Santa Rosa

Subregional Long-Term Wastewater Project

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**FINAL COST REDUCTION STUDY FOR
THE GEYSERS RECHARGE
ALTERNATIVE**

VOLUME I

**SANTA ROSA SUBREGIONAL
LONG-TERM WASTEWATER PROJECT**

Prepared for

City of Santa Rosa

November 1997

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Prepared by

Parsons Harland Bartholomew & Associates, Inc.

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1 INTRODUCTION AND SUMMARY

INTRODUCTION

The purpose of this study is to determine whether or not cost reduction opportunities exist for the Geysers Recharge Alternative as defined in the Santa Rosa Subregional Long-Term Wastewater Project EIR/EIS (EIR/EIS).

The City of Santa Rosa has been directed to have a plan for reclaimed water disposal in place by 1999 which will meet future capacity needs under all weather conditions. A Draft EIR/EIS released in July 1996 and a Final EIR certified in June 1997 examine four primary alternatives plus the No Action (No Project) Alternative. Two of the primary alternatives involve agricultural irrigation with reclaimed water, either in western or southern Sonoma County. Another involves increased discharge of reclaimed water into the Russian River. The fourth involves using reclaimed water to replenish the geothermal reservoir at the Geysers. The addition of this water source would enable the Geysers operators to produce more steam from the geothermal area and thereby prolong the life and economic production level of the steamfield and the geothermal power plants supplied by the steamfield.

A primary purpose of the EIR/EIS was to analyze the potential environmental impacts (that is to say, physical effects) of each of the alternatives described in the EIR/EIS. Preliminary estimates of construction and operating costs were also included. Those estimates were based on the assumption that the Santa Rosa Subregional Reclamation System would bear all costs of construction and operation. The estimates were also based on a consistent set of engineering and cost factors for each alternative and were considered conservative; i.e. they were intended to identify the maximum potential costs. Project costs will, of course, be an important consideration as the City makes its decision on a preferred alternative (as will environmental and other considerations). The analysis contained in this study is intended to examine in more detail the costs that might be incurred in the construction and operation of a Geysers project and to assess whether cost reduction opportunities exist for such an alternative or variations of it.

This Study provides additional refined cost estimates for new scenarios which utilize an alternative pipeline alignment and a range of reclaimed water flows, which deliver less water to the Geysers than proposed in the EIR/EIS (by distributing flow to other project components). Also, electrical power rates were revised to reflect the recent changes in costs associated with deregulation of the power industry. In addition, this report provides information on sources of potential public and private funding available and future environmental documentation required if the cost reduction scenarios were to be selected by the City as part of their preferred alternative.

This study has been supported by a grant from the U.S. Department of Energy, as appropriated by the U.S. Congress, together with assistance from UNOCAL, PG&E, and the California State Lands Commission.

SUMMARY

The EIR/EIS Geysers Recharge Alternative

The Geysers Recharge Alternative provides for transmission of reclaimed water from Delta Pond, just west of Santa Rosa, to the Geysers via 34 miles of pipeline located with the rights-of-way of public roads. Upon reaching the base of the Mayacamas Mountains, the pipeline follows Pine Flat Road up approximately 3,200 feet in elevation to reach the geothermal steamfield. The pipe size required is 42" and 48" in diameter. Four large pump stations are required: one at Delta Pond and three along Pine Flat Road. This alternative will involve discharge to the Russian River only during peak wet weather events (much less than one percent on average), and no additional storage is proposed. It is assumed that existing agricultural irrigation acreage will be reduced by about half through attrition, allowing 18 millions of gallons per day (mgd) of reclaimed water to be delivered to the Geysers. Figure 1-1 shows the Geysers Recharge Alternative as defined in the EIR/EIS.

