendix A).
3. City demand is assumed to grow commensurate with population (i.e., 3% per year).
4. The ratio of West Zone demand to East Zone demand is expected to decrease from 40:60 to 30:70 as the population grows (per Tables 4 and 6 of Boyle, 1995)
5. Surface water imports are assumed to be 4000 AF/yr according to the existing plan for City participation in the Nacimiento Project.
6. Surface water imports are assumed to begin in 2007 following design, construction, and startup of a new water treatment plant.
7. Groundwater used is calculated based on each year's difference between surface water imports and City demand.

Figure 2-1. Population, Water Demand, and Water Supply Sources Over Time



As discussed in previous reports (e.g., Boyle, 1995 & Todd, 2000), the City typically does not use its full Underflow allocation each year. Under the surface water supply import scenario considered here, this would not change; however, the City would be using a lower percentage of its allocation than it has in recent years. There is a general concern that reducing pumping from wells completed in the Underflow (e.g., the Thunderbird wells) may reduce the magnitude of the City's water rights to pump from this zone. However, there is no information in available reports that indicates the City would jeopardize its Underflow water rights by reducing pumping from its Underflow wells in accordance with the introduction of surface water into the system. However, the City may wish to confirm this. One method to possibly help maintain the Underflow water rights if necessary following the introduction of surface water would be to preferentially pump from the Thunderbird well field to meet the 4,000 AF/yr or so not met by imported surface water. Reactivating the Ronconi wells could also be a strategy to ensure that pumping from the Underflow unit is maintained. (This would require the implementation of treatment, such as microfiltration, at these wells because they have been determined to be under the direct influence of surface water.) The Borcherdt well, although located on the City's east side, is also classified as an Underflow well. However, serving the East Zone by increasing the proportion of water produced by Underflow wells may be limited by the system's west-to-east hydraulic capacity. Also, because the wells supply the City's distribution system directly, doing so would likely lead to water quality/customer equity impacts as discussed in Chapter 3 of this report.

2.2.3 Imported Water Quality

This section discusses the quality of the water that will be introduced into the City's system if and when surface water imports are brought on-line. Specifically, this section discusses the quality of treated Lake Nacimiento water considering three possible water treatment plant locations and four candidate water treatment plant configurations and process trains.

The City importing raw water from the Nacimiento project is a possibility, but is not considered here in detail. Our understanding is that a "phased approach" to City participation in the Nacimiento Project was originally considered. The first phase of such an approach would consist of importing raw water for local recharge for approximately 10 years prior to the implementation of a water treatment plant.

Raw water would not be suitable for direct delivery to City customers or blending with existing groundwater supplies, but could be used to recharge the Salinas River Underflow groundwater supply. The potential benefits to this approach are that (1) City costs to help construct a water treatment plant are deferred while the City is only accepting raw water, and (2) water storage and water rights associated with the Salinas River Underflow supply are enhanced by the addition of the imported surface water.

Under this scenario, the City would still have to pay their share of the Nacimiento Project facilities to transmit raw water from the lake to the City. (Cost-sharing strategies are still being discussed among the Nacimiento Participants Advisory Committee members.) The most important drawback of raw water imports relative to the City's water quality strategy, however, is that the City would not realize the full benefit of the relatively low-TDS lake water – both in terms of drinking water quality and wastewater effluent quality. That is, if the low-TDS lake water is recharged into the Salinas River Underflow, it will mix with the existing high-TDS shallow groundwater and likely only partially be recovered in City wells completed in that zone.

In addition to the potential loss of the TDS benefit of importing water, the City may also not be able to recover the full quantity of the recharged water. It is Malcolm Pirnie's understanding that this Project participation option (importing raw water) was introduced a number of years ago, before City water and wastewater quality issues were considered as critical as they are today.

2.2.4 Nacimiento Project Water Treatment Alternatives

Documents reviewed for this project (Carollo, 2002 & Nacimiento Participants Advisory Committee, 2001) indicate that a regional water treatment plant would likely be sited approximately halfway between Lake Nacimiento and the City (i.e., roughly 10 miles from each). For the purposes of considering possible water quality characteristics of imported treated water, we considered two additional locations. These were: (1) at the Lake, and (2) just at the north end of the City, to represent "worst-case" and "best-case" scenarios relative to DBP formation. These scenarios are discussed later in this section with regards to water age and DBP formation.

An earlier study that evaluated a regional treatment plant for Lake Nacimiento water considered the following treatment technologies (Boyle, 2002):

- Conventional treatment that included coagulation, sedimentation, and flocculation processes with GAC as the filter media in filtration.

- The Actiflo® process, which is a proprietary, ballasted, coagulation-flocculation process. In this process, microsand is used as ballast material to aid in the formation of floc. (Operation of the "hydrocyclone" centrifuge unit necessary for this process is generally energy-intensive.)

- Membrane treatment with or without GAC polishing treatment.

For all the above processes, Boyle (2002) suggested using either chloramines or ultraviolet (UV) light with chloramines for disinfection. The regional treatment plant considered had a capacity of 17 MGD. Boyle (2002) appears to have provided a well-developed discussion of regional water treatment plant options and treated water quality. For this exercise, we built on their work by focusing on (1) a local water treatment plant – discussed below – and (2) the considerations associated with introducing treated surface water into the City's distribution system – discussed later in this chapter.

A treatment plant dedicated to supplying water to the City of El Paso Robles would be approximately of 4-MGD (4000 AF/yr equals 3.6 MGD) capacity, roughly one-fourth the size of a regional treatment plant. This 4-MGD capacity is based on the City relying on surface water imports for its "base flow," or relatively constant production, and increasing or decreasing groundwater production to match City demand including peak demand. For a treatment plant as small as 4 MGD, it is economical to use automated, packaged treatment systems that are relatively easy to design, install, operate, and maintain as compared to a treatment plant the size of the proposed regional plant that is not available as a package and must be designed from the ground up. Giving due consideration to the water quality of Lake Nacimiento water as summarized in Appendix A, current/future drinking water regulations, and treatment plant size, the following four treatment scenarios were considered to be the most feasible alternatives for a City-dedicated 4-MGD water treatment plant:

- Conventional treatment with disinfection using chloramines (Scenario 1A).

- Conventional treatment coupled with granular activated carbon (GAC) post-filter adsorber and disinfection using free chlorine (Scenario 1B).

- Microfiltration (MF) with chloramines as the disinfectant (Scenario 2A).

- MF with GAC post-filter adsorbers and free chlorine as the disinfectant (Scenario 2B)

There are benefits and drawbacks and finished water quality differences associated with each of these water treatment scenarios. The treatment processes, chemicals, doses, detention times, and other parameters discussed in this section are planning-level estimates, and are indicated here for comparative purposes. More detailed analyses of the selected treatment processes will be necessary if a water treatment plant is to be implemented. A key concern for surface water treatment plant managers and operators nationwide is the need to achieve adequate microbial control while minimizing disinfection by-product formation. The Stage 1 Disinfectants/Disinfection By-Products (D/DBP) Rule limits for average TTHMs and haloacetic acids (HAA) in the distribution system are 80 µg/L and 60 µg/L, respectively. To limit the formation of TTHMs and HAAs, sufficient DBP precursor removal must occur in the treatment process. Using chloramines in place of free chlorine to maintain a distribution system residual can also help to control DBP formation.

Except for the proprietary Actiflo⊇ treatment process, the treatment trains that are being considered in this study agree with what were considered for the regional treatment facility. The Actiflo⊇ process is energy-intensive and also generates residuals that may be difficult to handle. Therefore, the Actiflo⊇ process was not considered to be a viable alternative for the City-dedicated plant considered here. However, because both conventional and Actiflo⊇ processes rely on coagulation for TOC removal, they are very similar in terms of DBP precursor removal performance.

A schematic of the Scenario 1A treatment train is shown as **Figure 2-2**. Treating the water conventionally using coagulation, flocculation, sedimentation, and filtration processes can achieve only a limited amount of total organic carbon (TOC) removal, and therefore may lead to problematic DBP concentrations. Therefore, for treatment Scenario 1A, chloramines were considered as the disinfectant to help ensure compliance with DBP regulations. The key conceptual design criteria for the Scenario 1A conventional treatment plant are summarized in **Table 2-2**. Ferric chloride was assumed as the coagulant for this evaluation for two main reasons. First, studies have shown that iron-based coagulants are generally superior to aluminum-based coagulants for TOC removal. This is a primary concern for treatment of Lake Nacimiento water because higher removal of TOC results in lower DBP concentrations. Second, ferric chloride generally removes iron and manganese better than alum. (As noted in Appendix A, available Lake Nacimiento data indicate possible problematic concentrations of iron and manganese.) Bench-scale studies such as jar tests will help in identifying the most appropriate coagulant among the available choices (e.g., aluminum sulfate, polyaluminum chloride, ferric chloride, and other proprietary coagulants) if and when a water treatment plant is moved forward in the planning and design process.

Figure 2-2. Schematic of Conventional Treatment (Scenario 1A)

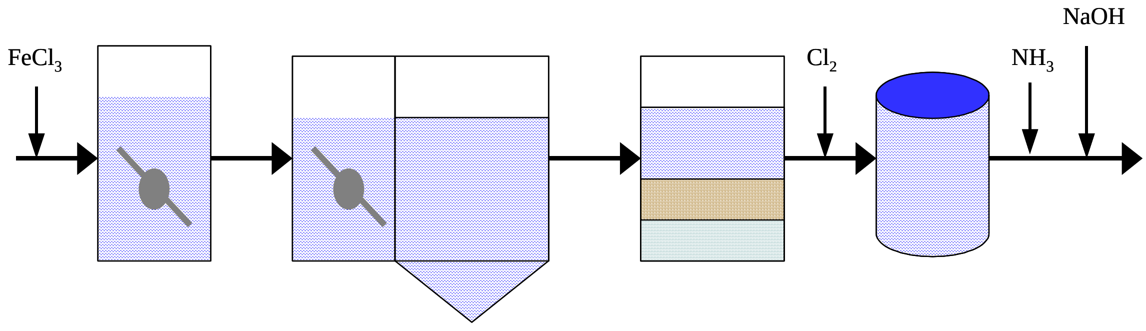


Table 2-2. Conceptual Design Criteria For Conventional Treatment Plant (Scenario 1A)

Parameter	Value
Rapid Mixing	
Coagulant ($FeCl_3$) Dose	15 mg/L
Detention Time	5 min
Flocculation	
Detention Time	30 min
Sedimentation	
Detention Time	2 hr
Overflow Rate	800 gpd/sf
Tank Depth	12 ft
Filtration	
Loading Rate	6 gpm/sf
Filter Type	Dual-media (anthracite/sand)
Detention Time	20 min
Chlorine Addition	
Chlorine Dose	2.8 mg/L
Finished Water Reservoir	
Detention Time	1 hr
Ammonia Addition	
Ammonia Dose	0.6 mg/L
pH Adjustment	
Target pH	7.5
Caustic Dose	2.5 mg/L

The conventional plant system will include a finished water reservoir to provide approximately one hour of detention time (after chlorine addition, before ammonia addition) to achieve the necessary free chlorine contact time prior to creation of the chloramine residual.

The unit process schematic for Scenario 1B is shown as **Figure 2-3**. The conceptual design criteria for Scenario 1B are shown in **Table 2-3**. Polishing treatment with GAC is the only additional treatment process or change in Scenario 1B compared to Scenario 1A. The assumed empty-bed contact time for the GAC filters is 15 min with a replacement frequency of 180 days. A pressure vessel is also possible for the GAC unit process at the treatment plant size considered. In this scenario also, the finished water is stored in a reservoir for about one hour after chlorination for contact time purposes.

Figure 2-3. Schematic of Conventional Treatment Coupled with Post-Filter Adsorber (Scenario 1B)

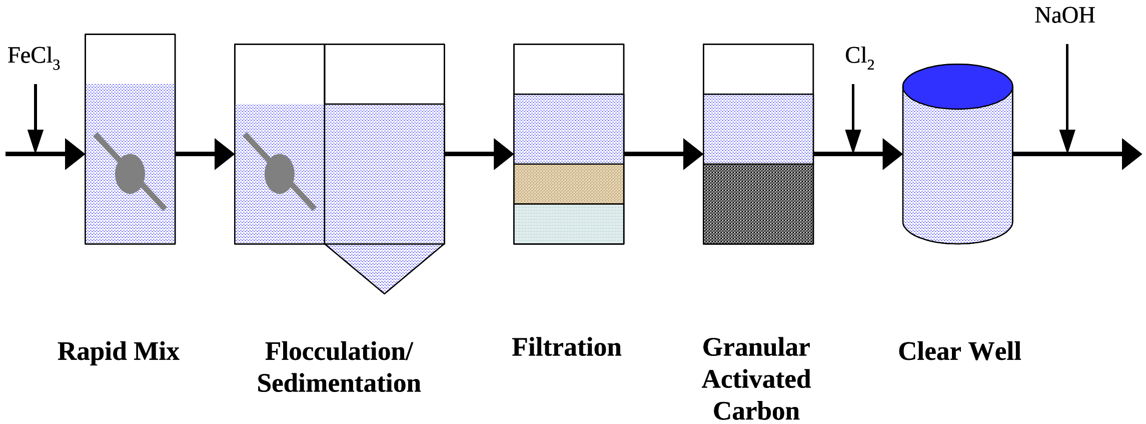


Table 2-3. Conceptual Design Criteria For Conventional Treatment Plant With Post-Filter Adsorbers (Scenario 1B)

Parameter	Value
Rapid Mixing	
Coagulant ($FeCl_3$) Dose	30 mg/L
Detention Time	5 min
Flocculation	
Detention Time	30 min
Sedimentation	
Detention Time	2 hr
Overflow Rate	800 gpd/sf
Tank Depth	12 ft
Filtration	
Loading Rate	6 gpm/sf
Filter Type	Dual-media (anthracite/sand)

Parameter	Value
Detention Time	20 min
Chlorine Addition	
Chlorine Dose	2 mg/L
GAC Adsorption	
Empty-Bed Contact Time	20 min
Replacement Frequency	180 days
Loading Rate	6 gpm/sf
Finished Water Reservoir	
Detention Time	1 hr
pH Adjustment	
Target pH	7.5
Caustic Dose	8.5 mg/L

The schematic for the MF plant of Scenario 2A is shown as **Figure 2-4**. As indicated, it may be necessary to add some coagulant prior to MF to achieve adequate turbidity removal. The conceptual design criteria for the MF system are shown in **Table 2-4**. Approximately 95 percent or more of the feed water that goes through the MF system will be product water (>95 percent recovery). The finished water reservoir after chlorine addition in Scenario 2A will be sized to yield a detention time of 5 min. Most of the disinfection credits are obtained by the MF treatment. MF treatment is capable of significant log removal of bacteria, *Giardia*, and *Cryptosporidium*; however, MF treatment alone is not effective for DBP precursor removal. Therefore, for Scenario 2A, to reduce formation of DBPs in the distribution system, chloramines were considered for disinfection.

Figure 2-4. Schematic of Microfiltration Treatment (Scenario 2A)

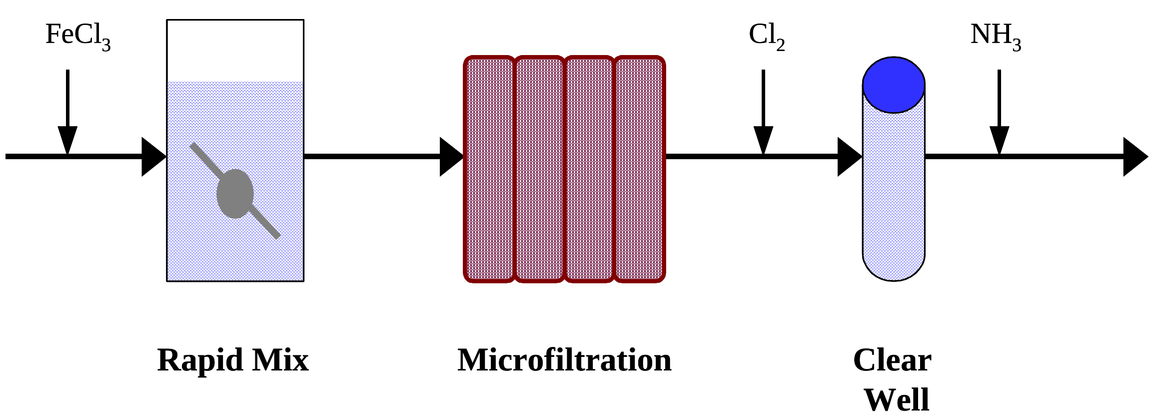


Table 2-4. Conceptual Design Criteria For Microfiltration Treatment Plant (Scenario 2A)

Parameter	Value
Rapid Mixing	
Coagulant ($FeCl_3$) Dose	5 mg/L
Detention Time	5 min
Microfiltration	
Recovery	>95%
Flux Rate	Depends on Membrane Type and Design (Pressurized or Submerged)
Operating Pressure	Depends on Membrane Type and Design
Chlorine Addition	
Chlorine Dose	2.5 mg/L
Finished Water Reservoir	
Detention Time	5 min
Ammonia Addition	
Ammonia Dose	0.6 mg/L

Illustrated as **Figure 2-5** is the schematic for MF treatment coupled with GAC polishing treatment (Scenario 2B). The GAC polishing treatment in Scenario 2B is expected to reduce TOC significantly. Therefore, free chlorine can be used for disinfecting the Scenario 2B water. The conceptual design criteria for Scenario 2B are shown in **Table 2-5**.

Figure 2-5. Schematic of Microfiltration with Post-Filter Adsorber (Scenario 2B)

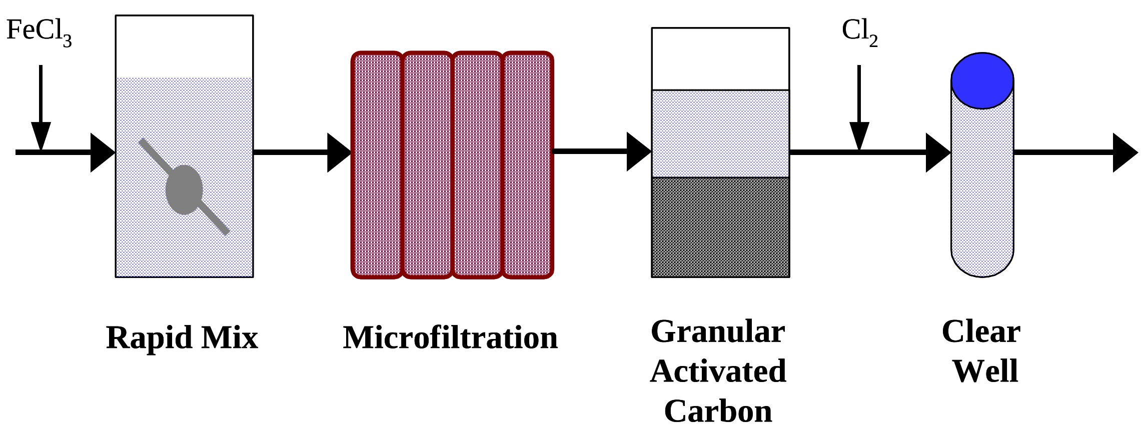


Table 2-5. Conceptual Design Criteria For Microfiltration Treatment Plant (Scenario 2B)

Parameter	Value
Rapid Mixing	
Coagulant ($FeCl_3$) Dose	5 mg/L
Detention Time	5 min
Microfiltration	
Recovery	95%
Flux Rate	Depends on Membrane Type and Design (Pressurized or Submerged)
Operating Pressure	Depends on Membrane Type and Design
GAC Adsorption	
Empty-Bed Contact Time	20 min
Replacement Frequency	180 days
Loading Rate	6 gpm/sf
Chlorine Addition	
Chlorine Dose	2.1 mg/L
Finished Water Reservoir	
Detention Time	5 min

Presently, the groundwater that is being supplied to the City's customers is being disinfected using free chlorine. If chloramines were considered to disinfect Lake Nacimiento water then due consideration must be given to potential issues of mixing of waters with different disinfectants in the distribution system. Specifically, if water with free chlorine is mixed with chloraminated water, the disinfectant residual may be lost, and taste-and-odor problems may result. There are utilities that have successfully used both chlorinated and chloraminated water in their distribution systems. However, careful planning including modeling and bench, pilot, and field experiments are necessary to ensure adverse impacts do not occur. Additionally, public relations/education (e.g., kidney dialysis centers, aquarium owners) must be conducted along with coordination with regulatory agencies (for Paso Robles, the California Department of Health Services). Generally, mixing residual disinfectants is risky and should be avoided if possible. Certainly, using GAC polishing treatment may enable the use of free chlorine as the disinfectant and thereby avoid the presence of variedly disinfected waters in the City's distribution system.

2.2.5 Water Treatment Plant Modeling Results/Treated Water Quality

Malcolm Pirnie's Water Treatment Plant (WTP) model was used to predict the treated water quality for the alternative treatment scenarios discussed above. The WTP model is an empirical model developed by Malcolm Pirnie in conjunction with the USEPA and the University of Colorado at Boulder, and simulates surface water treatment plant performance with a focus on disinfection and DBP formation. The WTP modeling approach includes estimation of organic removal by individual treatment processes, disinfectant decay based on the demands exerted by the organics in the water, and DBP formation based on the water quality at the treatment plant and in the distribution system.

The WTP model simulations were performed using the raw Lake Nacimiento water quality summarized in Appendix A. Other input parameters (specifically, ammonia, bromide, and UV_{254} absorbance) were estimated based on Lake Nacimiento data provided by the County of San Luis Obispo (County of San Luis Obispo, 2002). A conservative raw water quality scenario was generated, based on 90th percentile values of the ranges of water quality parameters shown in Tables 5-1 through 5-4 of Appendix A of this report.

Water age for our water quality modeling purposes is the total time that the treated water would spend in the transmission pipeline, City storage reservoirs, and in the distribution system. Water age is a significant parameter that governs the concentrations of DBPs in water reaching consumers. Assuming a typical water transmission velocity of 5-7 feet per second, it would take approximately 4-6 hours to transport water from Lake Nacimiento to the City. It is our understanding from review of available reports (e.g., Boyle, 1995) and conversations with Water Division staff (pers. comm., Dunham, 2003) that a range or average of water age in the City distribution system has not been previously estimated or calculated. Based on the system schematic and description in the Water Master Plan (Boyle, 1995) and the City's Water Atlas (City of El Paso de Robles, 1996), we estimated the system water age could range from zero to eight hours or more, with an average age at the low end (e.g., 1 to 2 hours). Because the wells (and the future Nacimiento turnouts) directly feed the distribution system, there is a high level of confidence associated with the low end of this range (essentially zero detention time). The upper end of the water age range is more difficult to estimate. This is because of the City's well and storage reservoir operations, which are typical of water utilities of its size. Specifically, water levels in the City's two 4.0 million gallon reservoirs and one 150,000-gallon reservoir activate or shut off the City's wells. Wells feed the system and customers directly, and feed the reservoirs when production exceeds demand. Wells shut off when the reservoirs are nearly full, at which time the reservoirs feed the system.

Total water age for our modeling purposes was conservatively estimated to be 2 days. This accounts for the estimated 4-6 hour transmission time, the estimated high end of the in-City detention time (8 hours), plus a significant factor of safety to account for the uncertainties associated with in-City operations. As discussed earlier, the greater the distance that the future treatment plant is from the City, the greater the travel time and DBP formation will be. If the water age in the City were known with greater accuracy, DBP concentrations could be modeled according to distance from the treatment plant to the City. However, the degree of uncertainty associated with the water age in the City system as described above exceeds the differences in travel time associated with the potential treatment plant sites. Therefore, it would not be meaningful at this conceptual planning stage to attempt to distinguish water quality characteristics according to travel distance, and a conservative 2-day water age is assumed for all model runs. However, depending on the City's future regional or local water treatment options, siting the plant as close to the City as possible is generally preferable from a water quality standpoint for disinfectant residual maintenance and to minimize DBP formation.

Summarized in **Tables 2-6** through **2-9** are the WTP simulation results for key water quality parameters for the four treatment scenarios. The surface water treatment processes considered do not remove hardness and TDS. Each table shows the results for water quality leaving the treatment plant ("finished water quality") and in the distribution system at the end of the 2-day period discussed above. Between Scenarios 1A (conventional treatment with chloramines) and 1B (conventional treatment with filter adsorbers and free chlorine for disinfection), Scenario 1B had lower TTHMs and HAAs leaving the plant because of the greater removal of organics by the GAC filter adsorber. At the end of two days, however, the levels of DBPs for Scenarios 1A and 1B are comparable (1B had more TTHMs and 1A had more HAAs) due to the greater degree of DBP formation associated with free chlorine disinfection. As expected, using chloramines for disinfection results in a lesser degree of DBP formation after finished water leaves the plant, and may be an economical alternative compared to post-filter adsorbers.

Table 2-6. WTP Model Predictions For Conventional Treatment Plant (Scenario 1A)

Parameter	Estimated Value
Finished Water Quality	
pH	7.5
Residual Total Chlorine (Chloramine)	2.0 mg/L
Average TOC	4.0 mg/L
TTHMs	25 µg/L
HAAs	20 µg/L
In Distribution System After 2 Days	
Residual Total Chlorine (Chloramine)	1.9 mg/L
TTHMs	35 µg/L
HAAs	25 µg/L

Table 2-7. WTP Model Predictions For Conventional Treatment Plant With Post-Filter Adsorbers (Scenario 1B)

Parameter	Estimated Value
Finished Water Quality	
pH	7.5
Residual Free Chlorine	1.5 mg/L
Average TOC	2.0 mg/L
TTHMs	10 µg/L
HAAs	10 µg/L
In Distribution System After 2 Days	
Residual Free Chlorine	0.5 mg/L
TTHMs	50 µg/L
HAAs	20 µg/L

Table 2-8. WTP Model Predictions For Microfiltration Treatment Plant (Scenario 2A)

Parameter	Estimated Value
Finished Water Quality	
pH	7.5
Residual Free Chlorine	0 mg/L
Residual Total Chlorine (Chloramine)	2.0 mg/L
Average TOC	4.0 mg/L
TTHMs	15 µg/L
HAAs	15 µg/L
In Distribution System After 2 Days	
Residual Free Chlorine	0 mg/L
Residual Total Chlorine (Chloramine)	1.8 mg/L
TTHMs	20 µg/L
HAAs	20 µg/L

Table 2-9. WTP Model Predictions For Microfiltration Treatment Plant With Post-Filter Adsorbers (Scenario 2B)

Parameter	Estimated Value
Finished Water Quality	
pH	7.5
Residual Free Chlorine	2.0 mg/L
Average TOC	2.0 mg/L
TTHMs	10 µg/L
HAAs	10 µg/L
In Distribution System After 2 Days	
Residual Free Chlorine	0.5 mg/L
TTHMs	30 µg/L
HAAs	30 µg/L

The TTHMs and HAAs in Scenarios 2A and 2B are somewhat lower than for Scenarios 1A and 1B. This is to be expected because of the superior removal of particulates and flocculated material by MF compared to conventional treatment, and the subsequent need for shorter chlorine contact time for primary disinfection. The 2-day TTHMs and HAAs for Scenario 2B treated water are higher than the 2-day TTHMs and HAAs for Scenario 2A treated water, again, due to the assumed use of free chlorine instead of chloramine in these scenarios. Among the four treatment scenarios, Scenario 2A had the lowest TTHMs and HAAs in the distribution system water due to the combination of microfiltration and residual disinfection with chloramines. All four treatment scenarios produced water that meets the Stage-2 DBP Rule limits for TTHMs (80 µg/L) and HAAs (60 µg/L).

These four treatment scenarios and model runs representing a potential future City-dedicated plant necessarily are conceptual-level only, limited by the extent of available raw water data, and do not provide an exhaustive or detailed analysis of all the treatment options or process combinations available to the City if such a plant is pursued. They do, however, represent the most practical and economic alternatives, given the quality of Lake Nacimiento water and the expected size of a City-dedicated plant. The model runs indicate that although GAC units can provide additional TOC removal beyond that provided by conventional treatment alone (and therefore lower DBPs in finished water leaving the plant), the benefits of doing so may not be as great as using chloramine instead of free chlorine as the residual disinfectant. This choice (for both the potential regional and City-dedicated treatment plant) is a function of several parameters, including the desires of other Project participants regarding disinfectant selection, the final distance from the plant to the City, and the various pros and cons – including cost – of converting the City's existing disinfectant to chloramine. These are discussed in Chapter 3 to the extent practical given the conceptual stage of this project. Much of the decisions regarding water quality and treatment will be dictated by still-undetermined variables – in particular, by what method, if any, the City will receive Lake Nacimiento water.

2.2.6 Blending Analysis

The analysis of potential blending impacts was conducted considering several factors. These include:

- ∉# The raw (Lake Nacimiento) water quality as discussed in Appendix A and noted above.

- ∉# The characteristics of the treated water from either a regional water treatment plant as discussed in Boyle (2002) or as described in the previous sections for a smaller City-dedicated water treatment plant.

- ∉# The characteristics of the City's existing groundwater and current operations regarding corrosion control and chlorination.

- ∉# The materials of construction of the City's existing water system.

When evaluating blending impacts from mixing two waters (in this case, treated surface water and groundwater) it is important to review the key parameters that define chemical compatibility between waters and can indicate potential problems. Waters from two or more sources can often be successfully mixed, but careful attention must be paid to avoid problems associated with corrosivity, disinfectant residual loss, taste-and-odor, color, and other system problems (e.g., excessive precipitation/scaling). The Langelier Saturation Index (LSI) and Calcium Carbonate Precipitation Potential (CCPP) are commonly used parameters that can indicate a water's tendency to either dissolve existing calcium carbonate scale (undesirable) or to deposit protective calcium carbonate scale (a mild degree of deposition is desirable). Each of the key parameters relative to blending treated Lake Nacimiento water with City groundwater is discussed below.

- ∉# **Hardness.** If a very soft water (e.g., 30-40 mg/L or less) is introduced into a system conditioned with water of moderate hardness or greater, adverse impacts may occur. Specifically, soft water is generally more "aggressive" or corrosive than hard water, and the relative lack of cations such as calcium or magnesium in it may lead to difficulties in forming a protective scale on the interior of a distribution system. City groundwater is on the high end of what is considered "hard" water (AWWA, 1999), ranging from 250 to 300 mg/L as $CaCO_3$. This is generally beneficial from a system corrosion perspective although it results in the widespread use of residential water softeners. Available data indicate that Lake Nacimiento water is moderately hard (AWWA, 1999), ranging from roughly 80 to 130 mg/L of hardness as $CaCO_3$. Surface water treatment would not affect the hardness of the lake water. Although there is some difference between the two waters in hardness, the expected blend of the two waters will still contain at least 150 to 175 mg/L of hardness, quite sufficient to provide beneficial scale material in drinking water distribution systems.

- ∉# **pH.** If waters of significantly different pH are blended, adverse effects can occur. In general, lower pH (more acidic) waters are more aggressive and may lead to dissolution of beneficial scale built up under more favorable pH conditions (slightly above the pH of saturation for calcium carbonate). The ambient pH of the City's existing system supplied by groundwater is approximately 7.5. Typically surface water treatment plants will control (raise) pH at the end of the treatment process because the addition of oxidants such as chlorine and coagulants such as ferric chloride tend to depress pH values through the treatment process. (This is especially true for utilities practicing enhanced coagulation, where pH is often depressed further to achieve maximum particulate and organic removal through the coagulation/flocculation/sedimentation process.) Typically a target pH will be set by a utility based on DBP and corrosion control concerns, and application of a chemical such as caustic soda will be used to achieve the target. Because of this flexibility, achieving pH compatibility between treated lake water and City groundwater is relatively straightforward. The water treatment plant modeling efforts described earlier in this chapter assumed a treated water target pH of 7.5 to match the City's groundwater. Therefore, no adverse blending impacts are indicated based on the pH values of the two waters.

- **Alkalinity.** Alkalinity and pH are interdependent, but in general, low alkalinity in source water or in blended waters suggests potential problems. Alkalinity provides buffering capacity against changes in pH, so with insufficient alkalinity, undesirable pH swings can occur, potentially leading to DBP and/or corrosion problems. Alkalinity also provides carbonate for beneficial calcium carbonate scale formation, so without sufficient alkalinity, protective scale might not form, regardless of pH conditions or water hardness. Data from Lake Nacimiento indicate that its alkalinity ranges from roughly 90 to 130 mg/L as $CaCO_3$, and City groundwater is higher, averaging about 250 mg/L. Although determining blended water alkalinity cannot be performed by simple mass proportions as with TDS or hardness and alkalinity benchmarks, both these numbers indicate adequate buffer capacity as well as sufficient carbonate content to continue to form beneficial scale in the City's distribution system. For comparison purposes, the alkalinity categories for source water incorporated into the TOC removal requirements of the D/DBP Rule are as follows: low, 0-60 mg/L; medium, 60-120 mg/L; and high, >120 mg/L.

Summarized in **Table 2-10** are the values for these three key parameters and others for the raw and variously treated water scenarios. These are based on the WTP model runs described in Section 2.3, which provide these finished water quality parameters in addition to those indicated in **Tables 2-6** through **2-9**.

Table 2-10. Selected Additional Raw and Treated Water Quality Parameters for the Four Modeled WTP Scenarios

Parameter	Representative Raw Water Value	Treated Water			
		Scenario 1A	Scenario 1B	Scenario 2A	Scenario 2B
Total Hardness (mg/L as $CaCO_3$)	124	124	124	124	124
pH (units)	8.1	7.5[1]	7.5[1]	7.5[2]	7.5[2]
Alkalinity (mg/L as $CaCO_3$)	130	120[1]	122[1]	123	123
TOC (mg/L)	4.1	3.8	1.8	3.9	2.1
UV_{254} Absorbance (cm^{-1})	0.06	0.03	0.02	0.03	0.02
SUVA[3] (cm^{-1})	1.5	0.8	1.1	0.8	1.1

[1]After pH adjustment via caustic addition
[2]Without caustic addition
[3]SUVA = Specific UV absorbance (100 * UV_{254} absorbance)/TOC)

As indicated in the table, no change in hardness was observed between the raw and finished waters, as expected based on the treatment processes considered. The pH of the water exiting the treatment plant was adjusted to 7.5 (to match the average pH of the groundwater) using caustic for Scenarios 1A and 1B. If caustic were not used for these treatment scenarios, the pH would be significantly lower (more acidic). Adjustment of pH for the plant models using microfiltration (Scenarios 2A and 2B) was not necessary to match the City groundwater pH. Alkalinity in the finished waters is slightly lower than in the raw water. This is to be expected based on some consumption of alkalinity by the treatment process during the coagulation step. As expected, lower TOC values and UV_{254} absorbance values were predicted in finished waters that include the GAC polishing treatment step (Scenario 1B and Scenario 2B).

There are several points to be made based on our review of available water quality and City water system information regarding the potential impacts of blending:

1. From a water quality standpoint, it appears quite feasible to blend Lake Nacimiento water and City groundwater. The characteristics of each are similar enough that blending of the two should not be problematic, provided common treatment steps are taken to prevent adverse impacts. These are discussed below.

2. Design and operation of the water treatment plant that will treat Lake Nacimiento water, whether regional or dedicated to Paso Robles, must account for pH adjustment (raising pH) at the end of the process. This is typically achieved by

the addition of caustic soda, and is necessary to ensure a low-pH, aggressive water is not introduced into the City system. A specific corrosion control product (e.g., an orthophosphate or polyphosphate product) may also be warranted, but this cannot be determined without additional bench-scale or pilot-scale investigations of various water blends. Adjustment of pH is a very common surface water treatment process and will be a significant step to ensure that no adverse water quality effects result from blending the two waters.

3. It is advisable to match the disinfectant used for the City's groundwater and the treated surface water. The City currently disinfects its well water with free chlorine. If free chlorine is used as the residual disinfectant at either a regional or City water treatment plant, slightly faster/higher DBP formation can be expected after the finished water leaves the treatment plant, but the City will be able to continue the use of free chlorine as its groundwater disinfectant. However, if chloramines or selected at the regional or City treatment plant, the City is advised to chloraminate its well water to match residual disinfectants.

4. When treated surface water is available, it is advisable to phase it into the City system gradually, for example, from 0 to the full 3.6 MGD over a period of 6-12 months. This will provide an extra level of protection in addition to the steps noted above against potential adverse blending effects by ensuring that existing protective scale in the City's distribution system is not disturbed by a sudden change in ambient water chemistry.

5. As noted in Appendix A, the installation of steel water pipes in the City has been minimal, so the associated corrosion concerns are relatively low. However, galvanized steel household plumbing is subject to corrosion. As an additional protective measure, the City may want to promote the replacement of galvanized pipe with pipe of an alternative material by home and business owners.

6. Because of the general compatibility of the waters as indicated by available data, the selection of the treatment process (e.g., conventional, microfiltration, with or without GAC) can be conducted independently of blending considerations. That is, each of the processes that would be considered for treatment of Lake Nacimiento water would produce finished water feasible to blend with City groundwater. Any chemical dosage or other operational adjustments necessary to prevent possible blending impacts can be made with any of the candidate treatment trains. The choice between free chlorine and chloramine as the disinfectant used at a regional or City-dedicated water treatment plant, however, will have implications for City operations. Specifically, if chloramine were selected, it would be advisable for the City to switch its groundwater disinfectant to chloramine as well. In terms of selecting a process for the treatment of Lake Nacimiento water, blending impacts are secondary in importance to the considerations of adequate microbial control, disinfection by-product minimization, and cost. The City or appropriate agency can proceed with conceptual design based on these criteria, and possibly conduct jar tests, pipe loop

tests, or others, to verify the expected lack of blending problems and selected corrosion control approach.

A review of the various blending experiences some other water utilities have had supports the assertion that Lake Nacimiento water and City groundwater are similar enough that blending is quite feasible, and that any potential adverse effects can be mitigated with common treatment and operational actions. These case studies also highlight the need to study and identify these actions prior to full-scale implementation, and to phase in any new source of water gradually. These case studies are summarized briefly below.

- *Santa Clara Valley Water District (SCVWD), San Jose, California, and San Francisco Public Utilities Commission (SFPUC), San Francisco, California*. In 1999, these two agencies studied the water quality effects of potential blending of their two waters (SCVWD distribution system water and SFPUC Hetch Hetchy water) during planning and design activities for the "Intertie," a connection between the two systems to be used in case of emergency or service outage (e.g., prolonged plant shutdown) for either utility (CDM, 1999). The two waters were significantly different according to the three parameters discussed above. SFPUC's Hetch Hetchy water is extremely soft, with hardness measurements occasionally as low as 10 mg/L, while SCVWD's is moderately hard, similar to Lake Nacimiento's. SFPUC adjusts its pH to a relatively high level (above 9) for corrosion control, while SCVWD maintains a pH closer to 7.2 to 7.5. Alkalinity in Hetch Hetchy water, like hardness, is very low relative to SCVWD's and most other waters – as low as 10 to 15 mg/L. Additionally, at the time, SCVWD used chloramine as its residual disinfectant while SFPUC relied on free chlorine.

  All of these water quality differences prompted the agencies to properly investigate the potential water quality impacts of blending and develop appropriate mitigation strategies. As a result, the two agencies collectively developed blending treatment steps to be taken at the Intertie in the event of its operation to maintain high water quality in either system receiving water from the other, and the strategies have proven successful in Intertie operations to date (pers. comm., Cabral, 2003). Specifically, aqueous ammonia and a corrosion inhibitor similar to that used in SCVWD's system (an orthophosphate product) are added when water is delivered from SFPUC to SCVWD. Although SFPUC has not yet had a need to receive deliveries from SCVWD to date, pH adjustment (addition) will likely be provided in such an instance. These treatment options to maintain disinfectant residual and corrosion protection were developed first through paper studies, and then refined through bench-scale investigations of various water blends and treatment products. Although the Intertie is not a consistently operated facility, the importance of its limited operation and bench-scale results to date to the City of Paso Robles are that it demonstrates successful blending with two waters with much greater differences between their chemistries than between City groundwater and Lake Nacimiento water.

- *Tucson Water, Tucson, Arizona.* The mitigation of blending-related water quality problems experienced by the City of Tucson is fully described in the published literature (Pearthree and Davis, 2000; Swanson, Chowdhury, and Davis, 1998). In short, the City experienced significant color, taste-and-odor, and other adverse water quality impacts upon the introduction of treated surface water into its previously groundwater-only system. A main cause appears to have been the rapid introduction of a new source of water into a system conditioned over the long-term for different water source chemistry, as opposed to a gradual phase-in. Because the potential problems were not thoroughly studied beforehand, their causes could only be investigated in retrospect.

  The chief water chemistry problem appeared to be the pH fluctuation in the treated surface water, and subsequent iron release and aesthetic impacts in blended drinking water. Bench-scale investigations after the full-scale problems occurred pH adjustment to a consistent, higher level (roughly 8.5) was found to be beneficial, as well as a low dose of a corrosion inhibitor product (in Tucson's case, polyphosphate). The introduction of surface water, with a TDS of roughly 650 mg/L, also represented a salinity increase for the City, whose groundwater TDS averaged 200-300 mg/L. The increased ionic strength associated with this salinity increase may have contributed to the corrosion problems, although bench-scale and pilot-scale studies after the fact were too limited to conclusively identify the problem. The most important aspect of the Tucson blending experience for the City of Paso Robles to note is that water quality problems were experienced following a rapid introduction of a new water source, with incomplete planning and blending mitigation strategies identified beforehand.

- *City of Tampa Water Department, Tampa, Florida.* In the summer of 2000, severe drought conditions prompted Tampa to quickly introduce a groundwater supply into its surface water-supplied system. Resulting consumer complaints regarding the color and turbidity of their drinking water were attributed to significant chemical differences between the new groundwater and the City's historical surface water supply. Specifically, the introduction of the high-TDS (1500-2200 mg/L) groundwater resulted in a much higher salinity and ionic strength in the City's finished water. Finished drinking water TDS values jumped from 300-400 mg/L to as high as 940 mg/L upon the introduction of groundwater, accompanied by a ten-fold increase in chloride concentrations in the system (roughly an increase from 20 to 200 mg/L). At the same time, the City decreased its target pH to 7.0-7.3 to prevent calcium carbonate formation on plant equipment, which unfortunately may have exacerbated conditions for consumers. The quick introduction of a new water source led to "red water" incidents – discolored water due to iron leaching and scale dissolution and detachment from the City's distribution system pipes. Both the introduction of a higher-TDS water, and the rapid introduction of the water, are similar to the Tucson experience described above.

A series of bench-scale tests was undertaken to determine the appropriate pH target for the blended water and other corrosion control strategies to prevent the adverse impacts of blending, and was successful. Specifically, various pH targets and different TDS blends were studied, and a higher pH (7.7-8.0) was found to mitigate the scale dissolution and iron release. If the City had had the time to properly study the blending issues in advance, as well as introduce the new source gradually, the "red water" occurrence may have been prevented. There are two points to be made from this case study relative to the potential blending scenario in the City of Paso Robles. First, because Paso Robles is anticipating introducing a source with lower TDS than its existing supply, lower ionic strength water can be expected, unlike Tampa's (and Tucson's) blending conditions. A decrease in TDS and ionic strength due to blending does not in itself guarantee that blending the waters will be problem-free, but the suspected primary cause of Tampa's problems does not appear to be an issue for Paso Robles. Second, even with the significantly different water qualities of the two Tampa sources, adverse effects were prevented once the problem was adequately investigated and appropriate treatment steps were implemented. This highlights the need to introduce new supplies gradually instead of suddenly, and generally to confirm corrosion control and other blending strategies with bench-scale or pilot-scale tests prior to full-scale implementation.

From these blending case studies it is important to note (1) the importance of phasing in new water sources gradually, (2) the success of utilities in blending waters of more disparate chemistry than the City of Paso Robles' two potential sources, and (3) the benefit of bench-scale and/or pilot-scale work in determining the effects of multiple interrelated water quality parameters on blending and identifying optimum mitigation strategies. In addition to the case studies noted above, many other cities (e.g., Phoenix, Arizona and neighboring communities) blend groundwater and surface water in their systems routinely with no adverse effects. Although individual water chemistries and treatment strategies (e.g., pH adjustment, corrosion inhibitor addition) vary based on specific conditions, the common feature of all successful blending projects is the gradual phase-in of new water (or the development of systems with both surface water and groundwater on-line over the long term). Both strategies avoid the "shock" of a rapidly introduced new water chemistry that can result in pre-existing scale dissolution, iron release, and consumer complaints.

2.3 EFFECT OF IMPORTING SURFACE WATER ON TREATED WASTEWATER QUALITY AND REGULATORY COMPLIANCE

As noted in Chapter 1 and discussed in Appendix A, the TDS content of the City's treated wastewater is the result of four main factors: (1) the TDS content of the City's source water, which is currently 100% local groundwater; (2) the increase in TDS that typically results from municipal water use; (3) the TDS load from residential water softeners; and (4) the TDS input from industrial/commercial sources. The City currently has compliance issues with respect to TDS (as well as the individual constituents of sodium, chloride, and sulfate) in its wastewater plant effluent.

Factor #2 above can be considered an unchangeable value for the purposes of salt management – TDS will always increase due to the inherent nature of water use, consumption, and disposal by a City's population. Also, the Salt Management Study (Carollo, 2001b) outlined a number of reasons why factor #3 above is difficult to control. Regulating or otherwise reducing the salt load from residential water softeners is not considered viable for the City to implement. There may be some opportunities regarding factor #4 (industrial/commercial sources); however, flow data to accompany the available salt concentration data would be necessary to quantify the potential benefits, as noted in Chapter 1.

This section focuses on the potential TDS benefit of introducing treated surface water to the City system. As a salt management alternative, it is unique in that it addresses all categories of potential salt sources in the City. Residential, commercial, industrial, and any other salt sources in the City area are essentially incremental additions to the salt already present in the City's source water. Therefore, reducing salt in the City's source water reduces the salt contribution across all potential categories of contributors.

Some of the previous studies reviewed alluded to the TDS benefits to be gained from introducing treated Lake Nacimiento water into the City's system. This section develops a quantitative estimate of that benefit, in terms of wastewater effluent TDS concentrations over time associated with the likely imported water scenario as developed in Section 2.2 of this report. The TDS benefit in the City's wastewater effluent is proportional to the ratio of treated surface water imported to City groundwater in the system. As discussed in Section 2.2, the City expects to import 4,000 AF/yr of Nacimiento water. When brought on-line, this will represent a decline in groundwater pumping, but groundwater production will have to increase with time to keep pace with City population. **Table 2-11** and **Figure 2-6** represent continuations of the water supply analysis presented earlier in this chapter, and focus on the TDS issue, showing the resultant wastewater plant effluent TDS based on the anticipated source water proportions over the coming decades. Coincident with groundwater production, effluent TDS is expected to decline sharply with the introduction of surface water, but climb steadily over the following years as the proportion of surface water to groundwater decreases. Surface water, groundwater, and incremental TDS values will of course vary somewhat from year to year, but the table uses consistent, representative values for illustrative purposes.

Table 2-11. Example WWTP Effluent Quality (TDS) Over Time With Surface Water Imports

Year	Surface Water Imports (AF/yr)	Groundwater Supply (AF/yr)	Average Surface Water TDS (mg/L)	Average Groundwater TDS (mg/L)	Combined Water Supply Average TDS (mg/L)	Example TDS Increase From City Use (mg/L)	Example WWTP Effluent TDS (mg/L)
2003	-	7300	190	510	510	470	980
2004	-	7519	190	510	510	470	980
2005	-	7745	190	510	510	470	980
2006	-	7977	190	510	510	470	980
2007	4000	4216	190	510	354	470	824
2008	4000	4463	190	510	359	470	829
2009	4000	4717	190	510	363	470	833
2010	4000	4978	190	510	367	470	837
2011	4000	5247	190	510	372	470	842
2012	4000	5525	190	510	376	470	846
2013	4000	5811	190	510	380	470	850
2014	4000	6105	190	510	383	470	853
2015	4000	6408	190	510	387	470	857
2016	4000	6720	190	510	391	470	861
2017	4000	7042	190	510	394	470	864
2018	4000	7373	190	510	397	470	867
2019	4000	7714	190	510	401	470	871
2020	4000	8066	190	510	404	470	874
2021	4000	8428	190	510	407	470	877
2022	4000	8801	190	510	410	470	880
2023	4000	9185	190	510	413	470	883

Notes and Assumptions (in addition to those indicated for Table 2-1)

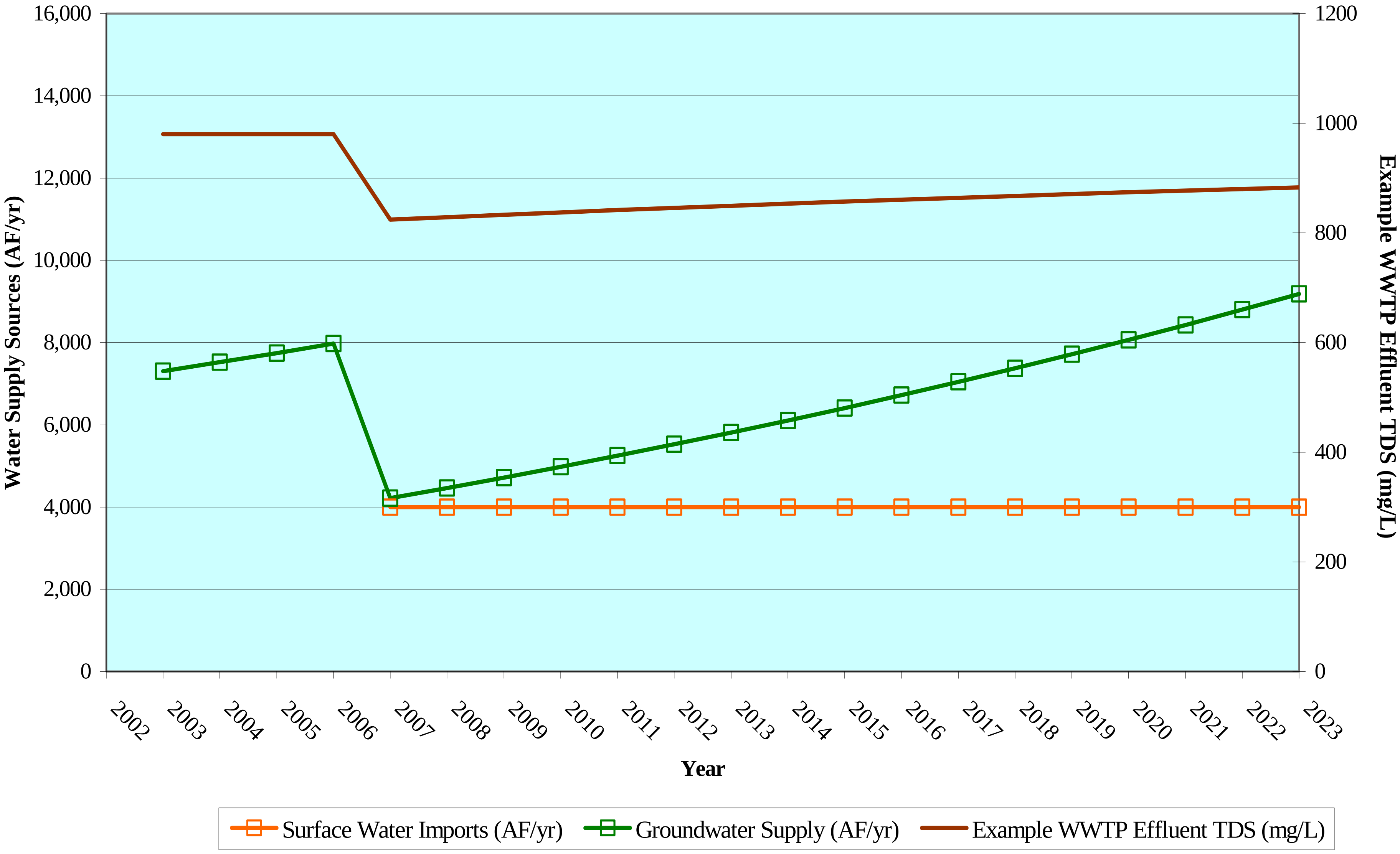
1. Surface water TDS value of 190 mg/L is based on average of Lake Nacimiento TDS results from 1993-2002 (County of SLO, 2002); other supporting information includes Boyle, 2002 and MCWRA/USACE, 2001.

2. Groundwater TDS value of 510 mg/L is based on City water quality reports from 1992-2001 (City of El Paso de Robles, 2002d) and the 2001 Salt Management Study (Carollo, 2001b).

3. Combined water supply TDS values are calculated based on expected proportions of surface water and groundwater for each year.

4. Example TDS increase from City use of 470 mg/L based on data compiled from Tables 2 and 3 of the 2001 Salt Management Study (Carollo, 2001b) and discussed in Section 2 of the draft Task 1 report.

Figure 2-6. Example WWTP Effluent Quality (TDS) Over Time With Surface Water Imports



As illustrated by the figure, the City can realize a significant wastewater regulatory benefit with respect to TDS if treated surface water is imported. The scenario shown features an approximately 1000 mg/L effluent TDS concentration, based on no surface water imports, an average City groundwater TDS concentration of 510 mg/L, and a incremental TDS increase through City residential, commercial, and industrial use of 470 mg/L. This is generally consistent with the current condition, and represents meeting the City's TDS discharge limit of 1100 mg/L with less than a 10% margin of safety. As available data indicate, TDS values in the City's effluent can vary greater than 10% from sampling period to sampling period. Therefore, the 2003 condition in **Figure 2-6** represents a fairly high-risk situation with respect to non-compliance for TDS. Upon the modeled introduction of surface water in 2007, the effluent TDS drops to approximately 820 mg/L[1]. This represents a value approximately 25% lower than the current discharge limit and a much greater factor of safety against discharge violations.

[1] This assumes equal brine contribution from residential home softeners before and after the introduction of surface water into the City system. However, the brine contribution may actually decrease, providing an additional incremental TDS benefit. A decrease in the number of homes with softeners cannot be assumed, because the blended hardness value will be approximately 200 mg/L when surface water is first introduced – still above the 150-mg/L guideline above which many consumers prefer to soften their water (AWWA, 1999). Nevertheless, softer water on average in the City system should translate into reduced brine discharge from each unit into the City's wastewater collection system.

3.0 ALTERNATIVES COMPARISON

3.1 INTRODUCTION

As discussed in Chapters 1 and 2, the City is currently facing several interdependent issues associated with wastewater discharge compliance. This chapter presents the development of a number of alternatives to address the issues, the criteria to evaluate the alternatives, and a relative ranking of the alternatives to determine the most desirable alternative(s) to move forward toward implementation. This summarizes the following aspects of the alternatives comparison:

- Preliminary alternative solutions developed by the City
- Additional alternative solutions developed by Malcolm Pirnie
- Evaluation criteria developed by the City and Malcolm Pirnie
- Ranking methodology for the alternative solutions
- Results of the alternative ranking evaluation

The analyses described in this chapter are planning-level. That is, they were conducted at a level of detail appropriate for understanding the likely positive and negative aspects of each candidate alternative, and their relevance to developing an overall water and wastewater quality strategy for the City. The information herein incorporates the information and analyses summarized in the previous two chapters and the Appendix A summary of efforts to date.

3.2 ALTERNATIVES CONSIDERED

The City developed several conceptual alternative solutions that may be implemented to address the potable water supply and wastewater effluent discharge/reuse issues facing the City.

- Do nothing

- Import treated water from a regional water treatment plant and blend it with existing groundwater supply

- Desalinate well water supply

- Desalinate wastewater (possibly for reuse application)

Malcolm Pirnie worked with the City and performed document reviews to understand work to date on these topics and develop those conceptual solutions into planning-level alternatives. Malcolm Pirnie also developed additional alternative solutions. Many of the following alternatives are not mutually exclusive (i.e., could be implemented in conjunction with each other) and in the following chapter of this report, combinations of the alternatives are considered to most efficiently meet effluent TDS standards and realize other benefits.

This section (3.2) briefly presents each alternative. The following section (3.3) discusses the criteria used to evaluate each alternative's relative attractiveness to the City. Finally, Section 3.4 presents the evaluation of each alternative, including conceptual-level costs for each, a comparison matrix for all alternatives, and a summary cost table.

1. **Do Nothing**

Under this alternative, the City would continue to treat and discharge wastewater into the Salinas River using the City's existing wastewater treatment plant, and rely entirely on its existing groundwater sources for its water supply. The "do nothing" alternative represents no change from the current condition.

2. **Achieve Greater Industrial and Commercial Discharge Quality Control**

The 2001 Salt Management Plan (Carollo, 2001b) indicated that reduction in TDS loading from the City's commercial facilities and industries was a possible method to reduce TDS concentrations in the City's treated wastewater discharge to the Salinas River. The City's four quarters of salt monitoring (City of El Paso de Robles, 2003b), which was conducted in response to one of Carollo's recommendations, confirmed that there are TDS concentrations in the City's wastewater collection system that exceed the City's Sewer Code limit of 1000 mg/L. Implementing this alternative involves the City successfully working with local businesses to reduce the TDS content of their discharges to consistently meet the City's existing Sewer Code limit (or better) to reduce TDS loading to the City's wastewater treatment plant.

3. **Participate in Nacimiento Project (Treated Water Option)**

This alternative calls for the City to participate in, and share the costs and benefits of, a regional project to transmit and treat water from Lake Nacimiento. The current level of City participation is planned to be 4,000 AF/yr of the 16,200 AF/yr available. The City would share in the design and construction of both the transmission infrastructure and a regional water treatment plant, and would receive deliveries of treated water.

The imported treated Lake Nacimiento water would be used to supplement the water produced by the City's existing groundwater wells. Based on the City's Water Master Plan (Boyle, 1995), there are three planned turnouts in the West Zone of the distribution system that would connect to the Nacimiento Project transmission line. For the East Zone of the City's distribution system, (an) additional turnout(s) may be necessary to equitably distribute the higher quality Lake Nacimiento treated water throughout the entire City. Hydraulic modeling to build on that performed by Boyle (1995) may be required to help the City define the need and location for any distribution system modifications in the East Zone.

4. **Participate in Nacimiento Project (Raw Water Option) and Treat Water with City-owned Plant**

This alternative involves participating in the raw water option of the Nacimiento Project, and features a water treatment plant dedicated to serving the City of Paso Robles, as opposed to a regionally owned and operated plant serving multiple (or all) Project participants. Under the raw water alternative, Project participants would receive raw water deliveries and be responsible for treating and delivering, or otherwise using, the Project water. Either a regional or a City-dedicated water treatment plant would be capable of producing high-quality finished water suitable for blending with existing City groundwater supplies.

5. **Import Lake Nacimiento Raw Water (Independent of Nacimiento Project) and Treat Water with City-owned Plant**

   This alternative is similar to #4 above, in that the City would be treating Lake Nacimiento water with its own treatment plant. However, this alternative assumes that the City cannot (or chooses not to) participate in the Nacimiento Project and its regional infrastructure. Therefore, under this alternative, the City would be paying for, and be responsible for, its own reservoir intake, transmission facilities, and treatment plant. This assumes that the City would have rights and access to 4,000 AF/yr of Lake Nacimiento water independent of the Nacimiento Project; this would have to be investigated if the City decides to move forward with this alternative.

6. **Participate in Nacimiento Project (Raw Water Option) to Recharge Salinas River Underflow**

   This alternative involves participating in the Nacimiento Project and importing the planned amount of 4,000 AF/yr as raw (untreated) water from Lake Nacimiento. This was originally conceived as a first phase of a "phased approach" to City participation in the Nacimiento Project: importing raw water for local recharge for approximately 10 years prior to the implementation of a water treatment plant. Raw water would not be suitable for direct delivery to City customers or blending with existing groundwater supplies in the City's water system, but could be used to recharge the Salinas River Underflow groundwater supply.

7. **Desalinate Well Water Supply**

   This alternative involves the desalination of a portion of the City's existing potable groundwater supplies so that the City's wastewater would contain lower TDS concentrations. As described in Chapter 1, the City currently pumps 100% of the City's potable water supplies from the City's Salinas River Underflow (shallow groundwater) and Paso Robles Groundwater Basin (deep groundwater). Under this alternative, wells that have the highest TDS concentrations would be treated using a reverse osmosis (RO) treatment process to lower TDS concentrations. Among the 16 wells that are currently in operation, Malcolm Pirnie evaluated RO treatment for the 7 wells that have TDS above 450 mg/L. For comparative purposes, this was done to achieve an average water system TDS concentration of approximately 350 mg/L, roughly equivalent to the water system TDS concentration if 4,000 AF/yr of Lake Nacimiento water were imported and blended with existing groundwater.

   The entire flow from a well would not be treated by RO and delivered to the system because the low TDS, hardness, and alkalinity of RO treated water can be very aggressive in terms of corrosion and pipe-scale dissolution. To avoid issues from overly soft and aggressive RO treated water, this evaluation considered splitstream treatment, wherein a portion of the well water is by-passed and treated by RO to produce a blended water of 300 mg/L TDS from each selected well or well cluster. This would in turn be blended with the water from the remaining wells (the wells that would not be desalinated) to supply the distribution system.

Selectively desalinating a portion of the groundwater supply will reduce the TDS concentrations in the WWTP influent and effluent waters. Approximately 15 to 20 percent of the RO feed water will end up as reject or concentrate stream, which would need to be disposed of. There are several ways this might be accomplished. Evaporation ponds were considered throughout this evaluation (i.e., this alternative and all others featuring desalination) for comparative purposes. Evaporation pond size is a function of RO feed and reject flows. The evaporation ponds should have liners to prevent salt from leaching through the sub-surface. The cost for evaporating reject or concentrate stream water is fairly expensive. The RO reject or concentrate stream may not be put to the sewer because that would defeat the goal of desalting which is to lower the TDS in the WWTP influent water. However, another option may be to send the reject stream to the ocean. This option would require the installation of a piping network in the City to collect the reject water from each desalting location and the installation of a pipe that would transfer the reject water from the City to the ocean. Other San Luis Obispo County municipalities may be interested in working with the City to design and construct the transfer pipe to the ocean. Although this option is not considered in detail in this report, further investigation could be performed to determine the viability of the option.

Desalting can also be performed on clusters of wells that are physically located in close proximity. For example, instead of treating the Thunderbird wells individually, it is possible to bring them to a central location and treat at the clustered location. Costs for clustering treatment will be lower. From an operation standpoint too, it requires less labor to maintain one central treatment facility than to maintain several small treatment plants.

Three of the City's Salinas River Underflow wells ("Ronconi" wells) are currently off-line because they have been determined to be under the direct influence of surface water. Although water quality data from these wells was not available for review, they are likely relatively high in TDS (i.e., between 500 and 600 mg/L), based on TDS results from other City wells completed in the Underflow. If the City desires, these wells could be brought back on-line if adequate treatment were provided. Specifically, a process such as microfiltration would need to be implemented to provide the level of treatment necessary to address the wells' surface water regulatory designation. This would be prior to, and in addition to, the reverse osmosis or equivalent process necessary to reduce TDS from these wells as necessary to meet the system TDS target as discussed above.

Re-activating these Ronconi wells is possible, but was not considered in detail in this report for three main reasons. First, doing so does not allow the City to realize any benefit related to its main goal of improving the TDS quality of its treated effluent. These wells are likely high in TDS and would require TDS removal just like the other high-TDS City wells that are already in operation. Second, re-activating these wells would be more costly than treating the existing wells in operation because of the additional surface water treatment step. Third, the City has sufficient well and pumping capacity to meet its water supply needs, so there is not a need to bring additional wells on line at this time.

8. Recharge WWTP Effluent (Without Desalination)

The City's treated wastewater could be directly recharged into local groundwater without any additional treatment such as desalination. This might be less costly than providing desalination of the City's effluent, but it would not provide the corresponding reduction in TDS load to local groundwater. Again, favorable locations for recharging based on local subsurface materials are generally in the flood plain of the Salinas River as previously reported (Carollo, 2001a) and therefore possibly difficult from a regulatory perspective U.S. Army Corps of Engineers (USACE) and possibly undesirably close to existing water supply wells. Appendix A contains more details on this issue.

9. Desalinate WWTP Effluent to Meet NPDES Discharge Limits

The effluent from the WWTP can be desalted using RO to satisfy the RWQCB discharge requirements for TDS. This alternative would require treatment of the secondary effluent using microfiltration (MF) to remove additional particulates and solids. It would only be necessary to desalinate a portion of the WWTP effluent to achieve effluent compliance. Desalinating a portion of the wastewater effluent to very low TDS levels and blending it back into the main waste stream is preferable to treating the whole flow to the target level. For comparative purposes, an 800-850 mg/L TDS target was selected, to be roughly equal to the WWTP effluent TDS that may result in the years following a potential import of Lake Nacimiento water. This target would be achieved by providing MF and RO treatment for roughly one-third of the City's wastewater flow (side-stream treatment) and recombining it with the remaining two-thirds of the secondary effluent for discharge to the river. An 800-850 mg/L TDS concentration is below the current NPDES permit requirement for TDS (1,100 mg/L) and would provide a reasonable margin of safety against non-compliance, based on historical WWTP effluent monitoring results. The RO waste stream would be sent to evaporation ponds.

Desalinating wastewater prior to discharge may also be necessary in conjunction with other alternatives to ensure that effluent standards are met. Specifically, as discussed in Chapter 2, importing treated surface water will provide a significant TDS benefit, but will not be operational for a number of years to allow for Nacimiento Project participant confirmation, design, construction, and startup. In the Chapter 2 scenarios, imported water was not expected to be on-line until 2007, for example. This alternative, to desalinate wastewater prior to discharge, could be implemented temporarily, to help ensure that effluent limits are met until the surface water project is operational.

10. Desalinate WWTP Effluent for Irrigation Reuse with Storage

In the Comprehensive Recycled Water Study (Carollo, 2001a), three potential reuse scenarios were developed, each requiring tertiary treatment, which can be achieved either by the unit processes presented in that report or by the MF/RO combination discussed in this report for wastewater effluent and well water applications. The scenarios were developed in detail in the Carollo study and are therefore not reproduced here. Appendix A (Table A-9) presents a summary of the reuse and other scenarios previously considered. Of the five main scenarios developed by Carollo and summarized in Appendix A, only the scenarios including wastewater disposal by evaporation are not considered further in this report, because the potential stakeholder concerns, land requirements, and lack of water supply benefits were considered to make these options relatively unattractive methods to cease river discharge as compared to the use and recharge scenarios developed. However, they still may be viable options. Briefly, the irrigation reuse with storage scenario enables the highest recycled water delivery volume per year of the scenarios considered, but is also the most expensive. It features additional wastewater treatment, recycled water distribution infrastructure, and a long-term storage basin to enable year-round ceasing of discharge to the river. Specifically, tertiary treated wastewater would be diverted into the storage reservoir during the non-irrigation season and put to use during the warmer months. This was the only reuse option developed by Carollo enabling the City to cease its Salinas River discharge year-round.

11. Desalinate WWTP Effluent for Irrigation Reuse with River Discharge

This scenario is very similar to the irrigation reuse with storage option, except that it includes a smaller storage option and therefore is not sufficient to cease river discharge year-round. The associated costs are significantly lower based on Carollo's evaluation.

12. Desalinate WWTP Effluents for Community-based Reuse with River Discharge

This is a similar scenario, but was developed for a different potential recycled water market. Like irrigation reuse with river discharge, storage capacity under this scenario is not sufficient to enable year-round avoidance of river discharge. This has a potentially lower recycled water volume delivered each year than the two reuse alternatives above, and Carollo indicates roughly the same capital costs as the irrigation reuse with storage option. Although this alternative requires less storage than alternative #10, capital costs have been estimated to be similarly high, due to the extensive recycled water distribution system necessary to deliver water to community-based reuse customers.

13. Desalinate WWTP Effluent for Recharge

As discussed above under alternative #6, recharging wastewater without desalination is theoretically possible, but likely infeasible because it would be difficult to demonstrate a benefit to the groundwater basin and gain approval for the project. Recharging desalinated wastewater, however, is an option that would be more feasible. Like the alternative involving desalination for river discharge, this alternative features side-stream treatment on the City's wastewater effluent to meet a target TDS level. As noted earlier in this section, the target TDS level for river discharge was set at 800-850 mg/L to provide an approximately equivalent alternative from a wastewater TDS perspective as imported surface water. For this recharge alternative to represent a benefit to the groundwater basin, the TDS concentration would likely have to be less than or equal to the average TDS concentration in area groundwater. TDS concentrations in the two main groundwater units underlying the City generally average between 450 and 550 mg/L, with the Salinas River Underflow unit generally showing higher TDS concentrations than the deeper Paso Robles Formation. Therefore, the minimum level of desalination considered for this alternative was that necessary to achieve a target of 450 mg/L[1].

14. Add East Site WWTP (Upstream Reclamation Plant)

This alternative would not directly address either of the primary project criteria (reduce TDS of all City WWTP discharge to below permit limits; cease discharge to the Salinas River) but would increase overall City WWTP capacity, allow discontinuation of wastewater pumping from the east side to the west side of the City, and would facilitate east side wastewater reuse/recharge if implemented as a tertiary treatment facility. This alternative was included here primarily for cost comparison purposes.

3.3 EVALUATION CRITERIA

Two primary criteria were used to evaluate each alternative: (1) whether or not the alternative reduced the TDS concentration at the City's treated wastewater to meet its existing effluent limit with a reasonable (~20%) margin of safety, and (2) whether or not the alternative would allow the City to cease discharge to the Salinas River year-round. To evaluate the relative attractiveness of each of the alternatives meeting one or both of these primary criteria, a number of secondary criteria were considered. Not all apply to each alternative, but they were selected to collectively cover all the major considerations from a planning-level pertinent to deciding to move forward with one or more of the identified alternatives. They are each described in this section, and then applied to each of the alternatives as described in Section 3.4 of this chapter.

[1] For the purposes of considering multiple or interim alternatives, RO treatment can be implemented modularly. That is, the City could install RO treatment to achieve the immediate 800-850 mg/L target for wastewater compliance for river discharge, then later add another module (e.g., 2 MGD) to remove additional TDS for recharge or reuse applications.

Water Supply Magnitude/Reliability

Although the immediate focus of the selected alternative will be to ensure the City's compliance with its wastewater effluent TDS limit, improving the City's water supply reliability may be a secondary benefit, depending on the alternative chosen. As noted in the Urban Water Management Plan (Todd, 2000), the City already has a certain amount of built-in "backup" – its wells are completed in two different aquifers, and are located in various spots throughout the City. If one well or well cluster experiences problems or needs to taken off-line, the City has numerous other wells and extra pumping capacity to continue to serve the City. As noted in the recent Groundwater Basin Study (Fugro, 2002), however, there are areas near the City experiencing water table depression. While the groundwater levels in the City's wells are currently stable, the nearby, localized decline in water levels indicates that the City's groundwater supplies are vulnerable to overdrafting. Importing surface water would serve to relieve the demand on local groundwater supplies, as well as add another level of system reliability. Therefore, those alternatives including importing surface water for water quality reasons were also viewed favorably in terms of their associated water supply reliability benefits. The degree to which each would increase water supply reliability was incorporated into the ranking of alternatives.

Groundwater Basin Levels

A criterion related to the water supply reliability discussion above involves ranking alternatives based on their ability to maintain or improve water levels in the Salinas River Underflow and/or Paso Robles Formation aquifers. Specifically, those alternatives that include augmenting existing groundwater supplies with surface water imports rate favorably in this area because they reduce the demand on local groundwater. Also, those alternatives featuring recharge benefit local groundwater basin levels by directly replenishing local groundwater. The degree to which each alternative would help to maintain or enhance current groundwater basin levels was taken into account during the ranking of alternatives.

Water Rights

Water rights are important to consider, not only in terms of the City's existing Salinas River Underflow rights, but also relative to alternatives featuring water recharge or recycling. Alternatives that would tend to preserve the City's existing Underflow water rights (i.e., continue current levels of pumping from Underflow wells) were considered more desirable than those that might jeopardize those water rights (i.e., decrease pumping from Underflow wells). As reported by Boyle (2002) and noted in Appendix A, if the Underflow basin is recharged (e.g., with imported surface water), the amount of river underflow legally available to the City increases by the amount of recharge. Therefore, those alternatives featuring recharge were considered beneficial from a water rights standpoint. Water recycling also introduces water rights considerations, though these are less well defined based on available information. For example, as noted in the

Comprehensive Recycled Water Study (Carollo, 2001a), ownership of effluent from a wastewater treatment plant where downstream users rely on the water is a current legal concern. Specifically, there are currently unresolved issues between dischargers and downstream water users regarding ownership of the water. Therefore, those alternatives that divert water from river discharge (although preferable from the RWQCB's point of view) were ranked as potentially problematic if downstream users were to claim ownership of the City's effluent.

Drinking Water Quality

Some of the alternatives under consideration will have no effect on the quality of the City's delivered water, while others will likely improve it. The clearest cases of this are the alternatives including imported treated surface water. They will result in the City's water becoming lower in both TDS and hardness, while maintaining relatively low concentrations of DBPs in the City's system as discussed in Chapter 2. Based on the water quality characteristics of Lake Nacimiento water and the City's existing groundwater supplies, blending the waters will not have any adverse water quality impacts provided corrosion control and disinfectant issues are properly addressed. Those alternatives that feature recharge of desalinated wastewater also offer a drinking water quality benefit, although less immediate. They will serve to reduce the concentration of TDS in water recharging local groundwater, and therefore would be expected to yield a net long-term benefit in regards to the quality of the City's pumped groundwater. The effect each alternative might have on the quality of the water in the City's water system was closely considered, and those alternatives that maintain or enhance the high quality of the City's drinking water were ranked favorably for this criterion.

Security/Vulnerability Position (U.S. Environmental Protection Agency [USEPA] Vulnerability Assessment Requirement)

An important overall water system feature considered during USEPA-required Vulnerability Assessments is redundancy of supplies. This was taken into account when ranking alternatives. Importing surface water or (to a lesser degree) implementing a reuse program would diversify the City's water supply sources and therefore reduce its risk of service disruption.

Capital and Operating Cost Competitiveness

Both capital and operating costs were considered for each alternative. In addition, life-cycle costs based on the net present value of each alternative were developed in order to enable direct comparisons among alternatives. To represent typical public works financing terms, a 20-year evaluation period and 7% discount rate were assumed for all alternatives. Sensitivity analyses using a longer evaluation period (30 years) and one-half percent interest rate fluctuations were also performed. Those costs that were incorporated from previous studies (e.g., Nacimiento Project costs, recycled water alternative costs) were modified if necessary so that this report presents all costs on equal bases and allows direct comparisons. The methodology used by others to develop previous cost estimates was not reviewed; cost estimates presented in other reports were assumed to be of high quality and incorporated directly here. Estimated costs presented in this report are necessarily not at the level of detail sufficient for final design and construction, but were developed for planning-level use and to enable comparison among alternatives, to help the City select the alternative(s) with which to move forward.

Regulatory Issues (Other Than Water or Wastewater Quality)

The main focus of this project includes complying with one regulation in particular: the City's current NPDES permit terms, which include TDS limits of 1,100 mg/L (an immediate concern), and the RWQCB's likely future directive to the City to cease its discharge to the Salinas River. As noted in Chapter 1, the City has difficulty consistently meeting its TDS, sodium, chloride, and sulfate limits[2]. Alternatives that do not address this critical regulatory issue are presented in this report, but not evaluated in any more detail than is appropriate. There are a host of other regulatory considerations associated with the various alternatives discussed in this report. The major ones are listed below, and others may be identified when one or more particular alternatives are moved forward toward implementation.

- NPDES Permit – the City's NPDES permit contains many other provisions besides effluent limits for TDS and related constituents. Any alternative selected will have to be consistent with all the terms of the City's NPDES permit, including its renewal, which was originally expected in February 2005, but is now imminent (Spring 2003).

- Water Supply Permit – a permit will be required from the California Department of Health Services if the City receives water from a new water source.

- Environmental Impact Report – environmental planning and documentation is required for any project with potentially significant impacts.

- Drinking Water Standards – the City must continue to comply with federal and state drinking water standards, and may need to meet surface water treatment requirements depending on the alternative(s) selected. In California, the Department of Health Services is the "primacy agency" responsible for implementing the drinking water program.

[2] In terms of water quality measurements and treatment technologies, TDS includes the three other constituents (sodium, chloride, and sulfate) of particular concern in the City's wastewater effluent. Therefore, for the purposes of discussing blending effects and the evaluation of alternatives in this report, the term "TDS" is used alone, although it is understood that the City's wastewater permit also addresses specific components of a TDS measurement.

- Brine Regulations – if the City selects an alternative involving brine evaporation or disposal, applicable requirements would need to be met. This would most likely involve ensuring the evaporation facility met RWQCB requirements for surface impoundments.

- Flood Plain Construction Regulations – as discussed in the Comprehensive Recycled Water Study (Carollo, 2001a), the USEPA would be involved if the City selects a recharge alternative that involves construction in the Salinas River flood plain.

- Water Recycling Regulations - as discussed in the Comprehensive Recycled Water Study (Carollo, 2001a), several agencies including the CA DHS, the State Water Resources Control Board, and the RWQCB have jurisdiction over recycled water projects in California. If the City decides to move forward with a recycling project, it will likely work through the RWQCB as the permitting agency.

Time Required to Implement

Because the City already has difficulty meeting its current effluent limits for TDS, this is a key consideration. Alternatives were evaluated in general terms for how many months or years from the present until they would be implemented and the City would be realizing the associated benefit. The time required for such common steps as coordination with other agencies, planning, pre-design, design, construction, and startup of the alternatives were considered, as well as any time constraints specific to each alternative.

Customer/Stakeholder Acceptance

In addition to all the technical criteria involved in selecting the alternative(s), its acceptability to the City's customers and other stakeholders must be considered. These were considered on a case-by-case basis and are often multi-faceted. For example, recharging treated wastewater would rate favorably in terms of the City's relationship with the RWQCB, one of its key stakeholders. Customer acceptance, may be difficult, however, if the public has negative perceptions of any type of wastewater recharge or reuse programs. Considering these types of issues was necessarily a subjective exercise, but was nevertheless important to help rank alternatives and identify potential delays or obstacles to implementation of the candidate alternatives. The main customers and stakeholders considered included:

- City drinking water customers
- City Council members
- Regional Water Quality Control Board
- Environmental groups
- Communities along the proposed Nacimiento Project alignment

- City residents in the vicinity of any new infrastructure (e.g., City-dedicated water treatment plant, wellhead treatment system, recharge basin)
- Local commercial and industrial businesses

3.4 EVALUATION OF ALTERNATIVES

This section describes the evaluation performed by Malcolm Pirnie of each alternative solution presented in Section 3.2. This section includes a summary of the evaluation/ranking methodology, the results of the evaluation, including the alternatives comparison matrix, and a cost summary. This evaluation incorporates and is intended to build on previous conclusions and recommendations, for example, the salt management alternatives presented in Table 6 of the Salt Management Study (Carollo, 2001b).

3.4.1 Ranking Methodology

Each of the alternatives presented in Section 3.2 were first considered in relation to whether they addressed the two primary wastewater regulatory criteria for this project (lowering effluent TDS concentrations and allowing the City to cease discharging to the Salinas River). Those alternatives addressing one or both of these criteria were then considered further in relation to the remainder of the evaluation criteria described in Section 3.3. Therefore, each alternative was assigned a “yes” or “no” designation for the wastewater regulatory criteria, and then assigned a series of numerical scores, one for each of the remaining evaluation criteria discussed in Section 3.3. The numerical scores are relative rankings intended to reflect the often multi-faceted aspects for each ranking. For example, when ranking the Lake Nacimiento Project alternatives in terms of water rights, a clear benefit is that they result in new rights to a surface water supply. However, a potential negative impact of importing water, with respect to water rights, is the associated decrease in groundwater pumping and potential jeopardizing of existing Underflow water rights. Such interrelated factors were considered in the development of the relative scores indicated for each alternative in the matrix that follows the narrative evaluations below.

3.4.2 Evaluation Results

The following sections describe the results of the alternatives evaluation, which are summarized in the comparison matrix at the end of this chapter. The comparison matrix summarizes the alternative ranking results based on whether each alternative meets the two primary project wastewater criteria, then based on water supply and other criteria. The following descriptions are intended to summarize the results of the evaluation based on key criteria for each alternative.

1. Do Nothing

The City’s current groundwater supplies have relatively high concentrations of total dissolved solids (TDS) that directly impact the City’s treated wastewater quality. As noted by the RWQCB (Briggs, 1999), the wastewater that the City discharges into the Salinas River does not consistently meet the TDS requirements specified in the National Pollutant Discharge Elimination System

(NPDES) permit for the City's wastewater treatment plant. In addition, the City is also facing compliance issues with respect to TDS component constituents sodium, chloride, and sulfate. As a result of the City's non-compliance with the NPDES permit, the "do nothing" alternative is not a viable option.

The RWQCB has indicated they are going to closely review whether the City should be allowed to continue discharging wastewater treatment plant effluent to the Salinas River (Briggs, 1999). The City is the only remaining municipal system discharging into the Salinas River. The RWQCB has required the City to investigate alternatives for discharging the wastewater treatment plant effluent. This is a reason why the "no action" alternative is not a viable solution for the City's treated wastewater discharging needs.

As discussed in Chapter 2, the City is also required to meet a significant increase in future water demand from population growth. Over the next 20 years, the City's water demand is expected to increase from approximately 7,500 AF/yr (current demand) to approximately 13,000 AF/yr (2023 projected demand). Attempting to meet this increased water demand entirely with groundwater from City wells may result in localized overdraft conditions and therefore not be sustainable. From a long-term water supply standpoint, it would be prudent for the City to secure additional supplies to supplement their existing water resources over the next 20 years. This is yet another reason why the "no action" alternative is not a viable solution for the City.

2. Achieve Greater Industrial and Commercial Discharge Quality Control

As previously identified (Carollo, 2001b), a salt management alternative to consider is reduction of TDS discharge from commercial and industrial businesses in the City's wastewater service area. At the time of the Salt Management Study, there was only limited salt monitoring data within the City's wastewater collection system and the relative contributions of residential areas and commercial/industrial facilities were not quantified.

The City has conducted four quarters of salt monitoring data in response to recommendations in the 2001 Salt Management Plan. Although they provide useful concentration data, there are significant limitations that preclude their use in determining relative mass loading estimates and therefore potential benefits of control measures. City staff (pers. comm., Columbo, 2003) have also provided additional information regarding this topic.

One limitation is that grab samples were used instead of the suggested flow-weighted composites. Therefore, there is a greater uncertainty associated with the sample results – they may reflect short-term low or high TDS values and may not necessarily be representative of average conditions necessary to understand mass loadings. A more significant limitation is that flows have not been quantified, in particular, the flows from commercial/industrial facilities. This information is difficult to develop, even with water use data known, because of the differences from facility to facility regarding the percentage of water used that is discharged to the wastewater system.

Available information is insufficient to quantify the magnitude of residential or commercial/industrial sources, and therefore insufficient to estimate the potential benefits of reducing TDS concentrations from these sources.

Nevertheless, City monitoring results (City of El Paso de Robles, 2003b) indicate that there are TDS concentrations in the City's wastewater collection system well in excess of the City's Sewer Code limit of 1,000 mg/L. As noted above, these are grab sample results and may be representative of short-term slugs of high TDS concentration wastewater in the system as opposed to long-term average conditions. Conversations with City staff indicate that the City has been working with local industry for some time to reduce the TDS load from their operations, and many facilities do not have the capability of making the process changes necessary to reduce their TDS discharges beyond their existing levels (pers. comm., Columbo, 2003). Therefore, the potential TDS benefits to the City's wastewater discharge associated with commercial/industrial control cannot be quantified without more data, and may be limited. Regarding residential salt contribution, the limitations inherent in reducing residential TDS load have been presented previously (Carollo, 2001b), although home water softener use may decline with the introduction of a blend of softer water to the City as discussed in the alternatives addressing imported surface water. Implementing this alternative alone would provide no water supply or drinking water quality benefits, but be relatively low in cost.

3. Participate in Nacimiento Project (Treated Water Option)

This alternative would allow the City to meet the current NPDES wastewater limit for TDS of 1100 mg/L. As estimated in Chapter 2, importing treated Lake Nacimiento water at 4,000 AF/yr (and implementing no other alternatives) will reduce the City's treated wastewater effluent TDS concentrations from 1,000-1,100 mg/L to 800-850 mg/L. Over time, effluent TDS concentrations will gradually climb with increasing groundwater use, but not reach existing levels if surface water imports continue.

This alternative would also provide the City with significant water supply benefits. Specifically, by adding Nacimiento Project water to the City's current water supplies, the City will be able to meet future water demands without relying completely on groundwater supplies. By adding a new water supply, the City would conserve its limited local groundwater resources because less water would be pumped from the local groundwater aquifers. This alternative would also increase the City's overall water supply reliability by adding a new source to the City's supply. In addition, Lake Nacimiento would provide the City with a higher quality of water supply, with TDS and hardness concentrations that are significantly lower than the City's groundwater.

This alternative would require the City to pay for its portion of a regional project to treat and transmit Nacimiento water to the City. Planning-level cost estimates for this alternative have already been developed (e.g., Carollo, 2002). Estimated capital costs for the City's participation in this project range from approximately $35.0 to $59.6 million, the operation and maintenance would cost approximately $1.41 million for the first year (the O&M costs would increase annually based on inflation), and the resulting total approximate annual costs (debt service plus annual O&M costs) would be $4.44 to $7.04 million. Malcolm Pirnie calculated the debt service assuming a 7% interest rate and a 20-year term. The low end of the cost estimates are based on a "railroad" approach, where the total capital cost of the project is distributed proportionally by reach for those participants who benefit from the facilities within the reach. The high end of the estimates are based on proportional allocation of capital costs between all Project participants, where the total capital cost of the project is distributed in direct proportion to each participant's requested entitlement. For conservative comparative purposes, the high-end estimates are incorporated into the cost summary at the end of this chapter. Debt service and total annualized costs were calculated similarly for all alternatives.

4. Participate in Nacimiento Project (Raw Water Option) and Treat Water with City-owned Plant

This alternative would meet the current NPDES wastewater limit for TDS of 1100 mg/L and provide similar water supply/quality benefits to the regional treated water option discussed above. Slightly less water supply reliability and potential water rights benefits would be associated with this alternative, because a smaller, City-dedicated plant may not offer the flexibility to increase lake imports if other Project participants drop out or if other changes occur.

In addition, this alternative would also allow the City to have full control of the water treatment plant while relying on the regional raw water project for raw water transmission. Instead of participating in a regional water treatment plant, the City would have complete control of its own water treatment plant. That would allow the City to manage/control long-term planning for the water treatment plant, repair and replacement schedules, staffing, water quality management (i.e., the ability to manage the treatment processes according to the blending needs in the City), budgeting, and so forth. Conversely, this alternative requires the City to provide more direct oversight of the water treatment plant, and will require the City to allocate and manage resources accordingly.

Malcolm Pirnie developed cost estimates for four packaged water treatment systems that would be capable of processing 4,000 AF/yr of Lake Nacimiento water per the City's expected level of Project participation. The packaged treatment systems included the following process trains: conventional treatment with chloramines for disinfection; conventional treatment with a GAC post-filter adsorber and free chlorine for disinfection; microfiltration treatment with chloramines for disinfection; and microfiltration treatment with a GAC post-filter adsorber and free chlorine for disinfection. Finished water reservoir and disinfection costs were added to the package treatment system costs. **Table 3-1** below and the cost summary table at the end of this chapter indicate the estimated cost of selecting this alternative.

Another cost the City may incur under this alternative and others involving importing surface water is for converting the disinfection of the City's well water from free chlorine to chloramine to match disinfectants if necessary as discussed in Chapter 2. Based on a typical chlorine to ammonia ratio of 4.1, upgrade costs (ammonia storage and feed systems) at all the City's existing operational wells/well clusters were estimated. These conceptual-level capital and O&M costs for ammonia addition are $1.2 million and $95,000 per year, respectively.

Table 3-1. Conceptual Cost Estimate of Alternative 4: Participate in Nacimiento Project (Raw Water Option) and Treat Water with City-owned Plant[1]

Capital Cost Item	Capital ($)
Conventional Treatment	$1,580,000
Finished Water Reservoir	$ 300,000
GAC Process Cost	$1,485,000
Disinfection with Chlorine	$88,000
Subtotal Process Costs	***$3,453,000***
Direct Capital Cost[2]	**$6,906,000**
Raw Water Transmission System[3]	$46,219,000
Pilot Scale Testing	$50,000
Operator Training	$10,000
Indirect Capital Costs	**$46,279,000**
Total Capital Cost	**$53,185,000**

O&M Cost Item	O&M ($/yr)
Conventional Treatment[4]	$203,500
GAC[4]	$240,600
Chlorine	$21,500
Power Cost for Water Transmission[5]	$390,000
Power Cost for Booster Pumps	$20,400
Total Annual O&M	**$876,000**

1. This alternative assumes that the City-owned plant would consist of conventional treatment with GAC post-filter adsorber and chlorine for disinfection (Scenario 1B). Of the four scenarios presented in Chapter 2, this is the highest cost scenario by approximately 10% and is indicated here for a conservative estimate of treatment costs.

2. Direct capital cost is estimated by multiplying the subtotal process costs by a capital cost multiplier of two. The capital cost multiplier includes site work, overhead and profit, contingencies, engineering and design, mobilization and bonding, legal and administrative costs, interest during construction, and installation.

3. This estimate is based on the total capital cost for the raw water option presented in Table 2.2 of the "Updated Draft: EIR Preparation Phase Engineering Report, Nacimiento Project" (Carollo, 2002). Paso Robles' portion was estimated based on peaking values. The raw water cost includes recharge facilities for Paso Robles, which will not be necessary if Paso Robles chooses to treat the raw water at a City-owned plant. However, the cost of the recharge facilities is estimated to be minimal relative to the overall cost of the project and within the accuracy range of the cost estimates.

4. Includes chemicals, labor, power, and materials.

5. This estimate is based on the regional pump stations (Intake Pump Station, Inline Booster Station, and Happy Valley Pump Station) indicated for the Lake Nacimiento project (Carollo, 2002). The variable frequency drive (VFD) pumps were assumed to operate on average at 50% power throughout the year or, equivalently, operate 50% of the time at full power. Paso Robles' portion of the electrical cost was calculated using their proportional allocation based on peaking values (5,200/16,449). Paso Robles' cost would decrease if costs were allocated based on participants' actual pumping requirements ("railroad approach"). This estimate is based on a long-term average rate of $0.08/kWh.

5. Import Lake Nacimiento Raw Water (Independent of Nacimiento Project) and Treat Water with City-owned Plant

This alternative would be similar to #4 above in terms of overall water supply, drinking water quality, and wastewater quality benefits to the City. However, a somewhat lesser degree of water supply reliability, potential benefit to local groundwater levels, and water rights benefits are associated with this alternative as compared to the two previous alternatives featuring participation in the regional project—either the raw or treated water options. If this option is implemented and the City does not participate in a regional water supply project (or one is not implemented), the flexibility associated with regional infrastructure is lost. Specifically, there would not be the same extra treatment and transmission capacity available, which the City could potentially use in the case of other participants decreasing or eliminating their participation.

This alternative is also less desirable that the other Nacimiento alternatives from a schedule and regulatory standpoint because to date, only the regional project has been seriously considered for use of Lake Nacimiento as a drinking water source, and a new EIR process would have to be started (the regional EIR is already near final). **Table 3-2** on the following page and the cost summary table at the end of this chapter indicate the estimated cost of selecting this alternative.

Table 3-2. Conceptual Cost Estimate of Alternative 5: Import Lake Nacimiento Raw Water (Independent of Nacimiento Project) and Treat Water with City-owned Plant[1]

Capital Cost Item	Capital ($)
Conventional Treatment	$1,580,000
Finished Water Reservoir	$ 300,000
GAC Process Cost	$1,485,000
Disinfection with Chlorine	$88,000
Subtotal Process Costs	***$3,453,000***
Direct Capital Cost[2]	**$6,906,000**
Permitting	$104,000
Land	$1,036,000
Operator Training	$10,000
Multi-Port Tunnel Reservoir Intake[3]	$4,800,000
Pipeline Installation	$12,545,000
Booster Pump Installation	$1,480,000
Pilot Scale Testing	$50,000
Indirect Capital Costs	**$20,025,000**
TOTAL CAPITAL COST	**$26,931,000**

O&M Cost Item	O&M ($/yr)
Conventional Treatment[4]	$203,500
GAC[4]	$240,600
Chlorine	$21,500
Power Cost for Water Transmission[5]	$370,000
Power Cost for Booster Pumps	$20,400
TOTAL ANNUAL O&M COST	**$856,000**

1. This alternative assumes that the City-owned plant would consist of conventional treatment with GAC post-filter adsorber and chlorine for disinfection (Scenario 1B). Of the four scenarios presented in Chapter 2, this is the highest cost scenario by approximately 10% and is indicated here for a conservative estimate of treatment costs.

2. Direct capital cost is estimated by multiplying the subtotal process costs by a capital cost multiplier of two. The capital cost multiplier includes site work, overhead and profit, contingencies, engineering and design, mobilization and bonding, legal and administrative costs, interest during construction, and installation.

3. The capital cost of the reservoir intake is based on that indicated in the "EIR Preparation Phase Engineering Report" (Carollo, 2002), which references original cost estimates prepared by the Harza Engineering Company of California in 1996. Malcolm Pirnie adjusted the original cost estimate to 2003 dollars by applying a 3% annual escalation rate. The estimate presented here was developed for a reservoir intake sized for the regional Lake Nacimiento project. Many of the component costs are common to any size intake; however, since a smaller intake would be required to deliver water to Paso Robles only, the cost of the reservoir intake can be expected to be somewhat less than the $4.8 M indicated.

4. Includes chemicals, labor, power, and materials.

5. This estimate is based on an assumed modification of the two regional pump stations (Intake Pump Station and Inline Booster Station) indicated for the Lake Nacimiento project (Carollo, 2002). The number of pumps was reduced to account for the reduced pumping requirement to deliver water to Paso Robles only. The variable frequency drive (VFD) pumps were assumed to operate on average at 50% power throughout the year or, equivalently, operate 50% of the time at full power. This estimate is based on a long-term average rate of $0.08/kWh.

6. Participate in Nacimiento Project (Raw Water Option) to Recharge Salinas River Underflow

The potential benefits to this approach are that (1) City costs to help construct a water treatment plant are deferred while the City is only accepting raw water, and (2) water storage and water rights associated with the Salinas River Underflow supply may be enhanced by the addition of the imported surface water.

Under this scenario, the City would still have to pay their proportional share of the Nacimiento Project facilities to transmit raw water from the lake to the City. The most important drawback relative to the City's water quality strategy, however, is that under the raw water scenario, the City would not realize the full benefit of the relatively low-TDS lake water – both in terms of drinking water quality and wastewater effluent quality. That is, if the low-TDS lake water is recharged into the Salinas River Underflow, it will mix with the existing high-TDS shallow groundwater and likely only partially be recovered in City wells completed in that zone. It is Malcolm Pirnie's understanding that this Project participation option (importing raw water) was introduced a number of years ago before water and wastewater quality issues were considered as critical as they are today.

7. Desalinate Well Water Supply

With regards to the primary project criteria, this alternative is capable of meeting the most immediate one: reducing the TDS concentration in the City's wastewater effluent to meet the current NPDES effluent limit of 1100 mg/L. Like the other alternatives, the conceptual design and costs were developed to allow equivalent comparisons; that is, the TDS benefit of this and other desalination alternatives were set to approximately equal the TDS benefit if treated Lake Nacimiento water were imported and blended with the City's existing groundwater supply. With regards to the more long-term of the two key project criteria, this alternative offers no direct benefit with respect to the City ceasing its discharge to the Salinas River.

With regards to water supply reliability and water rights, this alternative has little effect as compared to the current condition. It allows continued use of the City's existing wells, and is therefore positive in that it does not pose any threat to existing Salinas River Underflow water rights. However, it does not secure any new water sources or water rights, and therefore provides little benefit or change as compared to the City's current water reliability situation. It has little short-term effect on groundwater basin levels, as it calls for continued use of the City's existing wells according to current operational strategy. However, over the long-term with the projected population and water demand increases, implementing this alternative alone puts the City at risk of (1) inducing local overdraft conditions, and (2) not being able to meet the water demand of its build-out population.

This alternative would be expected to provide a benefit with respect to drinking water quality for the City's customers relative to current conditions. This is because the RO process would decrease TDS and also hardness, and provide customers with a water blend of a more moderate TDS and hardness content. As noted in Chapter 2 and similar to importing surface water, the decrease in delivered water hardness would likely not be enough that residential customers would stop using or uninstall their home water softeners, but the collective brine discharge resulting from a softer water in the City system would be expected to be somewhat less than the current amount. This makes the wastewater TDS benefits associated with lower-TDS source water alternatives (both this one and the surface water alternatives) slightly conservative; that is, somewhat greater TDS benefits would be expected than indicated by simple proportional calculations. This is discussed more fully in Chapter 2.

The most important regulatory issue associated with this alternative relates to brine disposal. Depending on the method selected, regulatory issues could be significant. The scenario considered in this report was disposal by an evaporation pond, which would need permitting prior to construction, as well as evaporate disposal (albeit only once every several years). Therefore, this alternative was ranked lower than other alternatives that did not involve brine disposal, and lower than the regional treated water surface water import alternative, where significant progress has already been made in terms of environmental permitting and documentation. Regarding drinking water regulations, the City would likely need to work with the California Department of Health Services to have the process change approved, but due to the water quality benefits stated above, this is not expected to pose a problem. The RO units would be installed at the City's existing well sites and pose a relatively low land acquisition (and time requirement) problem in that regard. However, an evaporation pond site would likely need to be acquired; this would take more time than alternatives with no land acquisition constraints, but not be as significant an issue as alternatives with larger recharge ponds or, for example, the irrigation reuse with storage option considered in the Comprehensive Recycled Water Study (Carollo, 2001a). A conceptual design summary indicating target TDS, necessary evaporation pond size(s), and other key parameters is provided in **Table 3-3** on the following page. Key design considerations and cost information for this alternative are summarized in **Table 3-4** and in the cost summary table at the end of this chapter.

Table 3.3. Conceptual Design Summary of Alternative 7: Desalinate Well Water Supply

(Desalination of Selected [>450 mg/L TDS] Wells)							
	Thunderbird #10	**Thunderbird #13**	**Thunderbird #17**	**Thunderbird #23**	**Butterfield #12**	**Dry Creek #18**	**Royal Oak #20**
Total Design Flow (mgd)[1]	1.48	1.44	1.44	1.87	0.58	1.44	1.15
Average TDS (mg/L)[1]	529	514	507	626	526	528	472
Target TDS (mg/L)[2]	≤300	≤300	≤300	≤300	≤300	≤300	≤300
RO Treatment Capability (~90% removal) for TDS (mg/L)	≤50	≤50	≤50	≤50	≤50	≤50	≤50
Design Flow to be Desalinated (%)	52	50	49	61	52	52	45
Flow to be Desalinated (mgd)	0.8	0.7	0.7	1.1	0.3	0.8	0.5
Reject from RO Process (%)	15	15	15	15	15	15	15
Reject (Brine) Flow (mgd)	0.1	0.1	0.1	0.2	0.04	0.1	0.1
Net Evaporation Rate (inches/year)[3]	59	59	59	59	59	59	59
Evaporation Pond Size (acres)[4]	23	22	21	37	9	22	16

[1] Based on available flow and TDS data by well as presented in Appendix A.
[2] Target TDS of ≤300 mg/L set for these wells to result in average water system TDS of 350-400 mg/L when blended with the remaining wells: for comparative purposes, a roughly equivalent TDS benefit to importing surface water.
[3] Net evaporation rate of 59"/year used throughout report based on a gross evaporation rate of 72"/year (average of evaporation rates measured at Lake Nacimiento and Santa Margarita Lake per information provided by the City (pers. comm., Deakin, 2003) and an assumed precipitation rate of 13"/year.
[4] Evaporation pond requirements shown specific to each well for illustrative purposes. Evaporation facilities for wells close to each other would likely be combined (e.g., 100 acres total for the four Thunderbird wells indicated).

Table 3-4. Conceptual Cost Estimate of Alternative 7: Desalinate Well Water Supply

Well Name	Yield (gpm)	Average Well Usage[1] (gpm)	TDS (mg/L)	RO Treatment Equipment Size (gpm)	Treatment Capital Cost[2] ($1000)	Evap. Pond Capital Cost[3] ($1000)	Total O&M Cost[2 4] ($1000/yr)
Thunderbird #10	1,025	688	529	532	$822	$2,280	$104
Thunderbird #13	1,000	687	514	502	$791	$2,150	$101
Thunderbird #17	1,000	725	507	493	$781	$2,120	$102
Thunderbird #23	1,300	112	626	787	$1,231	$3,380	$121
Butterfield #12	400	89	526	206	$367	$880	$42
Dry Creek #18	1,000	241	528	518	$812	$2,220	$78
Royal Oak #20	800	325	472	358	$589	$1,540	$65
Borcherdt #5	440	148	--	--	--	--	--
Sherwood #6	600	193	--	--	--	--	--
Borcherdt #9	1,000	301	444	--	--	--	--
Sherwood #11	1,150	487	407	--	--	--	--
Osborne #14	650	115	444	--	--	--	--
B. Schwartz #15	800	258	--	--	--	--	--
Tarr Well #19	400	17	369	--	--	--	--
Fox Well #21	800	119	415	--	--	--	--
Cuesta Well #22	200	9	445	--	--	--	--
				Total Cost	**$5,400**	**$14,600**	**$610**

[1] Based on annual well usage indicated for 1999 and 2001 per Appendix A.
[2] Includes ammonia feed costs for chloramine disinfection if necessary to match imported chlorinated surface water.
[3] Includes costs for purchasing additional land at $20,000 per acre.
[4] Includes costs for maintaining evaporation ponds.

8. Recharge WWTP Effluent (Without Desalination)

This alternative would result in meeting the primary project criteria. However, as noted in Chapter 1 and discussed in Appendix A, the City investigated groundwater recharge options in the 2001 Comprehensive Recycled Water Study. The investigation indicated that if the City decided to perform a groundwater recharge project, then the City would have to demonstrate that the recharged groundwater would benefit existing groundwater conditions. Unfortunately, due to the generally high TDS content of the wastewater treatment plant effluent, recharged groundwater would not be considered a benefit to the existing groundwater conditions. The investigation also indicated that both of the two main groundwater recharge methods that are currently recognized and regulated by the California Department of Health Services (spreading basins and direct injection) would be very difficult to site facilities in the City without impacting water supply wells. As a result, it appears that the City is not able to recharge wastewater without providing additional treatment to the wastewater treatment effluent, so this alternative is not evaluated further in this report.

9. Desalinate WWTP Effluent to Meet NPDES Discharge Limits

This alternative would result in meeting the most immediate of the two primary project criteria. However, this alternative alone does not provide any benefits to the City with regards to water supply. Specifically, this alternative alone does not provide the City with additional water resources, increase water supply reliability, preserve groundwater basin levels, or improve City drinking water quality. However, it is a very efficient way to meet the immediate TDS effluent limit criteria, as the desalination facilities would be sited in one location. There are other potential benefits to this alternative, such as preparing the City to meet future discharge regulations. For example, the desalination facility could be modified to meet more stringent future NPDES permit standards for TDS or to meet requirements for wastewater reuse or recharge applications. Regulatory issues include brine disposal, although generating brine from only one location (the WWTP) instead of multiple ones (wells/well clusters) makes this issue relatively attractive and cost-effective from this perspective. A conceptual design summary for this alternative including target TDS, necessary evaporation pond size, and other parameters is provided in **Table 3-5**. **Table 3-6** and the cost summary table at the end of this chapter summarize the costs for this alternative.

Table 3-5. Conceptual Design Summary of Alternative 9: Desalinate WWTP Effluent to Meet NPDES Discharge Limits

Total Design Flow (mgd)	4.9
Design Influent TDS (mg/L)[1]	1,200
Target TDS (mg/L)	Ω850
RO Treatment Capability (~90% removal) for TDS (mg/L)	Ω100
Design Flow to be Desalinated (%)	32
Flow to Be Desalinated (mgd)	1.6
Reject from RO Process (%)	15
Reject (Brine) Flow (mgd)	0.2
Net Evaporation Rate (inches/year)	59
Evaporation Pond Size (acres)	45

[1] Target of Ω850 mg/L set for comparative purposes (to provide approximately equivalent TDS benefit as importing surface water) and to provide 20-25% margin of safety against current NPDES limit.

Table 3-6. Conceptual Cost Estimate of Alternative 9: Desalinate WWTP Effluent to Meet NPDES Discharge Limits

Capital Cost Item	Capital ($)
MF Pretreatment System	$1,015,000
RO Treatment System	$823,000
Subtotal Process Cost	***$1,838,000***
Capital Cost (Subtotal Process Cost x Capital Cost Multiplier)[3]	**$3,676,000**
Membrane Housings	
MF	$195,000
RO	$165,000
Bench/Pilot-Scale Testing	$120,000
Permitting (at 3% of Process Cost)	$55,000
Land (at 1% of Capital Cost)	$37,000
Operator Training	$6,000
MF Backwash Discharge Pipeline	$6,000
RO Reject Evaporation Pond[1, 2]	$4,469,000
Indirect Capital Costs	**$5,053,000**
TOTAL CAPITAL COST	**$8,730,000**

O&M Cost Item	O&M ($/yr)
MF	$61,000
RO	$88,000
Evaporation Pond	$65,000
TOTAL ANNUAL O&M	**$210,000**

[1]Evaporation pond was sized assuming net evaporation rate of 59 inches per year.
[2]Evaporation pond costs include costs for purchasing land at $20,000 per acre.
[3]Capital cost multiplier of 2 includes site work, overhead and profit, contingencies, engineering and design, mobilization and bonding, legal and administrative costs, interest during construction, and installation.

10. Desalinate WWTP Effluent for Irrigation Reuse with Storage

This alternative has the potential to meet both of the two primary wastewater regulatory goals of this project. As discussed in the Comprehensive Recycled Water Study (Carollo, 2001a), there are various reuse options that the City can consider, specifically, irrigation reuse with storage, irrigation reuse with river discharge, and community-based reuse with river discharge (Scenarios 1 through 3 in that study). This alternative is the only one of the three that enables avoidance of river discharge year-round, due to the market considered and the large recycled water storage requirement. With regards to water supply reliability, none of the wastewater reuse alternatives offers the benefit of a new surface water supply source. However, implementing any of the three reuse options will offer the benefit of reducing City groundwater pumping, and therefore help to preserve basin groundwater levels and stave off potential overdraft conditions.

None of the three-reuse alternatives would have a direct effect on City drinking water quality. They do not offer the benefits of softer or lower-TDS water associated with the surface water import alternatives. However, there may a long-term drinking water quality benefit associated with desalinating water for reuse and using it within the basin. Specifically, that portion of the reuse water that makes its way to the groundwater basin would be of lower TDS concentration than the City's current wastewater effluent, a portion of which replenishes the groundwater basin via the Salinas River channel under current operations. Capital and operating costs for the irrigation reuse with storage alternative are relatively unfavorable, as indicated in the Carollo study and summarized in Table A-9 of Appendix A. For example, this alternative features a $55 million capital cost, largely due to the level of treatment, storage, and distribution facilities required. Significant regulatory approval is required for all three of these alternatives, as described in the Carollo study. None are expected to be prohibitive, but the combination of complying with water reuse regulations in addition to those associated with brine disposal rank these alternatives as relatively burdensome from a regulatory standpoint as compared to others considered in this report. The time to implement would be expected to be relatively long due to the significant water marketing, planning, engineering/design, permitting, siting, and construction required as compared to other alternatives. Water supply and treatment projects require many of the same steps, but the planning and environmental work for the regional plant and Nacimiento Project is already underway and was therefore ranked higher. Customer/stakeholder acceptance for reuse is difficult to rate at this time due to the variety of stakeholders. The RWQCB, for example, would look on such a project very favorably, while some others (e.g., City residents, potential reuse customers) might have a negative opinion of the concept of reusing wastewater, especially for unrestricted use. The irrigation reuse with storage option ranks higher than the other reuse options because it enables the City to cease river discharge year-round.

11. Desalinate WWTP Effluent for Irrigation Reuse with River Discharge

With regards to water supply reliability, drinking water quality, and groundwater basin levels, this alternative is similar to irrigation reuse with storage. It might yield slightly less water supply reliability benefit, because some water will be "lost" from the basin due to river discharge; however, this is a difficult difference to quantify at this time and would depend on how each project is implemented. The effect each reuse scenario has on water rights is also difficult to estimate based on available information and the unknowns identified in the Comprehensive Recycled Water Study (Carollo, 2001a) and summarized in Appendix A. The irrigation reuse with storage option was ranked slightly lower with respect to water rights than this alternative and the alternative discussed below, because if implemented as described, it would result in all, not just a portion, of the City's wastewater being reused in the area as opposed to flowing down the Salinas River or replenishing the Salinas River Underflow. If effluent ownership and related water rights concerns become contentious, this and the community-based alternative discussed below (which also still features river discharge) would pose less of a problem to the City than the irrigation reuse with storage option. Stakeholder acceptance for this alternative scenario is indicated as lower than the previous alternative because it would not result in year-round ceasing of river discharge and therefore be less attractive to the RWQCB.

12. Desalinate WWTP Effluent for Community-based Reuse with River Discharge

With regards to the criteria pertinent to this water/wastewater quality strategy, this alternative ranks very similarly to the irrigation reuse with river discharge scenario. The only significant difference pertinent to the comparison in this report is the much higher capital cost (~$55M) associated with this alternative as compared to the irrigation reuse option with river discharge. This capital cost is comparable to that indicated for alternative #10 and in this case is due to the extensive recycled water distribution network required to serve the community-based reuse market (Carollo, 2001a). There may be differences in customer/stakeholder acceptance give the different reuse market considered; however, these are difficult to quantify at this time.

13. Desalinate WWTP Effluent for Recharge

From a water supply reliability perspective, this alternative does not offer the same level of benefit as the alternatives involving importing surface water supplies. No new types of water sources are secured for the City under this alternative alone. However, it does serve to help maintain existing groundwater levels in the area and therefore maintain the viability of the City's existing groundwater supplies and help to prevent potential overdraft conditions. With regards to drinking water quality, this alternative would not have a direct effect on City drinking water quality. It does not offer the benefits of softer or lower-TDS water associated with the surface water import or supply well desalination alternatives. However, there is a long-term drinking water quality benefit associated with recharging desalinated water within the basin as compared to current conditions. Specifically, the recharged water would be of lower TDS concentration than the City's current wastewater effluent, a portion of which replenishes the groundwater basin via the Salinas River channel under current operations. Over the long term, this alternative may serve to decrease TDS concentrations in the basin and therefore in the City's groundwater supplies.

Capital and operating costs for this alternative were developed based on the recharge alternative for secondary wastewater developed by Carollo (2001a), coupled with treatment costs developed by Malcolm Pirnie to meet the TDS target as noted above. A conceptual design summary developed by Malcolm Pirnie of the desalination and brine disposal aspects of this alternative is provided in **Table 3-7** on the following page. Anticipated regulatory issues associated with this alternative are somewhat less favorable that most other alternatives. Specifically, they are expected to be somewhat less burdensome than reuse alternatives for the reasons described in those sections. However, as noted in the Comprehensive Recycled Water Study (Carollo, 2001a), siting would be relatively difficult for a recharge project in the area. The only suitable locations appear to be along the Salinas River channel, where the USACE has jurisdiction. Also, finding a site sufficiently distant from existing water supply wells would require more investigation. Because of these complications, this alternative ranks somewhat unfavorably in terms of regulatory constraints, time to implement, and overall stakeholder acceptance, although it would likely be viewed favorably by the RWQCB because it would enable the City to cease discharge to the Salinas River.

Table 3-7. Conceptual Design Summary of Desalination Components of Alternative 13: Desalinate WWTP Effluent for Recharge

Total Design Flow (mgd)	4.9
Design Influent TDS (mg/L)	1200
Target TDS (mg/L)[1]	Ω450
RO Treatment Capability (~90% removal) for TDS (mg/L)	Ω100
Design Flow to be Desalinated (%)	68
Flow to Be Desalinated (mgd)	3.3
Reject from RO Process (%)	15
Reject (Brine) Flow (mgd)	0.5
Net Evaporation Rate (inches/year)	59
Evaporation Pond Size (acres)	105

[1] Target of Ω450 mg/L set per Table 4-4 of the Comprehensive Recycled Water Study (Carollo, 2001a) and to provide demonstrable TDS benefit to groundwater basin.

Table 3-8 on the following page and the cost summary table at the end of this chapter summarize the costs for this alternative. The costs indicated are essentially the sum of previously developed costs for secondary wastewater recharge (Carollo, 2001a) and Malcolm Pirnie cost estimates to treat the City's effluent to 450 mg/L TDS or lower.

Table 3-8. Conceptual Cost Estimate of Alternative 13: Desalinate WWTP Effluent for Recharge

Capital Cost Item	Capital ($)
MF Pretreatment System	$1,829,000
RO Treatment System	$1,413,000
Subtotal Process Cost	***$3,242,000***
Capital Cost (Subtotal Process Cost x Capital Cost Multiplier)[3]	**$6,484,000**
Membrane Housings	
MF	$455,000
RO	$385,000
Bench/Pilot-Scale Testing	$120,000
Permitting (at 3% of Process Cost)	$97,000
Land (at 1% of Capital Cost)	$65,000
Operator Training	$6,000
MF Backwash Discharge Pipeline	$6,000
Evaporation Pond[1, 2]	$10,428,000
Recharge/Percolation Ponds[4]	$3,600,000
Indirect Capital Costs	**$15,162,000**
TOTAL CAPITAL COST	**$21,650,000**

O&M Cost Item	O&M ($/yr)
MF	$163,000
RO	$162,000
Evaporation Pond	$151,000
Recharge/Percolation Ponds[4]	$50,000
Total Annual O&M	***$530,000***

[1]Evaporation pond was sized assuming net evaporation rate of 59 inches per year.
[2]Evaporation pond costs include costs for purchasing land at $20,000 per acre.
[3]Capital cost multiplier of 2 includes site work, overhead and profit, contingencies, engineering and design, mobilization and bonding, legal and administrative costs, interest during construction, and installation.
[4] Per alternative #5 of the Comprehensive Recycled Water Study (Carollo, 2001a).

14. Add East Side WWTP (Upstream Reclamation Plant)

As discussed in Section 3.2, a new wastewater treatment plant on the east side of the City would add treatment capacity, eliminate east side to west side wastewater pumping, and facilitate reuse/recharge projects on the east side of the City if a tertiary plant were constructed. However, this alternative alone does not directly address this project's two main criteria regarding City wastewater compliance and was included in our evaluation primarily for cost comparison purposes.

The design and average capacities of the existing Paso Robles Wastewater Treatment Plant (WWTP) are approximately 4.9 MGD and 3 MGD, respectively. Approximately 1.9 MGD of this flow is from the east side of Paso Robles (including Templeton) and the remaining 1.1 MGD is produced by the west side (City of El Paso De Robles, 2001). The potential future WWTP considered here would treat current and projected wastewater flow from the east side, while the current facility would continue to treat the flow from the west side.

Assuming a current population of 28,900 contributing to the existing wastewater treatment facility, the per-capita wastewater generation is 104 gallons-per-day (GPD). This per capita wastewater generation of 104 GPD was used to project the citywide wastewater flows over the next twenty years, consistent with the population and water demand projections discussed in Chapter 2 of this report. This is shown in **Table 3-9** below.

Table 3.9. Approximate Projected Wastewater Production Rates for the Next 20 Years

Year	Templeton (population served)	West Zone Population Paso Robles	East Zone Population Paso Robles	West Zone Projected WW Flow MGD	East Zone Projected WW Flow MGD
2003	2,907	10,400	15,600	1.08	1.92
2004	2,907	10,584	16,196	1.40	1.98
2005	2,907	10,769	16,815	1.42	2.05
2006	2,907	10,953	17,458	1.44	2.11
2007	2,907	11,138	18,126	1.46	2.18
2008	2,907	11,322	18,819	1.48	2.25
2009	2,907	11,506	19,539	1.50	2.33
2010	2,907	11,691	20,286	1.51	2.41
2011	2,907	11,875	21,061	1.53	2.49
2012	2,907	12,059	21,865	1.55	2.57
2013	2,907	12,244	22,698	1.57	2.66
2014	2,907	12,428	23,562	1.59	2.75
2015	2,907	12,613	24,457	1.61	2.84
2016	2,907	12,797	25,385	1.63	2.94
2017	2,907	12,981	26,346	1.65	3.04
2018	2,907	13,166	27,341	1.67	3.14
2019	2,907	13,350	28,372	1.69	3.25
2020	2,907	13,535	29,440	1.71	3.36
2021	2,907	13,719	30,544	1.73	3.47
2022	2,907	13,903	31,688	1.74	3.59
2023	2,907	14,088	32,871	1.76	3.71

Based on projected wastewater flows shown in the table, a new east side WWTP would be expected to receive an average flow of 4 MGD upon City build-out in twenty years, provided the existing WWTP continues to serve the west side of the City. The presumed location of the new WWTP is on the east side of the Salinas River adjacent to the City's Lift Station #1, opposite the current WWTP. Conceptual-level costs for two plants were developed, as shown in **Table 3-10** on the following page. The first set of costs is for construction of a secondary treatment facility similar to the current WWTP. The second set of costs includes filtration to reduce turbidity for water reclamation. Desalination would represent a cost in addition to those shown in the table, in the order of $10 million (capital) and $250,000/yr (O&M).

Table 3-10. Conceptual Cost Estimate of Alternative 14: Add East Side WWTP (Upstream Reclamation Plant)

Wastewater Effluent Type:	**Secondary**	**Reclaimed**
Site Work and Landscaping	$ 1,400,000	$ 1,400,000
Preliminary Treatment Facility	$ 5,200,000	$ 5,200,000
Aeration Facility	$ 5,000,000	$ 5,000,000
Secondary Sedimentation Facility with RAS Pump	$ 2,300,000	$ 2,300,000
Filtration	N/A	$ 1,300,000
Disinfection Facilities	$ 800,000	$ 800,000
Non-Potable Water Pump Station	$ 400,000	$ 400,000
Solids Handling Facility	$ 5,600,000	$ 5,600,000
Odor Control	$ 900,000	$ 900,000
Operations Building	$ 1,000,000	$ 1,000,000
Instrumentation, Electrical, and Controls	$ 1,200,000	$ 1,300,000
Subtotal Capital/Construction Cost	**$23,800,000**	**$25,200,000**
Administration, Legal, Planning, Design, And Construction Management (35%)	$ 8,330,000	$ 8,820,000
EIR	$ 500,000	$ 500,000
Estimated Total Project Capital Cost	**$32,630,000**	**$34,520,000**
$/gal (based on construction cost)	**$ 6.0**	**$ 6.3**
$/gal (including EIR, admin, legal, etc.)	**$ 8.2**	**$ 8.6**
Power	$ 270,000	$ 280,000
Chemicals	$ 80,000	$ 80,000
Maintenance	$ 100,000	$ 110,000
Subtotal	**$ 450,000**	**$ 470,000**
Estimated Contingency (20%)	$ 90,000	$ 90,000
Estimated Total O&M Cost	**$ 540,000**	**$ 560,000**

Preliminary treatment would include headworks facilities to provide screening and grit removal, followed by flow equalization. After flow equalization, wastewater would enter an aeration facility where activated sludge with biological nutrient removal (BNR) processes would reduce biological oxygen demand (BOD_5), total suspended solids (TSS), and total nitrogen. After aeration, secondary clarifiers in the secondary sedimentation process would produce an effluent to meet the performance goals for a secondary treatment facility. Return activated sludge (RAS) produced in the sedimentation process would be pumped back to the aeration facility, while waste activated sludge (WAS) would be transferred to a thickener, digested in an aerobic digester, and dewatered.

Costs for producing a higher quality effluent for water reclamation include filtration facilities to reduce turbidity after secondary sedimentation. Depending on filter performance goals, it may be necessary to provide chemical addition to the secondary effluent prior to filtration.

Following filtration (or secondary sedimentation for a secondary treatment facility), the effluent would be disinfected in a chlorine contact chamber using sodium hypochlorite.

3.4.3 Alternatives Comparison Matrix and Cost Summary

The Alternatives Comparison Matrix on the following page summarizes the results of the evaluation described in Section 3.4 above. **Table 3-11**, which follows the matrix, summarizes the cost information for those alternatives that address one or both of the primary project criteria and have significant capital and/or operating costs. Specifically, the only viable alternative not shown in this table is #2 in the matrix ("Achieve Greater Industrial and Commercial Discharge Quality Control"). There would be City staff labor costs and possibly relatively minor equipment costs associated with this alternative, but these were considered negligible in relation to the costs of other alternatives considered, which each call for significant capital improvements. This table is the basis for the relative "Capital Cost Competitiveness" and "Operating Cost Competitiveness" scores in the matrix.

CITY OF EL PASO DE ROBLES
Water and Wastewater Quality Concerns - Water Quality Strategy

ALTERNATIVES COMPARISON MATRIX

Relative Ranking Key for Each Alternative/Criterion

1 = unfavorable
2 = somewhat unfavorable
3 = neutral
4 = somewhat favorable
5 = significantly favorable
TBD = to be determined

Water/Wastewater Strategy Alternatives

		Relative Ranking Criteria													
		Primary Criteria - Wastewater Regulatory Drivers		Water Supply Criteria					Common Criteria						
		Does Alternative Achieve Effluent TDS Compliance?	**Does Alternative Cease Discharge to Salinas River?**	Water Supply Magnitude/Reliability	Groundwater Basin Levels	Water Rights	Drinking Water Quality	Security/Vulnerability Position (U.S. EPA Vulnerability Assessment Requirement)	Capital Cost Competitiveness	Operating Cost Competitiveness	Regulatory Issues (Other than Water and Wastewater Quality)	Time to Implement	Customer/Stakeholder Acceptance	OVERALL RANKING	Comments
1	**Do Nothing**	No	No												Does not address either primary criteria - alternative not considered further.
2	**Achieve Greater Industrial and Commercial Discharge Quality Control**	TBD	No	3	3	3	3	3	5	5	4	4	2	3.5	Insufficient information to quantify TDS benefit at this time - can only be considered as a supplement to other alternatives.
3	**Participate in Nacimiento Project (Treated Water Option)**	Yes	No	5	5	5	4	5	1	3	4	3	4	3.9	Would provide the City with a base flow of 4,000 AF/yr of treated surface water via regional transmission line and treatment plant.
4	**Participate in Nacimiento Project (Raw Water Option) and Treat Water with City-Owned Plant**	Yes	No	5	5	5	4	5	1	4	4	3	4	4.0	Would provide the City with a base flow of 4,000 AF/yr of raw surface water via regional transmission pipe - City would own and operate its own treatment plant.
5	**Import Lake Nacimiento Raw Water (Independent of Nacimiento Project) and Treat Water with City-Owned Plant**	Yes	No	4	4	4	4	5	3	4	3	2	3	3.6	Would likely only be implemented if regional project does not materialize and City can obtain Lake Nacimiento water alone - requires City-owned reservoir inlet and all transmission/treatment infrastructure.
6	**Participate in Nacimiento Project (Raw Water Option) to Recharge Salinas River Underflow**	No	No												Does not address either primary criteria - alternative not considered further.
7	**Desalinate Well Water Supply**	Yes	No	3	3	3	4	3	3	4	2	3	3	3.1	Level of well water desalination to achieve TDS benefit equivalent with surface water imports considered for comparative purposes.
8	**Recharge WWTP Effluent (Without Desalination)**	Yes	Yes	2	4	4	2	3	4	5		2	2		Would theoretically address two primary project criteria but was considered infeasible due to difficulty in demonstrating benefit to groundwater basin by recharging high-TDS water.
9	**Desalinate WWTP Effluent to Meet NPDES Discharge Limits**	Yes	No	3	3	3	3	3	4	5	2	4	3	3.3	Level of WWTP effluent desalination to achieve TDS benefit equivalent with surface water imports considered for comparative purposes.
10	**Desalinate WWTP Effluent for Irrigation Reuse with Storage**	Yes	Yes	4	4	2	3	4	1	1	1	1	2	2.3	Based on Scenario #1 of Comprehensive Recycled Water Study (Carollo, 2001a).
11	**Desalinate WWTP Effluent for Irrigation Reuse with River Discharge**	Yes	No	4	4	3	3	4	4	3	1	1	3	3.0	Based on Scenario #2 of Comprehensive Recycled Water Study (Carollo, 2001a).
12	**Desalinate WWTP Effluent for Community-Based Reuse with River Discharge**	Yes	No	4	4	3	3	4	1	3	1	1	3	2.7	Based on Scenario #3 of Comprehensive Recycled Water Study (Carollo, 2001a).
13	**Desalinate WWTP Effluent for Recharge**	Yes	Yes	4	5	4	3	3	3	4	2	2	3	3.3	Based on Scenario #5 of Comprehensive Recycled Water Study (Carollo, 2001a) and Malcolm Pirnie desalination analysis to achieve TDS reduction sufficient to demonstrate benefit to groundwater basin.
14	**Add East Side WWTP (Upstream Reclamation Plant)**	No	No												Does not directly address either primary criteria. However, alternative would add City wastewater treatment capacity and was considered in this report for cost comparison reasons.

Table 3-11. Cost Summary for Alternatives That Address Primary Project Criteria

Alternative[a]	Total Capital Cost	Total Annual Capital Debt Service[b]	Total Annual O&M for Year 1[c]	Total Annual Costs (Debt Service + O&M)[c]
3. Participate in Nacimiento Project (Treated Water Option)[d]	$59.6	$5.63	$1.41	$7.04
4. Participate in Nacimiento Project (Raw Water Option) and Treat Water With City-Owned Plant	$53.2	$5.02	$0.88	$5.90
5. Import Lake Nacimiento Raw Water (Independent of Nacimiento Project) and Treat Water With City-Owned Plant	$26.9	$2.54	$0.86	$3.40
7. Desalinate Well Water Supply	$20.0	$1.93	$0.61	$2.54
9. Desalinate WWTP Effluent to Meet NPDES Discharge Limits	$8.73	$0.83	$0.21	$1.04
10. Desalinate WWTP Effluent for Irrigation Reuse with Storage[e]	$54.6	$5.15	$3.10	$8.25
11. Desalinate WWTP Effluent for Irrigation Reuse with River Discharge[e]	$12.5	$1.18	$1.30	$2.48
12. Desalinate WWTP Effluent for Community-Based Reuse with River Discharge[e]	$54.6	$5.15	$1.40	$6.55
13. Desalinate WWTP Effluent for Recharge	$21.7	$2.05	$0.53	$2.58
14. Add East Side WWTP (Upstream Reclamation Plant)	$34.5	$3.26	$0.56	$3.82

Table 3-11 Notes

a. Numbering of alternatives is per accompanying report text and report text and Alternatives Comparison Matrix – only those alternatives with significant capital costs that are viable alternatives to address one or both primary criteria are included in this table.
b. Annual capital debt service payments include principal and interest on the total capital costs for 20 years at a fixed 7% interest rate.
c. Future O&M costs would include adjustments for inflation.
d. This estimate is based on the total capital cost for the treated water option presented in Table 2.1 of the "Updated Draft: EIR Preparation Phase Engineering Report, Nacimiento Project" (Carollo, 2002). Paso Robles' portion was conservatively estimated using a proportional allocation (non-railroad approach) based on peaking values (5,200/16,449 acre-feet/yr). Cost spreadsheets developed by Boyle Engineers dated April 8, 2002 provided to Malcolm Pirnie by the City were also reviewed. However, the costs incorporated in this report and Table 3-11 reflect the slightly higher estimates provided in the referenced EIR Engineering Phase report – to be conservative and to allow direct comparison among costs for Nacimiento Project alternatives.
e. Costs for alternatives 10, 11, and 12 are from Scenarios 1, 2, and 3, respectively, of Comprehensive Recycled Water Study (Carollo, 2001).

For each alternative, the total annual capital debt service payments were calculated based on a loan with a 20-year period and a fixed 7% interest rate. These values were selected as typical municipal public works financing parameters. However, actual interest rate(s) and/or loan period(s) used to finance the elected alternative(s) may be higher or lower. This provides a brief discussion of how annual and total payments for a given alternative would vary with changes in these parameters. The annual debt service payments and the total payment over the loan period will change in value if the loan period and/or interest rate change. Given a fixed interest rate, increasing the loan period results in smaller annual debt service payments and a higher total payment over the loan period. Given a fixed loan period, increasing the interest rate results in higher annual debt service payments and a higher total payment over the loan period. Using a 20-year, 7 % interest rate loan as a baseline, annual debt service payments and total payments can vary as shown in **Table 3-12**. The two scenarios presented provide reasonable boundaries on the potential cost variation.

Table 3-12. Example Boundaries on Annual and Total Payments According to Variations in Interest Rates and Loan Periods

Interest Rate	**Loan Period (Years)**	**Annual Debt Service Payments as % of Baseline**
5%	30	69%
8%	20	108%
Interest Rate	**Loan Period (Years)**	**Total Payment as % of Baseline**
5%	20	85%
8%	30	141%

4.0 RECOMMENDATIONS – WATER/WASTEWATER QUALITY STRATEGY

The City must take action to address its immediate wastewater discharge concern – its current inability to regularly meet its numerical NPDES permit effluent limits for TDS and related constituents (chloride, sodium, and sulfate). Currently the City is at high risk for continuing to exceed its permit limits, which is not an acceptable situation. Based on the discussions in the previous three chapters, this chapter provides recommendations for the City to implement to address this high priority concern, as well as realize benefits relative to longer-term NPDES/wastewater concerns and the City's long-range plans.

This chapter provides conclusions and recommendations in two categories. First, findings from Chapter 2 regarding potentially importing surface water (water blending, treatment, and TDS benefits) are presented. Second, three specific recommendations regarding implementation of selected alternatives evaluated in Chapter 3 are provided.

4.1 FINDINGS REGARDING IMPORTING SURFACE WATER

1. Blending treated Lake Nacimiento water in the City's existing groundwater system is very feasible based on the water qualities of the two waters. It is recommended to match pH values, types of disinfectant residuals, and introduce the surface water gradually (e.g., over 6-12 months). Desktop modeling could be performed to confirm the compatibility of the two waters. Bench- or pilot- scale work would be necessary to determine whether a corrosion control product (e.g., a polyphosphate or orthophosphate product) would also be desirable.

2. In addition to the regional water treatment plant information compiled by Boyle (2002), a treatment plant dedicated to the City, if feasible, would provide high-quality finished water. Recommended technologies include conventional treatment and microfiltration, each with or without granular activated carbon (GAC) post-filter adsorption. If GAC is used, free chlorine could likely be used as the residual disinfectant, while chloramines would be required if GAC is not used. GAC will provide additional TOC removal, and therefore free chlorine could be used to match the City's existing disinfectant while still complying with disinfection by-product (DBP) regulations. If additional TOC removal were not provided by GAC addition at the water treatment plant, chloramines would likely be required to minimize DBP formation. In this case, the City should chloraminate its well water to avoid any adverse impacts of disinfectant blending.

3. Because of the general compatibility of the waters as indicated by available data, the selection of the treatment process (e.g., conventional, microfiltration, with or without GAC) can be conducted independently of blending considerations. In terms of selecting a process for the treatment of Lake Nacimiento water, blending impacts are secondary in importance to the considerations of adequate microbial control, disinfection by-product minimization, and cost.

4. The City can realize a significant wastewater regulatory benefit with respect to TDS if treated surface water is imported. Currently the City's wastewater TDS averages very close to its discharge limit of 1100 mg/L, and available data indicate this would be reduced to 800-850 mg/L upon the introduction of surface water, representing an approximate 25% margin of safety against discharge violations.

4.2 RECOMMENDED ALTERNATIVES

Three specific recommendations based on the alternatives evaluated in Chapter 3 are provided below. Malcolm Pirnie designed these to be considered as a group of three complementary alternatives to most efficiently address the City's immediate TDS compliance need, as well as provide the foundation for future ceasing of discharge to the Salinas River and for ensuring adequate water supply for future growth.

1. ***Desalinate WWTP Effluent.*** As indicated in Chapter 3, this alternative is the most cost-efficient way for the City to meet its current numerical TDS and related constituent effluent limits. It is also a necessary step for the City to take to prepare for ceasing discharge to the Salinas River, because wastewater desalination is a prerequisite for implementing any treated wastewater recharge or reuse program. Desalination can be implemented modularly; that is, a system to achieve current TDS compliance can be implemented now, and simply be enhanced in the future to achieve the lower TDS values necessary for a treated wastewater recharge or reuse program. Achieving wastewater effluent TDS concentrations at recharge/reuse standards or better (e.g., equal to or less than 450 mg/L) cannot be achieved without wastewater desalination. To consistently achieve this TDS concentration in wastewater effluent without desalinating wastewater would theoretically require desalinating the City's source water (well water and/or surface water) to near-zero TDS concentrations, which is neither practical nor desirable.

   Because of the immediate need for lower effluent TDS concentrations and the apparent inevitability of wastewater desalination for future recharge/reuse applications, we recommend that the City implement treated wastewater desalination – now to meet current TDS effluent limits, and to a greater degree in the future to meet recharge/reuse standards depending on evolving NPDES permit requirements. Depending on evolving NPDES requirements, the City may wish to either lease desalination equipment until a surface water project is brought on line (discussed below), or permanently upgrade its wastewater treatment plant with permanent desalination capability. Leasing may be desirable if the City's current TDS limit (1100 mg/L) remains in effect with its upcoming NPDES permit renewal, because either wastewater desalination or surface water imports alone would bring the TDS of the City's effluent comfortably below that level. If the RWQCB reduces the City's effluent limit to 900 mg/L or lower, it is recommended that the City purchase permanent desalination capability.

2. ***Import Lake Nacimiento Water.*** The method of City implementation of this alternative (participate in either the Nacimiento Project treated or raw water option, or import lake water independently) is largely a function of the results of ongoing City discussions with the Nacimiento Participants Advisory Committee. Of the three choices presented, all three would address the City's immediate TDS concern, but those that include participation in the Nacimiento Project are most favorable from a water supply and regulatory perspective. Unlike the regional options, importing Lake Nacimiento water independently has not yet been investigated and may not be feasible. If implemented, the City would have none of the water supply flexibility inherent in a regional project, and would have to bear the sole burden of ownership and maintenance of the 20-mile transmission line, as well as its own treatment plant, a significant and probably undesirable expansion of City responsibility and risk. The regional projects, which are already in the advance planning stages (the EIR for both options is to be completed in the coming months), are more attractive from a City perspective. The treated water option would be significantly more costly, but allow the City to rely on the regional system for its treated water and require the least degree of variation from current City operations. Significant cost savings are possible if the City participates in the raw water option of the Nacimiento Project and treats its own water with a package (largely pre-designed, commercially available) plant. With its own plant, the City also gains control over staffing and operation of the plant, and may have the opportunity to sell water to other agencies during periods of low demand.

   Importing Lake Nacimiento water by either means provides a unique set of benefits among the alternatives considered in this report. It would provide increased water supply reliability, improved drinking water quality, relief from local groundwater overdraft, and salt reduction across all TDS sources to the City's wastewater treatment plant. We recommend the City continue and expedite its work with neighboring municipalities to implement the Nacimiento Project. The City should consider the pros and cons of the treated water and raw water options as mentioned in the above paragraph and advocate for the option most favorable to the City (and likely to other participants as well). As discussed under recommendation #1 above, this alternative can be implemented in conjunction with wastewater desalination if necessary to meet a more stringent TDS effluent limit if put into place by the RWQCB.

3. ***Achieve Greater Industrial and Commercial Discharge Quality Control.*** City salt grab sampling results indicate that TDS concentrations well in excess of City Sewer Code standards can be found in the wastewater collection system. Although the mass salt loading from industrial/commercial facilities (and thus the potential benefit of this alternative) cannot yet be quantified based on available data, this alternative represents a relatively low-cost measure that the City can take in addition to others to further reduce the TDS loading to its wastewater treatment plant. Although it may not be enough on its own to reduce TDS concentrations in treated wastewater to below NPDES limits, this alternative may well provide an worthwhile incremental TDS reduction, and therefore (1) a

greater margin of safety against future TDS violations, as well as (2) decreased operating costs and brine disposal for a future City wastewater desalination system.

We recommend that the City perform an industrial/commercial wastewater flow monitoring program to complement the City's existing salt monitoring data. Flow-weighted composite wastewater quality samples should also be collected and analyzed to provide a more representative picture of industrial/commercial wastewater TDS concentrations. Following these steps, mass loading of salt from these facilities in the City's wastewater service area can be quantified, and the City can begin more active cooperation and/or Sewer Code enforcement for those facilities responsible for the most significant salt loadings to the City system.

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APPENDIX A

FINAL REPORT

Summary of Existing Water/Wastewater Quality Information – Full Version

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CITY OF EL PASO DE ROBLES
WATER & WASTEWATER QUALITY CONCERNS – WATER QUALITY STRATEGY

PREPARED FOR:

City of El Paso De Robles
1000 Spring Street
Paso Robles, CA 93446

MARCH 2003

MALCOLM PIRNIE, INC.
2000 Powell Street, Suite 1180
Emeryville, CA 94608

4639001

APPENDIX A

FINAL REPORT
SUMMARY OF EXISTING WATER/WASTEWATER QUALITY INFORMATION – FULL VERSION

CITY OF EL PASO DE ROBLES
WATER & WASTEWATER QUALITY CONCERNS – WATER QUALITY STRATEGY

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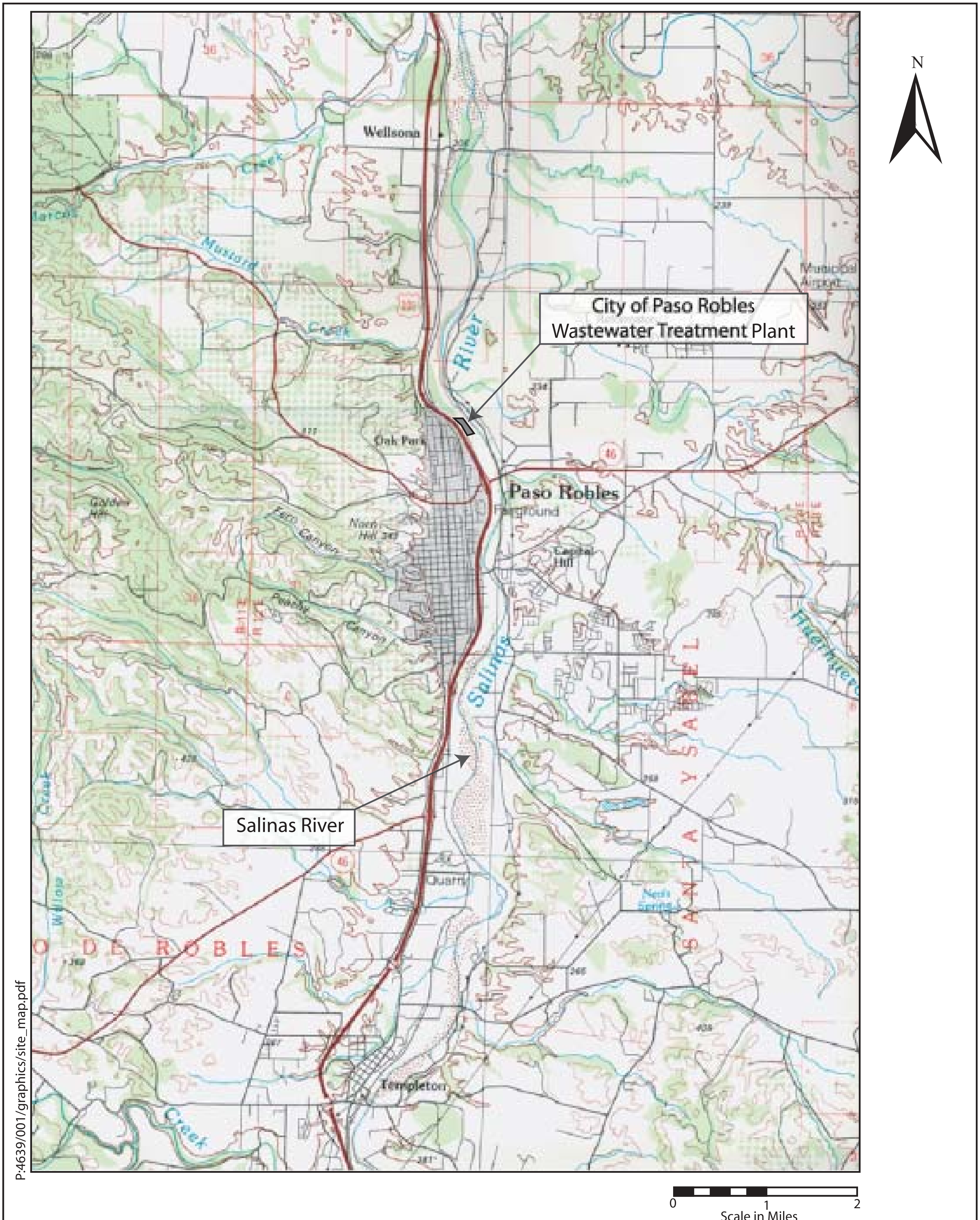
APPENDIX A

1.0 INTRODUCTION

This appendix is the complete version of Chapter 1 of this report, which provided a brief summary of available water and wastewater information pertinent to the development of a water/wastewater quality strategy for the City. Specifically, this section provides a more complete description of the City's current status with respect to:

- Discharge of treated wastewater to the Salinas River
- Characteristics of treated wastewater and compliance with limits for Total Dissolved Solids (TDS)
- Existing water system and delivered water quality
- Water rights, magnitude, quality, and reliability of the City's Salinas River Underflow (shallow groundwater) water supply source
- Water rights, magnitude, quality, and reliability of the City's Paso Robles Groundwater Basin (deep groundwater) water supply source
- Recycled water as a potential water supply source for the future
- Imported surface water as a potential water supply source for the future

This summary was developed by Malcolm Pirnie based on available reports and other documents provided by the City for review. The information presented herein is not intended to be an exhaustive discussion of the reports provided for our review. Instead, it is intended to provide a compilation and discussion of the information in previous documents that directly pertains to the development of a water/wastewater quality strategy. The summary information herein provides the foundation for the analyses conducted during this project, namely, the analysis of the potential effects of introducing treated surface water into the City's distribution system and the evaluation of various alternatives for the City to consider to address its water and wastewater quality issues. **Figure A-1** is a location map of the study area.



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MALCOLM PIRNIE

Location Map
Paso Robles, California

MALCOLM PIRNIE, INC

Figure A-1

2.0 CITY OF PASO ROBLES WASTEWATER DISCHARGE SUMMARY

This section summarizes available information on the quantity and quality of the City's treated wastewater as it pertains to the development of a water/wastewater quality strategy.

2.1 Average and Maximum Wastewater Flows

The average dry weather flow design capacity of the City's wastewater treatment plant is 4.9 million gallons per day (MGD). At the time of the development of the City's 1998 NPDES permit, flows averaged 2.8 MGD, and the 2001 Carollo Salt Management Study indicates an average flow of 2.9 MGD for 1999 (Carollo, 2001b). A 6% per year annual increase in City wastewater flow is indicated by data from 1994-1999 (Carollo, 2001a). The service area of the City's wastewater treatment plant includes the City of Paso Robles as well as the community of Templeton and the Paso Robles Boys School. The plant provides secondary treatment prior to discharge to polishing/percolation ponds and ultimately the Salinas River (RWQCB, 1998). Previous reports (Todd, 2000) indicate that the City's wastewater treatment plant capacity is sufficient to handle City growth for the next twenty years or more; however, the Central Coast Region of the California Regional Water Quality Control Board (RWQCB) has expressed concerns about the current hydraulic/treatment capacity of the plant (Briggs, 1999).

2.2 Discharge to the Salinas River

Currently the City's treated wastewater is discharged to the Salinas River under NPDES Permit 98-42 issued by the RWQCB. The RWQCB has required the City to investigate alternatives to continuing to discharge to the river, noting that the City is the only remaining municipal system discharging into the Salinas River. The City has been notified that the RWQCB generally encourages wastewater reclamation, and that prior to the February 2005 renewal of the City's NPDES permit, the RWQCB will closely review whether the City should be allowed to continue to discharge to the Salinas River (Briggs, 1999).

2.3 General Wastewater Treatment Process/Quality

The City's current wastewater treatment process consists of ferric chloride addition (to reduce hydrogen sulfide in the digester gas), screening, grit removal, primary clarification, biological treatment via trickling filters, secondary clarification, chlorination, discharge to polishing ponds (dechlorination occurs during the detention in the ponds), and discharge to the Salinas River. It is Malcolm Pirnie's understanding that there have historically not been any wastewater treatment upsets or significant problems.

Based on data provided in the 2001 Comprehensive Recycled Water Study (Carollo, 2001a), annual averages of the City's effluent five-day biochemical oxygen demand (BOD_5) and Total Suspended Solids (TSS) concentrations were 13 and 21 mg/L, respectively, during the 1994-1999 period, as compared to their monthly average NPDES effluent limitations of 25 mg/L and 30 mg/L. A review of the City's "Quarterly Constituent Reports" for the wastewater treatment plant from 1992-2002 (City of El Paso de Robles, 2002c) indicates consistent removals of suspended solids and BOD_5, generally equal or greater than 95%. Based on 1994-1999 data, the City also appears to be well in compliance with permit limitations for selected metals (aluminum, boron, copper, iron, and zinc). The report also concludes that the City's wastewater discharge does not have a detrimental impact on the groundwater in the immediate vicinity of the plant (the Salinas River Underflow unit) based on dry weather (no river flow) monitoring data for TDS, sodium, chloride, and hardness. Regarding nitrogen, data are only available for 1992 and 1993 (City of El Paso de Robles, 2002b). Total Nitrogen was measured quarterly during those years, ranging from 2.1 to 14 mg/L, with a media value of 5.2 mg/L. The "Quarterly Constituent Reports" indicate that no effluent limitation is in place for nitrogen.

2.4 Total Dissolved Solids (TDS)

According to the RWQCB (Briggs, 1999), the City has historically had problems in complying with its effluent limitations for TDS. The precise reason for non-compliance is not stated in the 1999 correspondence; however, review of the 2001 Salt Management Study and the City's NPDES permit (Carollo, 2001b; RWQCB, 1998) indicates that the violations have been exceedances of the City's 1100 mg/L daily maximum TDS concentration limit. (Based on the permit provisions, the City is regulated for TDS on this daily maximum basis and not according to monthly average concentrations, weekly average concentrations, mass loading values, or any other basis.)

The TDS content of the City's treated wastewater is the result of four main factors: (1) the TDS content of the City's source water, which is currently 100% local groundwater; (2) the increase in TDS that typically results from municipal water use; (3) the TDS load from residential water softeners; and (4) the TDS input from industrial/commercial sources.

Table A-1 summarizes the TDS concentrations of the City's water and wastewater. In addition to the data in the table, Todd (2000) states that the average monthly TDS concentration in treatment plant effluent was 1,000 mg/L from 1994-1999, based on data compiled by Carollo Engineers in 2000. Sodium, chloride, and sulfate data are also included in the table. The 2001 Salt Management Study indicates the City also has difficulty consistently meeting NPDES effluent limitations for these constituents. The table illustrates the general increase in TDS from source water to effluent and that the City does not have a sufficient margin of safety with regards to compliance for TDS or the other three constituents shown. Available data indicate that, during the January 2000 monitoring event, concentrations of TDS, chloride, and sulfate were equal to or in excess of their respective daily maximum effluent limitations. A review of the City's "Quarterly Constituent Reports" for the wastewater treatment plant from 1992-2002 (City of El Paso de Robles, 2002c) confirms that the City's effluent is typically at or near its effluent limitations for these constituents.

Table A-1. Water and Wastewater Quality Summary

	Source Water for WWTP Service Area		Influent to WWTP		Effluent from WWTP	NPDES Permit Requirements
	avg.	*max.*	*avg.*	*max.*	*one monitoring event (January 2000)*	*daily max.*
TDS (mg/L)	612	730	992	1200	1100	1100
Sodium (mg/L)	122	280	220	280	200	225
Chloride (mg/L)	67	120	314	470	320	310
Sulfate (mg/L)	137	160	141	180	190	180

Compiled from Tables 2 and 3 in 2001 Salt Management Study (Carollo, 2001b); values represent January 1997 – January 2000 quarterly monitoring data, except as noted.

Based on available data, Carollo estimated that TDS loading to the City's wastewater treatment plant would need to decrease by 2,419 lb/day to meet permit limits. This was based on a 100-mg/L decrease in TDS concentration in the plant influent (i.e., reducing the 1997-2000 maximum TDS influent concentration of 1200 mg/L to the permit limit of 1100 mg/L). (The City would likely set a more ambitious target for TDS load reduction to provide a margin of safety in meeting their permit requirements.)

The data presented in the table demonstrate that the TDS increases in the City's service area are higher than average. Specifically, TDS concentrations in wastewater from typical municipal use can be expected to be 150-380 mg/L higher than the source water supplied to the area, as referenced in the 2001 Salt Management Study. Available TDS concentration data from 1997-2000 summarized in **Table A-1** indicates that TDS increases through City use appear to be quite a bit higher than typical municipal increases, as can be seen by the 380 and 470 mg/L increases in the average and maximum measured values, respectively. This is likely a reflection of the additional salt load from home treatment units employing ion exchange and/or industrial/commercial sources.

A number of alternatives were examined in the 2001 Salt Management Study to address the City's wastewater compliance issues and were presented in three main categories: source water management, residential water softener management, and industrial/commercial control. These are discussed in detail in the 2001 Salt Management Study and are briefly summarized here in **Table A-2**.

Table A-2. Summary of Previously Identified Salt Management Alternatives

Category	Alternative	Conclusion
Source Water Management	Preferentially Pump from Wells of Higher Water Quality	TDS improvement probably marginal. Counter-productive with respect to maintaining Salinas River Underflow water rights.
	Augment Well Water Supply with Treated Surface Water	Would bring effluent into compliance. Amount of imports and timing need to be considered.
	Desalinate Well Water	Would bring effluent into compliance. Amount to desalinate a function of water quality objectives and cost.
Residential Water Softener Management	Implement Rental Canister Units for New Developments	Not feasible to address TDS problem (e.g., timing, SB 1006, marginal benefits).
	Limit Residential Softening to Hot Water Uses in New Homes	Not feasible to address TDS problem (e.g., timing, SB 1006, marginal benefits).
	Implement Voluntary Conversion to Rental Canister Units in Existing Homes	Not feasible to address TDS problem (e.g., non-enforceable, still adds sodium).
Industrial and Commercial Control	Implement Salt Management Plans for Industrial/Commercial Facilities	Marginal effluent improvement but relatively easy to implement.
	Require Off-Site Disposal of Brines and Other TDS Wastes	Marginal effluent improvement; City could subsidize costs, or industries could pay.
	Implement Pre-Treatment Program	Possibly only marginal benefit; may not bring effluent into compliance.

Paraphrased from Table 6 of 2001 Salt Management Study (Carollo, 2001b).

The 2001 Salt Management Study identified two significant data gaps regarding the City's salt loadings and wastewater compliance:

- Monitoring of residential wastewater in the City's collection system had not been conducted; therefore, the residential contribution of salts to the City's wastewater could only be estimated at the time of the report.

- Only limited sampling data regarding industrial/commercial contributors were available, although three facilities had been identified as the largest potential contributors.

In response to Carollo's recommendations to further quantify salt contributions according to the various types of contributors to the City's wastewater collection system, the City's Wastewater Division conducted one year of salt monitoring in selected locations. One difference in the methodology of the City's program as compared to Carollo's recommendations was that the City used grab samples instead of composite samples (pers. comm., Columbo, 2003). The City performed monitoring at two locations representing residential discharge (one in the City's West Zone, and one in the East Zone), and at sixteen locations to characterize commercial/industrial discharges. Monitoring results were documented by the Wastewater Division in four quarterly reports (City of El Paso de Robles, 2003b). The reports provide concentration data, but do not include calculations of mass loadings (and therefore relative contributions) to the City's wastewater treatment plant. Specific flow data would be necessary to perform these calculations. Nevertheless, useful findings can be developed from the reported salt concentration data alone. These are summarized below in addition to information provided by City Wastewater Division staff (pers. comm., Columbo, 2003).

- The year of salt monitoring (July 2001 – July 2002) confirmed that the City's wastewater discharge compliance difficulties for TDS are due to a combination of source water, residential, and commercial/industrial factors. The monitoring confirmed the known high TDS content of the City's source water (groundwater), and no particular industry or residential area, for example, appeared to be a single high contributor of TDS increases in the City.

- The City's monitoring documents increases above background (source water) TDS concentrations in residential areas ranging from 239 to 359 mg/L and averaging 290 mg/L. This is comparable to the typical municipal increase of 150-380 mg/L noted earlier in this section, which includes not only residential contributions, but industrial and other potentially high-salt dischargers as well. Therefore, the reported range of salt concentration increases from City residential use alone appears to be higher than average, consistent with the known high use of home water softeners in the area.

- The City's monitoring documents concentrations of TDS and related constituents in the collection system in excess of the City's Sewer Code Limits. This is shown in the table on page 3 of the Fourth Quarter Review Report, where maximum readings for three of the four quarters of monitoring (1,900, 2,100, and 1,400 mg/L of TDS) significantly exceed the stated City Sewer Code Limit of 1000 mg/L. As stated in the report, "All industrial sites still have a wide range of analytical results with all but a couple sites being in violation of the constituent's limits in both Sewer Code and plant discharge limits a majority of the time."

- Since the time of the four quarters of salt monitoring, the community of Templeton has brought their new wastewater treatment plant into service. One particular facility that previously discharged to the City's wastewater plant is now in the Templeton service area, and recent results of the City's wastewater influent monitoring for TDS and related constituents are lower than average. Whether this decrease is associated with the service area switch of the one facility cannot be confirmed based on available data.

It is important to note that concentration data alone are insufficient to develop relative salt loadings to the City's wastewater treatment plant from the City's source water and residential, commercial, and industrial dischargers. For example, TDS concentrations downstream of a particular industry may be in the thousands of milligrams per liter, but its discharge flow may be very small compared to the source water supplied to the City, or the flow from another type of TDS source. In a case such as this, the site in question may have an insignificant contribution to the salt loading to the City's wastewater plant when considered in context of the rest of the City. Relative mass loadings (e.g., in lbs/day) of salt from source water and the types of salt contributors in the City could be calculated using the City's monitoring data discussed above along with (if available) measured or estimated flow contributions for each of the commercial/industrial contributors.

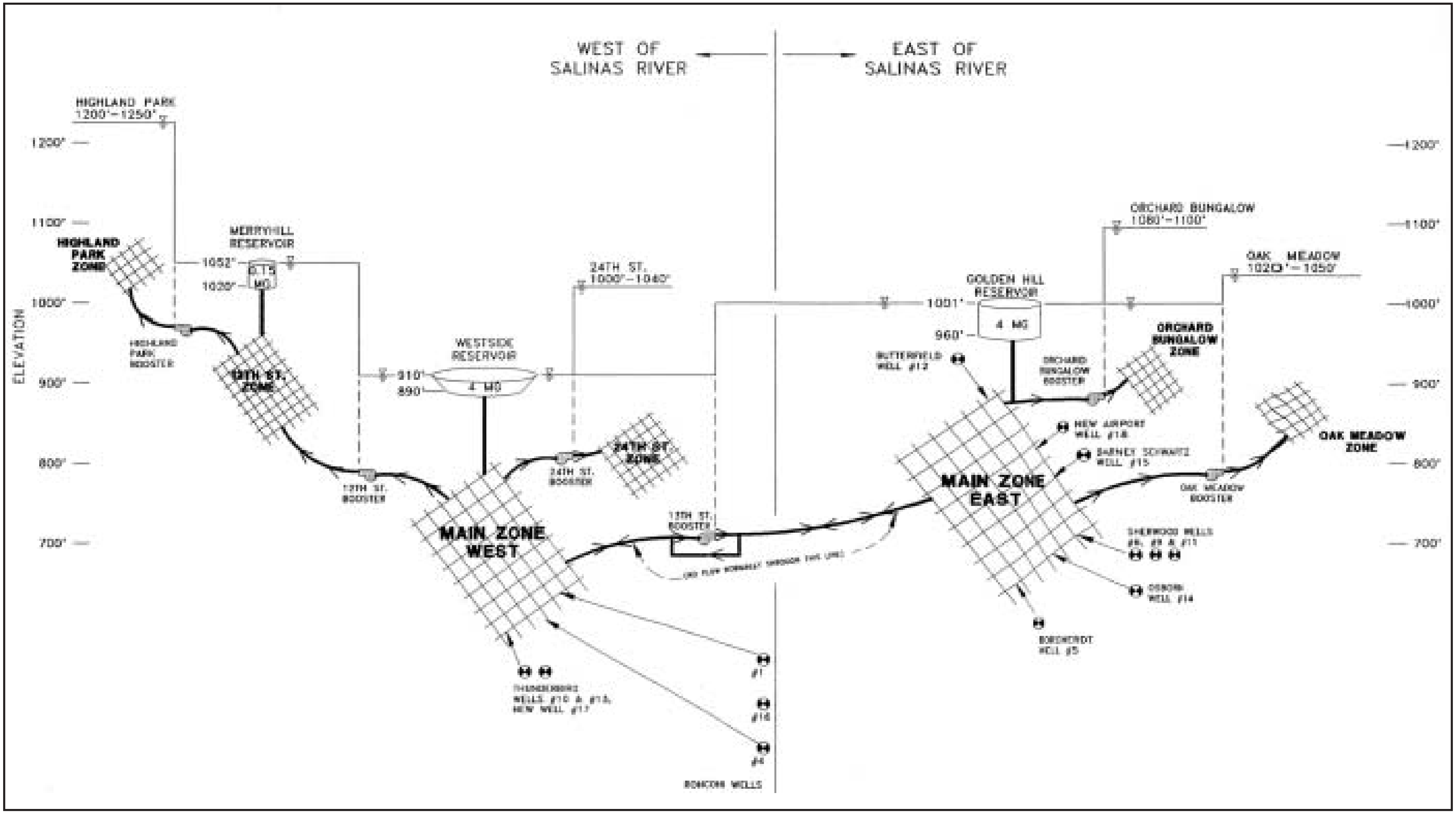
3.0 CITY OF PASO ROBLES WATER SUPPLY SUMMARY

This section summarizes available information on the City's water supply situation as it pertains to the development of a water/wastewater quality strategy. A brief description of the City's water system is provided, and current water supply sources are discussed. Potential future water supply sources are discussed in sections 4 and 5 of this appendix.

3.1 City Water System Description

The City water system currently serves a population of 25,200 via approximately 8,422 service connections (City of El Paso de Robles, 2002b). The City currently has 18 municipal supply wells distributed throughout the service area, which are depicted in **Figure A-2**, adapted from the City's updated Water Master Plan (Boyle, 1995). City wells, which are completed in two major groundwater units as discussed below, range in total depth from 84 to 1,075 feet. Seven wells are located in the Salinas River Underflow where depth to groundwater has ranged from 8 to 44 feet over the last 20 years. The Underflow wells show no long-term trend with respect to groundwater levels. Three of the seven wells (Ronconi 1, 4 and 16) were found to be influenced by surface water and were abandoned in 1994 due to the City's difficulty in meeting more rigorous disinfection contact time requirements (based on the Surface Water Treatment Rule) than the original system design allowed. There are 11 municipal supply wells completed in the Paso Robles Formation, with one well on standby due to high sulfate levels and another well restricted to park irrigation due to high concentrations of iron and manganese. Depths to groundwater in the Paso Robles Formation ranged from 115 to 185 feet in 1999 and, based on data from the past ten years, have showed no declining or other trend. Extraction rates for wells in the Salinas River Underflow range from 813 to 1,300 gpm and, in the Paso Robles Formation (deeper groundwater), the extraction rates range from 400 to 1,150 gpm (Boyle, 1995). Based on monthly reports prepared by the City during 2001 and 2002 (City of El Paso de Robles, 2001 & 2002a), the percentage of water pumped from Underflow wells ranges from 40% to 70% of the City supply. Based on the 2001 and 2002 information, the ratio between the Underflow and the deeper Paso Robles Formation sources varies seasonally, with demand. Specifically, a higher fraction of water is drawn from the Underflow wells when demand is lower in the colder months, and production from the Formation wells is increased to meet the higher demand during the warmer months of the year. A summary of the City's wells is provided in **Table A-3**. Water quality information presented in the table is addressed in the sections following the table.

The City's water system consists of the West and East Zones, which are divided by the Salinas River and generally operate independently; however, a pipeline and a booster pump station are in place to allow the two Zones to exchange water in case of emergency (Boyle, 1995).



SOURCE: 1993 Water Master Plan - April 1995 Update, prepared by Boyle Engineering Corporation for the City of El Paso de Robles, April 1995

MALCOLM PIRNIE	City of El Paso de Robles Existing Water System Schematic	MALCOLM PIRNIE, INC. FIGURE A-2

Table A-3. Water Supply Well Summary

	Well Name	Well Number	Screened Interval (ft. bgs)	Reported Depth to Water (ft.)	Yield (gpm)	Total Pumped in 1999 (MG)	Total Pumped in 2001 (MG)	TDS (mg/L)	Sodium (mg/L)	Chloride (mg/L)	Sulfate (mg/L)	Hardness (mg/L)	Status
Salinas River Underflow	Ronconi #1	-	-	15	839	-	-	-	-	-	-	-	off-line since 1994: under surface water influence
	Ronconi #4	-	-	15	813	-	-	-	-	-	-	-	off-line since 1994: under surface water influence
	Ronconi #16	-	-	15	1,000	-	-	-	-	-	-	-	off-line since 1994: under surface water influence
	Thunderbird #10	27S/12E-09M02	60-210	32	1,025	417	306	529	30	52	161	410	active
	Thunderbird #13	27S/12E-09M03	70-130	31	1,000	331	391	514	32	50	146	381	active
	Thunderbird #17	27S/12E-09M04	70-130	35	1,000	386	376	507	50	49	124	354	active
	Thunderbird #23	27S/12E-09M06	90-140	41	1,300	101	17	626	39	75	177	465	active
	Borcherdt #5	27S/12E-04K02	175-400	58	440	-	78	-	-	-	-	-	active
Paso Robles Formation	Sherwood #6	27S/12E-02D01	160-758	140	600	-	0	-	-	-	-	-	on standby due to high sulfate
	Sherwood #9	27S/12E-02E01	175-600	180	1,000	90	226	444	88	67	34	210	active
	Sherwood #11	27S/12E-02F02	275-592	160	1,150	287	225	407	70	57	31	226	active
	Butterfield #12	26S/12E-22J01	275-775	140	400	26	68	526	115	68	88	202	active
	Osborne #14	27S/12E-02L02	180-524	161	650	39	82	444	58	68	29	322	active
	B. Schwartz #15	26S/12E-26H02	260-340 400-660	120	800	-	-	-	-	-	-	-	off-line due to high manganese and surface water influence; high sodium also indicated
	Dry Creek #18	26S/12E-24D03	400-1075	102	1,000	102	151	528	142	57	143	134	active
	Tarr Well #19	26S/13E-18K01	350-885	158	400	4	14	369	60	67	29	206	active
	Royal Oak #20	27S/12E-02H01	290-370 410-430 470-590	175	800	160	182	472	58	107	29	324	active
	Fox Well #21	26S/12E-13N01	450-1060	200	800	59	66	415	57	70	47	234	active
	Cuesta Well #22	26S/12E-22L02	330-430	120	200	1	8	445	104	49	49	231	active

Table A-3 Notes

Well name, well number, screened interval, depth to water, yield data, and 2001 pumping information from City of Paso Robles Well Water Information table and attachments (City of El Paso de Robles, Undated). 1999 pumping information from Salt Management Study (Carollo, 2001b). Somewhat different values for well yields, depth-to-water values, and screened intervals from those indicated in the table above are reported in the Drinking Water Source Assessment (City of El Paso de Robles, 2002).

Aquifer designation (i.e., Salinas River Underflow or Paso Robles Formation) from Monthly Water Reports (City of El Paso de Robles, 2001 and 2002a). Per City designation, Thunderbird wells are West Side Wells while the rest of the active wells are East Side Wells (City of El Paso de Robles, 2001 & 2002a). (Borcherdt #5 is the only active well both designated as a Salinas River Underflow and an East Side well.)
Ronconi well information and notes re: off-line/standby wells are from Water Master Plan (Boyle, 1995), except indication of high sodium in B. Schwartz #15 (per 7/2/02 City Council agenda). Water Master Plan (1995) also indicates slightly different yields for some wells as compared to those indicated in the table above. Significantly shallower depth-to-water values for 3 wells are indicated in the Water Master Plan also – for Thunderbird #17, Dry Creek #18, and Tarr Well #19. (The rest of the depth-to-water values in the Water Master Plan agree with the values in the table above.)

Water quality data are average values per the Salt Management Study (Carollo, 2001b). The report suggests that these are 1999 averages, but does not state so. Hardness is assumed to be expressed as mg/L as $CaCO_3$.

Dashes indicate information not available or not reported.

Physical Barrier Effectiveness (PBE) assessments performed for the City Drinking Water Source Assessment (City of El Paso de Robles, 2002b) indicate “low” and “moderate” PBEs for active Salinas River Underflow wells and “high” PBEs for active Paso Robles Formation wells.

New well (#8) to be drilled near City airport (per 11/19/02 City Council agenda).

It is Malcolm Pirnie's understanding that the City service areas for water and wastewater are nearly the same. Water service is generally metered. Commercial/industrial sewer use is metered, while residential sewer charges are based on a fixed fee. The West Zone, which is roughly 100 feet higher than the East Zone, receives predominantly Salinas River underflow water from the City's shallow wells (relatively high TDS), while the East Zone receives predominantly deeper groundwater (lower TDS).

Like those of other cities, the City's distribution system consists of a network of pipelines with varying age, material, and condition. The City's oldest pipelines can be found in the West Zone, some of which date back to the 1900s. The oldest pipelines in the East Zone date back to the 1940s. The City's pipeline distribution system consists of asbestos cement (AC), cast iron (CI), ductile iron (DI), polyvinyl chloride (PVC), and steel. The majority of the pipelines are AC, which were installed from the 1950s through the mid-1980s. PVC has been the material of choice since the mid-1980s for replacing old pipelines and installing new ones. The use of steel pipelines has been minimal and has only been done for pipelines 4" or less in diameter. DI pipelines were used exclusively for main pumping lines starting in 1972. CI was installed prior to the late 1950s. This information is provided in the City's Water Master Plan (Boyle, 1995) and is supported by information in the City's Water Atlas (City of El Paso de Robles, 1996b).

3.2 Existing Delivered Water Quality

The City's water has consistently met drinking water standards and generally has not had problems with stagnant areas of the system, high coliform counts, or loss of chlorine residual (Dunham, 2002). A review of the City's annual Water Quality Reports (City of El Paso de Robles, 2002d) for the last decade generally confirms this. Only one positive coliform count was reported, in 1992. Additionally, no synthetic organic or volatile organic compounds (SOCs and VOCs) have been detected based on information reviewed. The water delivered represents a blend of water from the City's numerous wells. All well water is chlorinated, with a target residual of between 0.8 and 1.1 mg/L of free chlorine. **Tables A-4** through **A-6** on the following pages provide a summary of water quality monitoring results for 1992 through 2001.

3.3 Groundwater (Existing Water Supply Source)

The City currently relies on groundwater for 100% of its municipal water supply. There are two main sources of this groundwater: the Salinas River Underflow and deeper groundwater within the Paso Robles Groundwater Basin. The alluvium along the Salinas River is the unit containing the Salinas River Underflow, which refers to shallow groundwater flowing as a subterranean stream in direct connection with the Salinas River. Groundwater within the Paso Robles Formation is the most extensive area aquifer, consisting of 1800 feet of unconsolidated sand, silt, gravel, and clay. The Paso Robles Formation provides groundwater not only to the City of Paso Robles but also to other municipal, domestic, and agricultural users throughout the basin (Todd, 2000). Additional information regarding these two groundwater supply sources is provided in the subsections below.

Table A-4. Delivered Water Quality Summary - Primary Regulated Substances (Part 1)

Water Quality	Aluminum (mg/L)		Antimony (σg/L)		Arsenic (σg/L)		Barium (mg/L)		Beryllium (mg/L)		Cadmium (σg/L)		Chromium (σg/L)		Cyanide (mg/L)		Fluoride (mg/L)		Gross Alpha Activity or Alpha Emitters (pCi/L)		Mercury (σg/L)	
Report Date	Avg.	Range	Avg.	Range	Avg.	Range	Avg.	Range	Avg.	Range	Avg.	Range	Avg.	Range	Avg.	Range	Avg.	Range	Avg.	Range	Avg.	Range
2001	0.005	ND - 0.068	NR	NR	5.36	ND - 20.9	0.06	ND - 0.2	NR	NR	NR	NR	NR	NR	NR	NR	0.25	ND - 0.81	2.5	ND - 5.1	NR	NR
2000	0.054	ND - 0.697	NR	NR	5.26	ND - 20.9	0.68	ND - 0.197	NR	NR	NR	NR	NR	NR	NR	NR	0.33	ND - 1.11	5.1	1.1 - 5.1	NR	NR
1999	0.066	ND - 0.7	NR	NR	15	ND - 15	0.55	ND - 0.27	NR	NR	NR	NR	NR	NR	NR	NR	0.48	0.08 - 1.1	5.1	1.1 - 5.1	NR	NR
1998	0.009	ND - 0.058	NR	NR	3.933	ND - 15	0.059	ND - 0.267	NR	NR	NR	NR	NR	NR	NR	NR	0.478	0.08 - 0.93	3.6	1.1 - 10.16	NR	NR
1997	ND	ND	ND	ND	4.94	ND - 15	0.056	ND - 0.267	ND	ND	ND	ND	ND	ND	ND	ND	0.475	0.26 - 0.93	2.4	0.7 - 4.35	ND	ND
1996	ND	ND	ND	ND	6.12	ND - 18	0.077	ND - 0.28	ND	ND	ND	ND	ND	ND	ND	ND	0.344	0.23 - 0.8	1.9	0.7 - 2	ND	ND
1995	ND	ND	ND	ND	6.12	ND - 18	0.077	ND - 0.28	ND	ND	ND	ND	ND	ND	ND	ND	0.344	0.23 - 0.8	1.87	0.7 - 2	ND	ND
1992	0.1	0.1 - 0.1	NR	NR	9	5 - 28	0.15	0.09 - 0.36	NR	NR	1	1 - 1	6	5 - 7	NR	NR	0.4	0.1 - 0.8	2.6	0.4 - 4.9	0.2	0.2 - 0.2

Table A-4. Delivered Water Quality Summary - Primary Regulated Substances (Part 2)

Water Quality Report Date	Nickel (mg/L)		Nitrate (mg/L as NO_3)		Nitrate + Nitrite (mg/L as N)		Nitrite (mg/L as N)		Selenium (σg/L)		Thallium (mg/L)		TTHMs (σg/L)		Turbidity (NTU)	
	Avg.	**Range**	**Avg.**	**Range**	**Avg.**	**Range**	**Avg.**	**Range**	**Avg.**	**Range**	**Avg.**	**Range**	**Avg.**	**Range**	**Avg.**	**Range**
2001	NR	NR	8.54	ND-26	1.8	ND - 4.32	NR	NR	2.93	ND - 24	NR	NR	11.95	3.9 - 12.6	3	NR
2000	NR	NR	9.85	ND - 40.9	2.4	ND - 5.7	NR	NR	3.89	ND - 24	NR	NR	24.8	ND - 49.6	2	NA
1999	NR	NR	13.19	4.4 - 35.6	2.9	0.61 - 6.41	NR	NR	5.4	ND - 26.3	NR	NR	9.5	2.3 - 16	4.8	NA
1998	NR	NR	11.61	4.58 - 41.6	2.5	0.61 - 6.41	NR	NR	5.05	ND - 34.3	NR	NR	18.8	5.6 - 31.7	1.17	0.01 - 6.5
1997	ND	ND	11.17	2.7 - 28.4	2.3	0.6 - 6.4	ND	ND	6.53	ND - 34.3	ND	ND	7.5	ND - 20.5	1.73	0.1 - 6.5
1996	ND	ND	10.95	2.1 - 34.5	2.28	0.97 - 5.28	ND	ND	6.68	ND - 24	ND	ND	11.05	ND - 18.3	0.464	0.11 - 3
1995	ND	ND	11.11	2.0 - 35.9	2.3	0.97 - 5.28	ND	ND	6.68	ND - 24	ND	ND	18.78	3.9 - 36.7	0.464	0.11 - 3
1992	NR	NR	6.7	1.0 - 12.6	NR	NR	NR	NR	5	5 - 5	NR	NR	11.30	2 - 36	0.35	0.1 - 2

Table A-5. Delivered Water Quality Summary - Secondary Regulated Substances

Water Quality	Apparent Color (Color Units)		Chloride (mg/L)		Iron (σg/L)		Manganese (σg/L)		MBAS (mg/L)		Odor-Threshold (units)		Silver (σg/L)		Specific Conductance (σmhos/cm)		Sulfate (mg/L)		Total Dissolved Solids (TDS) (mg/L)		Zinc (σg/L)	
Report Date	**Avg.**	**Range**	**Avg.**	**Range**	**Avg.**	**Range**	**Avg.**	**Range**	**Avg.**	**Range**	**Avg.**	**Range**	**Avg.**	**Range**	**Avg.**	**Range**	**Avg.**	**Range**	**Avg.**	**Range**	**Avg.**	**Range**
2001	NR	NR	68.22	45 - 120	16.43	ND - 230	2.21	ND - 31	NR	NR	1	1 - 1	NR	NR	842.36	686 - 1,200	85.59	26.3 - 182	486	369 - 720	NR	NR
2000	NR	NR	65.22	46.2 - 107	26.85	ND - 233	NR	NR	NR	NR	1	1 - 1	NR	NR	845.62	686 - 1,120	86.72	26.3 - 182	479.38	369 - 626	NR	NR
1999	1.15	0 - 5	64.37	48.5 - 107	26.85	ND - 233	NR	NR	NR	NR	1.15	1 - 2	NR	NR	860.38	670 - 1,120	83.62	28.9 - 177	480	370 - 630	NR	NR
1998	0.83	0 - 5	69.37	48.5 - 120	9.667	ND - 116	3.75	ND - 45	NR	NR	1.25	1 - 2	NR	NR	875.42	670 - 1,200	81.717	28.9 - 161	489.12	369 - 715	NR	NR
1997	3.3	0 - 5	67.57	50 - 120	39.2	ND - 270	3.8	ND - 45	ND	ND	1.2	0 - 2	ND	ND	888.1	670 - 1,200	92.77	29 - 161	517.63	369 - 715	ND	ND
1996	3.4	0 - 4	67.45	42.7 - 116	26	ND - 170	6.6	ND - 45	ND	ND	1.4	0 - 4	ND	ND	869.3	710 - 1,150	90.91	24 - 160	539.75	435 - 705	ND	ND
1995	3.4	ND - 4	67.45	42.7 - 116	26	ND - 170	6.6	ND - 45	ND	ND	1.4	0 - 4	ND	ND	869.3	710 - 1,150	90.91	24 - 160	539.75	435 - 705	ND	ND
1992	4.4	3 - 10	74	45.4 - 115.4	100	100 - 100	30	30 - 30	0.02	0.02 - 0.02	1.4	1 - 3	5	5 - 5	NR	NR	96.7	30.1 - 207.2	566	450 - 743	50	50 - 50

Table A-6. Delivered Water Quality Summary - Tap Water Samples and Unregulated Substances (Part 1)

Water Quality	Bicarbonate (mg/L)		Boron (σg/L)		Calcium (mg/L)		Carbonate (CO_3) (mg/L)		Copper (mg/L)		Hydroxide (OH) (mg/L)		Lead (mg/L)		Magnesium (mg/L)	
Report Date	**Avg.**	**Range**	**Avg.**	**Range**	**Avg.**	**Range**	**Avg.**	**Range**	**Value**	**Range**	**Avg.**	**Range**	**Value**	**Range**	**Avg.**	**Range**
2001	305.6	256 - 430	266	ND - 740	64.4	16 - 110	NR	NR	0.29 (90th percentile)	NR	NR	NR	NR	NR	24.5	6.3 - 39.5
2000	303.46	256 - 351	NR	NR	66.58	31.20 - 135	NR	NR	1.1 (90th percentile)	NR	NR	NR	NR	NR	28.24	6.3 - 39.5
1999	307.21	260 - 354	NR	NR	66.3	30.1 - 135	NR	NR	1.1 (90th percentile)	NR	NR	NR	NR	NR	29.12	14.2 - 42.2
1998	313.81	260 - 400	NR	NR	61.89	30.1 - 101	NR	NR	1.08 (90th percentile)	NR	NR	NR	NR	NR	29.03	14.2 - 42.2
1997	317.4	260 - 400	NR	NR	57.99	30.1 - 104	ND	ND	ND	ND	ND	ND	ND	ND	30.42	14.2 - 56
1996	313.8	276 - 397	NR	NR	58.31	30 - 94	ND	ND	ND	ND	ND	ND	ND	ND	29.07	14.2 - 44
1995	313.8	276 - 397	NR	NR	58.31	30 - 94	ND	ND	ND	ND	ND	ND	ND	ND	29.07	14.2 - 44
1992	NR	NR	NR	NR	80.7	41.5 - 133.1	NR	NR	0.05	0.05 - 0.05	NR	NR	0.005	0.005 - 0.005	27.3	14.1 - 43.1

Table A-6. Delivered Water Quality Summary - Tap Water Samples and Unregulated Substances (Part 2)

Water Quality	pH (units)		Potassium (mg/L)		Sodium (mg/L)		Total Alkalinity (mg/L as $CaCO_3$)		Total Hardness (mg/L as $CaCO_3$)		Vanadium (σg/L)	
Report Date	**Avg.**	**Range**	**Avg.**	**Range**	**Avg.**	**Range**	**Avg.**	**Range**	**Avg.**	**Range**	**Avg.**	**Range**
2001	7.37	7.10 - 7.62	1.9	ND - 4.2	82.6	31.9 - 240	250.9	210 - 360	263.6	93 - 412	19	ND - 57
2000	7.41	7.16 - 7.73	1.69	ND - 3.4	70.88	31.9 - 146	249.08	210 - 288	284	128 - 465	NR	NR
1999	7.57	7.3 - 8.0	1.88	1.10 - 3.10	69.45	30.20 - 142	251.94	213 - 290	284.53	133.6 - 465	NR	NR
1998	7.56	7.3 - 8	2	1.1 - 3.9	79.13	30.2 - 190	257.27	213 - 328	267.75	133.6 - 410	NR	NR
1997	7.59	7.4 - 8	2.2	1.1 - 3.9	86.3	30.2 - 190	260	213 - 328	263.55	157 - 410	NR	NR
1996	7.61	7.4 - 8	2.23	1.5 - 3.4	86.5	37 - 184	253.8	219 - 335	265.26	133.6 - 408	NR	NR
1995	7.61	7.4 - 8	2.23	1.5 - 3.4	86.5	37 - 184	253.8	219 - 335	265.26	133.6 - 408	NR	NR
1992	7.71	7.57 - 7.91	2.04	1.3 - 3.4	71.4	31.4 - 165.5	NR	NR	285.6	50.8 - 509.6	NR	NR

<u>Notes on Tables A-4 through A-6</u>

Water Quality Reports are not available for 1993 and 1994.
There are no reported detections of either SOCs or VOCs so they are not indicated in the tables.
There are no reported detections of high coliforms, so they are not indicated in the tables (the only reported coliform was one positive sample out of 364 collected in 1992).
NR = Not Reported.
ND = Non Detected.
Aluminum has also a secondary standard in addition to its primary standard.

3.3.1 Salinas River Underflow

The Paso Robles Groundwater Basin is composed of two main units: (1) a thin upper alluvium, which overtops (2) an extensive sedimentary basin. The upper alluvial deposit occurs beneath the flood plains of the rivers and streams within the groundwater basin and consists primarily of sand and gravel.

The thickness of the unit varies locally, reaching a maximum estimated depth of 80 feet near the confluence of the Salinas and Estrella rivers. Transmissivity of the alluvium is estimated to be 52,000 gpd/ft. Wells completed in the younger alluvium are present along the Salinas and Estrella rivers and the length of the Huer Huero Creek (Fugro, 2002). The portion of this thin upper alluvium along the Salinas River is known as the Salinas River Underflow.

3.3.1.1 Water Rights/Magnitude

The City of Paso Robles has water rights to a specific quantity of water from the Salinas River Underflow (shallow groundwater). Underflow is subject to appropriative water rights and is permitted by the State Water Resources Control Board. As of September 2000, the City had rights to an annual extraction of 4,600 acre-feet (AF) of the Underflow and in 1999 only used 3,800 AF. The City currently has the capacity to pump the entire volume. It was assumed during the development of the 2000 Urban Water Management Plan that use of the Underflow would gradually increase to account for the entire 4,600 AF (Todd, 2000). A somewhat larger allowable extraction from the Underflow is indicated in the Master Plan Update (Boyle, 1995): 8 cubic feet per second (cfs), which is equal to roughly 5,800 acre-feet per year (AF/yr). The 1941 Salinas River Withdrawal Permit is cited as the granting the City the 8 cfs from the wells adjacent to the Salinas River.

If the basin is recharged (e.g., with imported surface water), the amount of river underflow legally available to the City increases by the amount of recharge. It would not be necessary for the City to demonstrate that the additional water withdrawn from the basin is the same water that was recharged in order to realize this increase in allowable Underflow withdrawal (Boyle, 2002).

3.3.1.2 Quality

Wells screened within the Salinas River Underflow produce water with TDS concentrations between 300 and 800 mg/L (Todd, 2000). Based on TDS data compiled by Carollo for the Thunderbird wells (Carollo, 2001b), TDS concentrations in water produced by these wells average approximately 540 mg/L. This is somewhat higher than the average TDS in water produced by the City's deeper wells as discussed in the following subsections.

3.3.2 Paso Robles Groundwater Basin (Deep) Groundwater

Below the alluvium of the Paso Robles Groundwater Basin is the Paso Robles Formation, a sedimentary unit that extends from ground surface to more than 2000 feet below sea level. The Paso Robles Formation is a series of thin, often discontinuous sand and gravel layers interbedded with thicker layers of silt and clay. Transmissivity of the Paso Robles Formation is estimated to be 10,000 gpd/ft. The main aquifer for the City of Paso Robles is within the Paso Robles Formation and underlies the Salinas River alluvium. This unit then thins and deepens to the east, becoming the deep aquifer zone east of the Huer Huero Creek. This deep aquifer zone is approximately 150 feet thick and occurs at an average depth of 700 feet below ground surface (bgs). Above and below this aquifer zone are thin lenticular production zones, with those above the deep zone tapped by domestic wells up to 400 feet deep. The deep aquifer zone is primarily used for deep irrigation wells and municipal supply wells (Fugro, 2002).

Underlying the Paso Robles Formation are several older geologic formations that typically have lower permeabilities and can act as reservoirs for geothermal water. One such unit is beneath the City of Paso Robles. The City of Paso Robles has historically been the site of hot springs. An investigation concluded that the source of these hot springs was the deep circulation of meteoric waters along faults, especially along the Rinconada fault. This groundwater is not considered part of the Paso Robles basin because the quality of the water produced is usually very poor. The groundwater here is often highly mineralized and characterized by elevated boron concentrations that restrict agricultural uses (Fugro, 2002).

3.3.2.1 Water Rights

As mentioned above, the groundwater of the Paso Robles Groundwater Basin is available to and appropriated by the City of Paso Robles as a source of water supply. The City extracted 2,300 AF from the Basin in 1999. This source of groundwater is not subject to explicit limitation. However, multiple users draw on this water source, and these demands are increasing (Todd, 2000).

3.3.2.2 Magnitude

The basin covers an area of approximately 790 square miles (505,000 acres), and the total watershed area is approximately 1,980 square miles. The total estimated groundwater in storage within the Paso Robles Groundwater Basin is approximately 30,500,000 AF. This value changes with time depending on the relative amounts of recharge and pumpage. The main area of groundwater recharge to the basin is where the shallow alluvial sand and gravel beds are in direct contact with the Paso Robles Formation. Near Paso Robles, the large aquifer in the Paso Robles Formation is in direct contact with the younger alluvium along the Salinas River channel (Fugro, 2002). Refer to Figure 27 of the Fugro (2002) report for a hydrogeologic cross section of the area.

According to Fugro (2002), perennial yield of the basin is defined as the rate at which water can be pumped over a long-term period (i.e., over several or more years) without decreasing the groundwater in storage. The perennial yield for the Paso Robles Groundwater Basin (which includes the Atascadero subbasin) has been calculated to be 94,000 AF/Y. Despite growth in the area, total net groundwater pumpage in the basin declined steadily from 1984 through 1998. Fugro (2002) did not specify why there was a decrease in pumping; however, reasons may include increased irrigation efficiency, residential water awareness/conservation, variations in rainfall, and/or other factors. In the following two years (1999 and 2000), it appeared that groundwater pumping was increasing, which may be the start of a new trend. In the year 2000, groundwater pumpage in the Paso Robles Groundwater Basin was approximately 82,600 AF. Fugro (2002) also noted that pumpage exceeded the perennial yield from 1980 through 1990. Only during the last decade has pumpage been less than the perennial yield. These trends should be further evaluated by considering the amount of recharge to the basin for a specific year in conjunction with pumpage (Fugro, 2002).

Water level data show that over the base period considered by Fugro (from July 1980 through June 1997) there is no definitive upward or downward water level trend for the basin except in the area near the City of Paso Robles where water levels have declined. Refer to Figures 32 and 33 in the Fugro (2002) report that present regional water surface maps for Spring 1980 and Spring 1997, respectively. Fugro (2002) estimated that this decrease that has occurred over the last 20 years is approximately 78,000 AF (about an 0.88% decrease). This decrease over time in the City of Paso Robles area is where Dry Creek flows northwesterly into Paso Robles. Dry Creek flows through an area where well yields are much lower than those generally found in the central part of the basin; this is likely due to the presence of older, less permeable sediments associated with uplift along the Creston anticlinorium. These less permeable sediments are also further away from the major recharge sources of the Huer Huero Creek and Estrella River. Refer to Figure 34 of the Fugro (2002) report for an illustration of the change in water surface elevation between Spring 1980 and Spring 1997. Coupled with less permeable sediments, this area is undergoing rapid development of rural residential housing, vineyards, and golf courses that currently rely entirely on groundwater for their water supply. Because of this recent demand on the groundwater, water levels have decreased, causing the groundwater flow patterns to shift and forcing the hydraulic gradient east of Paso Robles to steepen. Available data do not indicate any immediate impact on the City's wells; however, this localized groundwater level decline underscores the susceptibility of Basin water levels to increased groundwater use and the impacts to private wells near the City.

3.3.2.3 Reliability/Safe Yield Issues

As of September 2000, decreases in two City wells (Sherwood wells 9 and 11) were noted. These decreases could be related to local pumping in excess of natural recharge and again may highlight the susceptibility of groundwater levels in the area. Installation of additional City wells outside the City limits may not be possible. Todd (2000) suggested continued monitoring of local groundwater levels to evaluate whether overdraft conditions of the basin are beginning to be established. To offset the development of basin overdraft, it was suggested in the Urban Water Management Plan that conservation methods could be employed, and/or an additional surface water supply could be added to the City's groundwater supply (Todd, 2000).

As noted in the Urban Water Management Plan, the annual growth rate in the City is approximately 3%, and the population is estimated to reach approximately 34,400 by 2020. The ultimate population had been previously estimated at 70,700 (Boyle, 1995). It is Malcolm Pirnie's understanding that the differences in the City build-out population and associated water demand numbers in these documents are the result of differences in areas used. A build-out population of 60,000 or more generally includes both the City and outlying areas, is associated with the Planning Impact Area (PIA), and can be used as an estimate of the maximum number of people that a facility in the area may need to serve in the future. As of this writing (January 2003), the projected build-out population for the City can be assumed to be 42,000, with the potential to be somewhat higher depending on future annexation.

To support City growth, the total water demand was projected during the development of the Urban Water Management Plan to increase significantly from the

1999 demand of 6,025 AF/yr. Estimates of 2020 demand include 10,600 AF/yr and 11,130 AF/yr, although the assumptions used to develop these two different figures are not evident. The combined capacities of the City's Underflow wells (up to 4,600 AF/yr) and the basin wells (9,800 AF/yr) appear to meet the demands in the near future. However, the City may face groundwater supply shortages in the long-term. To address possible future groundwater supply shortages, the Urban Water Management Plan (Todd, 2000) considered three possible scenarios. The first of these is the continued use of groundwater alone, the second is the use of groundwater and imported surface water (Lake Nacimiento), and the third option is the use of groundwater in conjunction with recycled wastewater. The first of these three scenarios as explored in the Urban Water Management Plan is briefly summarized in the two paragraphs below. The other two are noted in later sections of this appendix.

In 2000, the total City water demand was 7,560 AF/yr, which was met by existing groundwater sources. Future water demands are expected to be nearly 150 percent of 2000 production as noted above. The Salinas River Underflow would provide 4,600 AF/yr, and the groundwater basin would provide the remaining 6,530 AF/yr. Although the current capacities of the City's wells appear to be sufficient to satisfy the future demand, the City could face water supply limitations. These limitations include competition for water supplies both on a local and regional level, inability to install and operate additional City wells beyond the current City limits, and the possibility of creating overdraft conditions in the basin (Todd, 2000).

Considering the Paso Robles Groundwater Basin as a whole, agricultural pumpage currently accounts for 69% of total basin pumpage. Depending on new trends (e.g., continued addition of vineyards) or additional water demand exerted by the agricultural industry, the basin pumpage could approach or exceed the perennial yield in the near future. Domestic demand (municipal, small community systems, and rural domestic) has increased at a steady rate since 1980, and this trend is expected to continue. Fugro (2002) indicated future water demands for the area (based on domestic and agricultural growth as developed in the 1998 San Luis Obispo County Master Water Plan Update) to be 120,620 AF/yr by the year 2020. If and when this future water demand exceeds the perennial yield of the Paso Robles Groundwater Basin, an additional water supply source for the area will be required if basin overdrafting is to be prevented.

3.3.2.4 Quality

In water produced by the deep Paso Robles Groundwater Basin wells, TDS concentrations generally range from 300 to 1000 milligrams per liter (mg/L), averaging 450 mg/L (Todd, 2000). The corresponding range for Salinas River Underflow well water is 300 to 800 mg/L, with a somewhat higher (540 mg/L) average (Carollo, 2001b).

According to Fugro (2002), the quality of the groundwater in the basin is relatively good with a few areas of poor quality. They identified six major water quality degradation trends for the basin as a whole as listed below. In some cases, only one well was used to determine the trend indicated, so additional data would, in most cases, be needed to confirm that they were representative of more widespread conditions. The trends identified are:

- Increasing TDS and chlorides in shallow Paso Robles Formation deposits along the Salinas River in the central Atascadero subbasin. The most visible trend of water quality deterioration is in a shallow well (105 ft deep) located in the Salinas River valley, approximately one mile downstream of the City of Atascadero wastewater percolation ponds. Available data from this well (28S/12E-14K01) indicate TDS concentrations increasing by approximately 10 mg/L per year.

- Increasing chloride concentrations in the deep, historically artesian aquifer in the area northeast of Creston.

- Increasing TDS and chlorides near San Miguel.

- Increasing nitrates in the Paso Robles Formation in the area north of Highway 46, between the Salinas River and the Huer Huero Creek.

- Increasing nitrates in the Paso Robles Formation in the area south of San Miguel.

- Increasing TDS and chloride concentrations in deeper portions of the aquifer near the confluence of the Salinas and Nacimiento Rivers.

In a report authored by the DWR in 1981, they concluded that the salt loading of the Salinas River Underflow was attributable to mineralized flows from wells and springs and to the City of Paso Robles wastewater treatment plant discharges. Recently, Fugro (2002) concluded, however, that the deep geothermal waters are not deteriorating the quality of the groundwater near the City of Paso Robles. Through their study they found that there is no increase in concentration of TDS, sodium, or chloride with increased well depth. However, their conclusions were based upon limited data and recommend that additional data be collected over time to verify their conclusions. Figure 50 from the Fugro (2002) report illustrates TDS concentrations across the Paso Robles Groundwater Basin. In general, elevated concentrations of TDS are present downgradient of both wastewater treatment plants, as well as throughout the Groundwater Basin. The widespread presence of elevated TDS concentrations is indicative of other TDS sources (anthropogenic or natural) in addition to wastewater discharges.

4.0 RECYCLED WATER (POTENTIAL FUTURE SOURCE)

4.1 Water Rights

The 2001 Comprehensive Recycled Water Study (Carollo, 2001a) provided the City with a detailed evaluation of the City's water recycling options and associated project scenarios and estimated costs. Relative to water rights, the report makes several points:

- Ownership of effluent from a wastewater treatment plant is a current legal concern. When treated wastewater is discharged to a surface water, as it is in Paso Robles, there are currently unresolved issues between dischargers and downstream water users regarding the ownership of the water.
- When either the purpose of use or point of discharge of treated wastewater is changed, approval must be obtained.
- If a municipality discharging to a surface water body desires to obtain an equal amount of water downstream of the point of discharge, water rights must be considered.
- Adoption of a groundwater management plan may introduce other water rights issues.

The report also mentions that many farmers fear that accepting recycled water would force them to give up existing groundwater or surface water rights. However, some water rights protection is provided under the Water Code for recycled water users.

4.2 Recycled Water Alternatives/Magnitude

The City currently does not recycle any of its treated wastewater. Wastewater recycling has been noted as a means to address possible future groundwater supply shortages (Todd, 2000) and has also been investigated in detail (Carollo, 2001a) to address a RWQCB requirement.

Groundwater recharge was investigated in the 2001 Comprehensive Recycled Water Study as a potential alternative to river discharge of treated wastewater, and the major findings are summarized below:

- Two main groundwater recharge methods are currently recognized and regulated by the California Department of Health Services: spreading basins and direct injection. Other types of wastewater disposal (e.g., evaporation/percolation ponds) that may incidentally result in groundwater recharge, but are not designed for it, are not considered recharge facilities.

- Surface spreading facilities would not be easily located, because the suitable soils for recharge are located near the Salinas River, and are, therefore, too close to existing water supply wells.

- Direct injection facilities would be difficult to site because of similar issues: it would be difficult to site injection facilities both sufficiently far away from existing water supply wells and in a favorable hydrogeologic location.

- For both types of groundwater recharge projects, a benefit to the groundwater would have to be demonstrated, and this would be complicated by the generally high TDS content of the wastewater plant effluent.

The 2001 Comprehensive Recycled Water Study identified over 50 potential recycled water customers of various types (e.g., industries, parks, golf courses). This information is summarized in Table 4.1 of the study report (Carollo, 2001a). Two of the identified industries in the area were considered potential recycled water users. The majority of potential recycled water uses in the area are irrigation (landscape and agriculture). Of these, 45 sites were identified as potential recycled water users for landscape irrigation and include a cemetery, parks, golf courses, schools, land developments, and others. Four potential agricultural sites were identified (three vineyards and one farm).

Although it is not stated specifically in the 2001 Comprehensive Recycled Water Study, it appears that the potential recycled water demand is high enough to allow all of the City's treated wastewater flow to be applied to recycled water uses during the warmer months. A treated wastewater flow of 2.9 MGD is roughly equivalent to 270 AF/mo. Over the roughly 900 acres of potential landscape irrigation applications, this is approximately equal to 3.6 inches of precipitation, less than the irrigation demand for the April-October time period indicated in Table 4.3 of the study. Recycled water demand could exceed the wastewater flow for more months throughout the year if agricultural areas and vineyards participate as well. Their potential acreage is much higher than that of irrigated landscaped areas.

The study discusses effluent disposal alternatives in addition to potential recycled water applications. Even with a large number/high acreage of recycled water participants, recycled water would not be needed for irrigation during the generally rainy winter months. The study's findings regarding these disposal alternatives are summarized in **Table A-7** below. Wetlands habitat creation as a method of wastewater disposal was also considered but ruled out due to the unsuitability of area soils.

Table A-7. Summary of Effluent Disposal Alternatives

Disposal Alternative	Summary of Findings
Continued River Discharge	City already implementing. Required shallow monitoring well data indicate no water quality impact on local groundwater.
Evaporation Ponds	Siting relatively easy but impermeable soils (low percolation) require large ponds.
Percolation Ponds	Siting difficult - favorable soils for percolation typically located in flood plain.
Evaporation/Percolation Ponds	Gypsum may be used to aid percolation in clay areas and allow a pond to be located out of the flood plain area, but with a smaller size than an essentially evaporation-only pond.

Information from Sections 2 and 3 of 2001 Comprehensive Recycled Water Study (Carollo, 2002a)

4.3 Quality

Different levels of water quality are required for different recycled water uses. Generally, the level of treatment required increases with the degree to which humans will be in contact with the recycled water application. For example, the water quality standards and treatment levels for recycled water to be used for spray irrigation of food crops are significantly higher than those set for landscape irrigation in areas of limited public access. Tables 2.2 and 2.4 of the 2001 Comprehensive Recycled Water Study summarize the existing and proposed recycled water treatment regulations, respectively. **Table A-8** summarizes the report's conclusions regarding potential recycled water applications in the City of Paso Robles according to recycled water types (quality/treatment levels).

Table A-8. Summary of Recycled Water Types and Compatibility of City Facilities

Recycled Water Type	Compatibility of City Wastewater Treatment Facilities
Disinfected Tertiary	Would require significant facility upgrades (e.g., the addition of a solids contact basin, tertiary filtration, and chlorine contact basin upgrades).
Disinfected Secondary – 2.2	Would likely require filtration and has no proposed matching uses. Was not considered further.
Disinfected Secondary – 23	City nearly meets criteria with existing level of treatment. Would likely only require increased chlorine dose.
Undisinfected Secondary	(not evaluated in report – suggests that City effluent already meets or exceeds criteria)

Information from Sections 2 and 3 of 2001 Comprehensive Recycled Water Study (Carollo, 2002a)

Given the disposal alternatives and compatibility of existing City facilities with recycled water types, five alternative scenarios for treated wastewater reuse and disposal were developed in the 2001 Comprehensive Recycled Water Study. These scenarios described project requirements, siting considerations, and costs. They are discussed in detail in the study and are summarized in **Table A-9**.

4.4 Regulatory Drivers/Requirements

As noted in Section 2 of this appendix, the City's treated wastewater is currently discharged to the Salinas River. The RWQCB has required the City to investigate alternatives to continuing to discharge to the river, noting that the City is the only remaining municipal system discharging into the Salinas River. The City has been notified that the RWQCB generally encourages wastewater reclamation, and that prior to the February 2005 renewal of the City's NPDES permit, the RWQCB will closely review whether the City should be allowed to continue to discharge to the Salinas River (Briggs, 1999). Therefore, although the City is not currently under a requirement to cease its treated wastewater disposal to the river, it appears that this will become a regulatory requirement.

Table A-9. Reuse and Disposal Scenarios

Scenario	Selected Features	Water Delivered	Capital Cost	Annual O&M Cost	Cost
#1 – Irrigation reuse with storage	• avoids river discharge • requires new treated wastewater long-term storage reservoir (~4,500 AF) • requires tertiary treatment and distribution facilities for delivery to irrigation users	10,305 AF/yr	$54.6 M	$3.1 M/yr	$610/AF
#2 – Irrigation reuse with river discharge	• river discharge still required for non-irrigation season and when treated wastewater flow exceeds reuse demand • requires short-term storage basin (~1.3 MG) • requires tertiary treatment and distribution facilities for delivery to irrigation users	4,369 AF/yr	$12.5 M	$1.3 M/yr	$470/AF
#3 – Community-based reuse with river discharge	• river discharge still required for non-irrigation season/times and when treated wastewater flow exceeds reuse demand • requires short-term storage basin (~2.6 MG) • requires tertiary treatment and distribution facilities for delivery to community-based (generally accessible to the public) uses	2,912 AF/yr	$54.6 M	$1.4 M/yr	$1,570/AF
#4 – Evaporation ponds in highlands	• avoids river discharge • requires ~80 acres of evaporation ponds • #4a requires gypsum addition to aid percolation (~1,500 lb/day) and ~15 acres of ponds	4,369 AF/yr	$8.5 M	$98,000/yr	$140/AF
#4a - Evaporation/perc. ponds with chemical addition			$4.3 M	$258,000/yr	$120/AF
#5 – Percolation ponds in lowlands	• requires ~ 9 acres of percolation ponds in flood plain (RWQCB and Army Corps of Engineers approval)	4,369 AF/yr	$3.6 M	$46,000/yr	$60/AF

Information from Sections 5 and 6 of 2001 Comprehensive Recycled Water Study (Carollo, 2002a)

The 2001 Comprehensive Recycled Water Study notes that implementation of a reuse project would require compliance with California Water Code Title 22 and possibly the Groundwater Recharge Guidelines from the Department of Health.

4.5 Recycled Water Conclusions

The main conclusion of the 2001 Comprehensive Recycled Water Study is that traditional reasons for a municipality to consider water recycling are not in place in the City of Paso Robles. The reasons cited are:

- The City currently meets its NPDES permit
- There is no imminent shortage of potable water
- All irrigation demands are currently being met with groundwater
- The cost for reuse water exceeds the cost of other water supply options

It should be noted that based on information available, the first bullet above is not accurate; the City has been out of compliance with its effluent limitations for TDS, chloride, and sulfate, as noted in Section 2 of this appendix.

Other concluding points made include:

- Analyses of recycled water projects should be conducted based on costs, but also consider non-economic factors, including water supply reliability, political considerations, and public perception.

- Agreements between the City and the recycled water users are required.

- Depending on the application, water quality concerns such as salinity and nitrogen need to be considered in addition to the typical regulatory parameters (e.g., BOD_5, coliform) governing recycled water.

Todd (2000) also notes that Salinas River Underflow is used for municipal water supply by San Miguel and for irrigation downstream, and that reducing effluent discharge to the river if a reuse project were implemented would decrease recharge to groundwater and diminish available water for reuse downstream.

5.0 SURFACE WATER (POTENTIAL FUTURE SOURCE)

To address the City's possible future groundwater supply shortages, the Urban Water Management Plan (Todd, 2000) considered three possible scenarios. The first of these is the continued use of groundwater alone, the second is the use of groundwater and imported surface water (Lake Nacimiento), and the third option is the use of groundwater in conjunction with recycled wastewater. Regarding the second option, Todd (2000) concluded that it would be prudent for the City to consider Lake Nacimiento as a supplemental water source to increase water supply reliability and to ensure long-term sustainability of the City's water supply. The Urban Water Management Plan also briefly addressed the City's potential to import California State Water Project water from the California Aqueduct, noting that the SWP is already unable to fulfill its maximum entitlements to its existing contractors.

The San Luis Obispo County (SLO County) Flood Control and Water Conservation District has a 17,500 AF/yr entitlement from the Nacimiento Reservoir (Lake Nacimiento) based on an agreement executed with Monterey County in 1959 (Carollo, 2002). SLO County has been considering the transmission and distribution of this entitlement water to North and South SLO County water purveyors for many years. Of the 17,500 AF/yr, 16,200 AF/yr have been allocated for future use by North and South SLO County water purveyors, and the remaining 1,300 AF/yr have been reserved for local lakeside use (Carollo, 2002). When water purveyors were asked to submit requests for water from the Nacimiento Reservoir, the City of El Paso de Robles (City) submitted a request for 4,000 AF/yr (3.57 mgd, 5.52 cfs) on average with a peaking factor of 1.3 to be delivered at three locations in the City system (Carollo, 2002). The amount of water requested by the City and fourteen other purveyors totaled 13,575 AF/yr, leaving 2,625 AF/yr of the 16,200 AF/yr available as contingency for SLO County (Carollo, 2002).

According to Todd (2000), if the Nacimiento water supply is added, it will not be used or will not be ready until 2010. Therefore, a combination of Underflow and Basin groundwater would continue to be the City's water source until 2010. After 2010, Lake Nacimiento water would supply 4,000 AF, and the remaining projected supply (5,345 AF) would come from a combination of Salinas River Underflow and deeper groundwater. Therefore, excess groundwater production capacity would exist, which would allow some low-yield wells to be destroyed, if desired, and would allow for an emergency supply to build up in the basin.

Todd (2000) notes that the City of Paso Robles would benefit in several ways if they did use the surface water supply from Lake Nacimiento:

- The imported surface water supply would be independent of the local groundwater supply. By using an imported source of water, the aquifer is allowed to replenish, allowing groundwater levels to recover. This would be very important especially if the basin is considered to be in overdraft.

- The TDS for Lake Nacimiento water averages 150 to 300 milligrams per liter (mg/L). If this source of water were blended with the groundwater, the quality of the water served to the City customers would improve with respect to TDS. In addition, introducing a relatively low TDS water source to the City would result in lower wastewater discharge TDS concentrations and an increased ability of the City to meet its effluent discharge requirements.

There are two basic ways that the City could begin participation in the transmission and distribution of water from Lake Nacimiento ("Nacimiento Project"): either (1) by importing raw (untreated) water from the lake or (2) by receiving treated lake water.

Raw water would not be suitable for direct delivery to City customers or blending with existing groundwater supplies, but could be used to recharge the Salinas River Underflow groundwater supply. The potential benefits to this approach are that (1) City costs to help construct a water treatment plant are deferred, while the City is only accepting raw water, perhaps for 10 years, and (2) water storage and water rights associated with the Salinas River Underflow supply are enhanced by the addition of the imported surface water. A drawback to importing raw water for recharge is that the City would not realize the full benefit of the relatively low-TDS lake water, both in terms of drinking water quality and wastewater effluent quality. That is, if the low-TDS lake water is recharged into the Salinas River Underflow, it will mix with the existing high-TDS shallow groundwater and likely only partially be recovered in City wells completed in that zone. It is Malcolm Pirnie's understanding that this Project participation option (importing raw water) was introduced a number of years ago before water and wastewater quality issues were considered as critical as they are today.

The second of the two options (the City participating in the implementation of a regional drinking water treatment plant and receiving treated water deliveries) would require the City to bear the costs of the water treatment plant sooner than the first option. However, it would result in the delivery of finished potable water suitable for direct delivery to customers or blending in the distribution system with existing groundwater supplies, provided the potential water quality effects of blending are addressed. It is Malcolm Pirnie's understanding that the Nacimiento Project Environmental Impact Report (EIR) is still in draft form and may be finalized during the first quarter of 2003. The City needs to make a decision regarding its participation in the Nacimiento Project by Spring 2003.

5.1 Water Rights

Based on available information, the City has not executed an agreement for Nacimiento water with SLO County, nor has it secured water rights for any Nacimiento water. The City currently participates in the Nacimiento Participants Advisory Committee to work on issues common to the potential Project participants.

5.2 Magnitude

Per the City's request, SLO County is planning to provide the City 4,000 AF/yr of Nacimiento Project water on average with a peaking factor of 1.3 to be delivered at three locations in the City system (Carollo, 2002). Of the fifteen purveyors that requested water from SLO County, the City requested the greatest amount. Other requests ranged from 30 to 3,380 AF/yr.

5.3 Quality

5.3.1 Raw Water Quality

Tables A-10 to A-13 present Lake Nacimiento raw water quality data as compiled by Boyle (2002), along with the corresponding finished drinking water quality standards. The time period that these raw water data represent is not reported except where noted; however, based on the temperature data, they appear to include both winter and summer values. All lake monitoring results are exactly as reported by Boyle (2002); however, some of the finished drinking water standards and comments were edited for the following tables for clarity.

Table A-10. Lake Nacimiento Inorganic Mineral Water Quality

Parameter	Measured Values	Finished Drinking Water Standards
Calcium	19 to 30 mg/L	
Magnesium	9 to 13 mg/L	
Sodium	6 to 10 mg/L	
Chloride	8 to 12 mg/L	500 mg/L[2]
Bicarbonate	70 to 110 mg/L	
Nitrate	< 2 mg/L	45 mg/L (as NO_3^-)[1]
Iron	0.08 to 1.24 mg/L	0.30 mg/L[2]
Manganese	0.01 to 2.8 mg/L	0.05 mg/L[2]
Alkalinity (as $CaCO_3$)	90 to 134 mg/L	
Hardness (as $CaCO_3$)	84 to 128 mg/L	
TDS	150 to 300 mg/L	500 mg/L[2]
pH	7.3 to 8.9 units	6.5 to 8.5[2]
Temperature	9°C to 23°C	
Langelier Index	-1.2 to 0.9	> 0 (non-corrosive)[2]

adapted from Boyle (2002)

Notes:
[1] Primary Maximum Contaminant Level
[2] Secondary Maximum Contaminant Level

Table A-11. Other Lake Nacimiento Water Quality Parameters

Parameter	Measured Values			Finished Drinking Water Standard/Required Treatment
	Min	Avg	Max	
Total Organic Carbon (TOC)	3.3 mg/L	4.1 mg/L	5.2 mg/L	15 to 35% removal depending on alkalinity[1]
Turbidity	1.4 NTU	10.5 NTU	25.8 NTU	0.5 NTU (95% of the time)[2]
Color Units (CU)	7 CU	19 CU	33 CU	15 CU[3]

adapted from Boyle (2002)

Notes:
[1] Stage 1 Disinfectant/Disinfection By-Products Rule
[2] Primary Maximum Contaminant Level
[3] Secondary Maximum Contaminant Level

Table A-12. Lake Nacimiento Water THM Test Results

Chlorine Residual	THMs Formed* Depth of Water Sample	
	5 feet	80 feet
0 mg/L	< 1 σg/L	< 1 σg/L
1	33	28
3	129	125
4	160	175
5	180	186
6	201	227

adapted from Boyle (2002)

* Note that the formation of THMs observed is based on the chlorination of *raw* water. Disinfection with chlorine would likely occur after the coagulation, flocculation, and filtration processes have removed a significant portion of the THM precursors in the form of TOC. Much lower THM formation would, therefore, be expected during treatment of Lake Nacimiento water.

Table A-13. Variations of Langelier Index, Temperature, and Iron and Manganese Concentrations by Depth in Lake Nacimiento

Parameter	Water Depth in Feet		Comments
	5 feet	80 feet	
Langelier Index	+0.1 to +0.5	-0.7 to –1.2	<0 values indicate corrosive water
Temperature (^{o}C)	12 to 23	8 to 9	
Manganese (mg/L)	<0.005 to 0.017	0.012 to 0.042	0.05 mg/L[1]
Iron (mg/L)	0.08 to 1.02	0.28 to 2.80	0.30 mg/L[1]
Dissolved Oxygen (DO)	8.5 mg/L[a] 12.9 mg/L[c]	0.2 mg/L[b] 7.5 mg/L[d]	a. September 1993, 17.8^{o}C b. September 1993, 7.8^{o}C c. March 1993, 11.7^{o}C d. March 1993, 9.2^{o}C, 100 feet

adapted from Boyle (2002)

Note:
[1] Secondary Maximum Contaminant Level

Note that the Boyle (2002) report does not indicate the source of the water quality data, nor in most cases the sample collection dates. In order to perform a complete evaluation of a potential water supply, the range of water quality parameters under various hydrologic conditions (average, pre-drought, drought, and post-drought) should be well understood, since this could have a significant impact on the feasibility and cost of treatment and, consequently, the value of a water supply. Based on conversations with SLO County staff, Lake Nacimiento water quality data from 1993 to 2002 are available from SLO County and can be reviewed and summarized by Malcolm Pirnie upon the City's request.

- The Lake Nacimiento water is of suitable quality for use as a drinking water source provided appropriate treatment is practiced.

- TDS and hardness are relatively low and should not adversely affect treated water quality or treatment of the water.

- Problems might be experienced with iron, and possibly, manganese.

- The Langelier Index data indicate that the water has corrosive tendencies and may require corrosion control for drinking water use.

- The Langelier Index, temperature values, and iron and manganese concentrations vary somewhat with depth based on sample data provided.

- The DO concentrations in the Lake also vary considerably with respect to depth and temperature.

Based on available information, Malcolm Pirnie generally agrees with Boyle's conclusions regarding the quality of Lake Nacimiento water. Below are examples of additional issues to consider:

- Conclusions regarding the suitability of Lake Nacimiento water for drinking water are limited to the parameters for which water quality data are available. For example, the Boyle data does not include data on synthetic organic compounds, algal concentrations or other taste-and-odor causing compounds, or others that may affect the suitability of the lake for water supply use in addition to the ones summarized.

- The apparent seasonal stratification of the Lake can affect the quality of the water supply from the Lake. Various engineering solutions (e.g., multi-level intake ports, hypolimnetic oxygenation[1]) are available to address this issue.

- Based on a TOC concentration range from 3.3 to 5.2 mg/L and an alkalinity (as $CaCO_3$) concentration range from 90 to 134, the TOC removal requirement would range from 15 to 35% based on USEPA requirements.

- Concentrations of disinfection by-products (DBP) in delivered water would be expected to increase with increased distance between the treatment plant and each participating municipality, due to the increased detention time available for DBP formation.

[1] The three most viable intake options considered in the EIR Preparation Phase Engineering Report (Carollo, 2002) take this water quality variation with depth into account. Two of the options have multi-port intakes that allow the selection of water release elevations; the third option combines a single-port intake with a recommended study of stratification at the Lake.

5.3.2 Treated Water Quality

If a water treatment plant is constructed to treat Lake Nacimiento water, the treated water quality would be subject to all applicable laws, rules, and regulations related to drinking water quality at the federal and state levels. Under the Federal Safe Drinking Water Act (SDWA), the United States Environmental Protection Agency (USEPA) is responsible for setting all federal drinking water standards; however, the USEPA is also authorized to grant primacy to individual states, allowing them to administer and enforce the SDWA. A state with primacy must adopt and enforce every standard that the USEPA adopts, but the state also has the option of setting even more stringent standards than those of the USEPA and setting additional standards, if warranted. In California, a state with primacy, the agency responsible for the monitoring of drinking water quality and the enforcement of drinking water regulations is the Department of Health Services (DHS). Enforceable drinking water standards are called Maximum Contaminant Levels (MCLs), which are based on a chemical's health risk, detectability, treatability, and costs of treatment. Boyle (2002) also provides additional details regarding the state and federal regulations, including the Safe Drinking Water Act and its rules (e.g., Surface Water Treatment Rule) that apply to drinking water quality.

For treatment of surface water sources, such as Lake Nacimiento, the microbiological quality of the treated drinking water supply is often the primary concern. Therefore, the pre-design of the proposed water treatment plant prepared by Boyle focuses on an evaluation of the filtration process to be applied to Lake Nacimiento water, since this will determine the ability of the plant to meet microbiological and turbidity requirements. Filtration processes have varying levels of ability to remove/inactivate the microorganisms of primary concern, namely *Giardia*, viruses, and *Cryptosporidium*, as reflected by the different removal "credits" (measured by # of *log* removals) assigned by the DHS to different filtration processes. The following filtration processes were considered by Boyle (2002) for the water treatment plant to treat Lake Nacimiento water:

∉# Conventional treatment – a sequence of processes including rapid mixing, flocculation, sedimentation, and gravity filtration through either dual media or deep bed granular activated carbon (GAC) filters;

∉# Actiflo® Process with Conventional Filtration – proprietary system that involves the addition of "Microsand" to accelerate settling of particles, thus resulting in reduced detention time and area requirements relative to conventional filtration; and

∉# Membrane treatment – uses thin polymeric films with very small pores that exclude solids with large diameters, such as *Giardia* and *Cryptosporidium* cysts.

The first two technologies are granted the same removal credits by the DHS, while membrane treatment has a higher removal credit for *Giardia*. For example, while membrane filtration can consistently achieve 6-log removal of *Cryptosporidium* oocysts and *Giardia* cysts (which is much higher than the minimum 3-log removal/inactivation required for *Giardia* and the minimum goal of 2-log removal/inactivation for *Cryptosporidium* oocysts), conventional rapid-rate filtration typically only achieves the 2 to 3-log removal required.

Disinfection of Lake Nacimiento water is also a key consideration in the design of the water treatment plant since: 1) water quality regulations require that disinfection be used as one of the primary barriers against *Giardia* and viruses[2] that are not removed by other treatment processes, and 2) a disinfectant residual concentration is required in the distribution system. Compliance with the D/DBP Rule is one of the key factors to consider in selecting treatment technologies to both achieve microbial control and produce sufficiently low concentrations of disinfection by-products. Four of the most commonly-used disinfectant chemicals and the potentially most problematic regulated by-products associated with each are shown in **Table A-14**. (Trihalomethanes and haloacetic acids are indicated for both free chlorine and chloramines, although it is understood that for a given water, chloramine disinfection will tend to result in significantly lower by-product concentrations than will free chlorine.)

Table A-14. Disinfection Chemicals and Their Regulated By-Products [3]

Disinfectant	Maximum Residual Disinfectant Level Goal	Critical Regulated By-Products	By-Product MCL (D/DBP Rule)
Chlorine	4.0 mg/L	THM HAA_5	80 σg/L 60 σg/L
Ozone	-	Bromate	10 σg/L
Chlorine Dioxide	0.8 mg/L	Chlorite Chlorate	1.0 mg/L
Chloramine	4.0 mg/L	THM HAA_5	80 σg/L 60 σg/L

Given its TOC levels, Lake Nacimiento water has the potential to form THM and HAA_5 levels in excess of the current MCLs upon chlorination. The potential for bromate formation with ozonation is unknown since levels of bromide ions, which react with ozone to form bromate, are unavailable. Many major water purveyors (including the Metropolitan Water District, East Bay Municipal Utility District, and the San Francisco Public Utilities Commission) have turned to or will be turning to chloramination as a primary means of disinfection in order to meet the D/DBP Rule, since the use of chloramine significantly reduces the formation of THMs and HAAs. For this reason, chloramine is an attractive choice for disinfecting Lake Nacimiento water; however, the use of chloramine would preclude the blending of Lake Nacimiento water with water disinfected with chlorine. The blending of chlorine- and chloramine-disinfected water results in erratic disinfectant residuals and, therefore, should be avoided. Given Lake Nacimiento water's role as a supplemental supply likely to be mixed with water from other sources disinfected with chlorine (e.g., the City's groundwater and river underflow supply), the use of chloramine is generally not advisable (Boyle, 2002).

In its report, Boyle (2002) proposes the use of UV technology for primary disinfection, with chlorine as a secondary disinfectant. To avoid excess formation of THMs and HAA_5, precursors (TOC) are proposed to be removed using GAC.

As discussed above, a variety of treatment process options are available to produce treated Lake Nacimiento water that meets all of the applicable drinking water regulations. The characteristics of the finished water may vary somewhat depending on the type of process selected.

[2] *Cryptosporidium* inactivation is presently not required but is likely to be required in the near future.
[3] Stage 1 Disinfectant/Disinfection By-products Rule

When considering blending waters from different sources, careful consideration must be given to water chemistries, blending proportions, distribution system and residential plumbing materials, and water quality goals before implementation. Other communities (e.g., Tucson, Arizona) have experienced significant water quality and aesthetic problems when introducing new water sources into their distribution systems without full prior consideration of the possible effects. Paper studies (such as this water/wastewater quality strategy project) provide valuable information, but typically bench-scale and/or pilot-scale studies are required to follow up the paper studies before the source water switch/blend is implemented. This is because the complex interactions of water chemistry, microbiology, and pipe materials are highly specific and should be investigated as such to prevent adverse water quality and aesthetic problems.

5.4 Costs

The capital costs of providing raw and treated Lake Nacimiento water to SLO County water purveyors were estimated by Carollo (2002) to be $146.2 M and $188.5 M, respectively. Because these are conceptual-level cost estimates, Carollo cautions that the actual costs may range from 50% higher to 30% lower than estimated costs. The treated water supply alternative assumed includes: 64 miles of 8-inch to 36-inch diameter pipeline, a multi-port intake at the Nacimiento Reservoir, a water treatment plant, three pump stations, three storage reservoirs, and a connection to the Chorro Valley pipeline. The raw water supply alternative includes all of the above facilities except for the water treatment plant. The City will be responsible for all facilities beyond the turnout(s) to its system from the transmission pipeline carrying raw or treated water. It is Malcolm Pirnie’s understanding that the City of Paso Robles is an active member of the Nacimiento Participants Advisory Committee, which is continuing to work on potential Project costs and distribution of costs among participants.

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