Alternative Pipeline Alignment/Conservation Easements

An alternative pipeline alignment (Alternative Alignment A) located southeast of Pine Flat Road, outside of public rights-of-way, appears to be technically feasible (see Figure 1-2). Alternative Alignment A is about four miles shorter than the Pine Flat Road alignment used in the EIR/EIS Geysers Alternative. The new alignment, however, has an intermediate high point which requires an additional 485 foot of lift and traverses extremely rugged topography. This cross-country alignment results in a present worth cost¹ savings of between 7 and 9 percent (depending on the volume of water delivered to the Geysers) over the Pine Flat Road alignment used in the EIR/EIS. Considering the preliminary stage of engineering design used for the cost estimates, this may not be a significant difference.

Alternative Alignment A traverses properties encumbered by Conservation Easements owned by the Sonoma County Agricultural Preservation and Open Space District. A preliminary evaluation of the language establishing the Conservation Easements indicates that installation of pipelines was not considered and is thus not allowed within the Conservation Easements. However, the City of Santa Rosa does have the authority to condemn an easement for the pipeline across the Conservation Easements on behalf of the Subregional Reclamation System.

Water Balance Analysis

Reclaimed water deliveries to the Geysers can be reduced from approximately 18 mgd as defined in the EIR/EIS to between 5 and 18 millions of gallons per day (mgd) by distributing flow to other project components. By increasing river discharge rates up to five percent and/or changing assumptions regarding attrition of existing agricultural acreage, deliveries to the Geysers can be varied as desired.

A concern expressed by the Geysers operators regarding the EIR/EIS Geysers Alternative was the seasonal variation of flows: high flows in the winter, low flows in the summer. With the addition of river discharge and by employing a bimodal target storage curve, this study shows that reclaimed water deliveries can be equalized over the seasons of the year, although lower delivery rates produce more variability in the monthly flows.

¹ Present worth cost consists of one-time capital costs plus discounted values for 20 years of operating costs. These present worth cost savings were calculated using an inflation rate and salvage values.

Source: Parsons Engineering Science
USGS quad maps

Santa Rosa

Geysers Cost Reduction Study

EIR/EIS ALTERNATIVE 4
GEYSERS RECHARGE

PARSONS
HARLAND BARTHOLOMEW
and ASSOCIATES, INC.

Figure 1-1

System Components

A reduction in reclaimed water flows to the Geysers allows pipe sizes to be reduced from 42-inch and 48-inch diameters for the EIR/EIS Geysers Alternative to 18-inch through 36-inch diameters. Pump station sizes and other project components were also reduced proportionately. A preliminary surge analysis shows that pressures created in the pipeline due to valve closures and emergency situations can be accommodated by installing special valves at the pump stations, air vacuum relief valves at intermediate high points, and proper instrumentation.

Electric Power Rates

Due to deregulation of the power industry and use of non-firm power sources during the first years of operation electric rates are expected to decrease. In addition, this study has refined the calculation of power needs by using incremental increases in flows to the Geysers for each of the 20 years calculated. Together with the reduction in overall water deliveries, the changes in power rates and power needs reduce annual operating expenses from \$6.7 million for the EIR/EIS Geysers Alternative to \$3.0 million for the 18 mgd Pine Flat Road scenario.

Estimated Construction and Operating Costs

The cost reduction factors identified in this study have reduced the capital cost of the EIR/EIS Geysers Alternative from \$208 million to between \$94 and \$156 million, depending on the pipeline alignment and amount of reclaimed water delivered to the Geysers. Present worth costs decrease from \$282 million for the EIR/EIS Geyser Alternative to between \$107 and \$191 million. The present worth costs indicate the cost in 1997 dollars of the project over 20 years, accounting for both one-time capital costs and annual operating expenses. Estimates for the various scenarios are shown in Table 1-1.

Table 1-1

Estimated Capital, Operating, and Present Worth Costs for the Cost Reduction Scenarios
(thousands of dollars)

Alternative/Scenario (millions of gallons per day)	Capital Costs	Annual Operating Costs	Present Worth Costs	
			At 0% inflation without Salvage ¹	At 3.4% inflation with Salvage
EIR/EIS Alternative	\$208,252	\$6,683	\$281,885	Not applicable
Pine Flat Road Pipeline Alignments				
5 mgd	\$108,900	\$1,700	\$127,900	\$128,100
11 mgd	\$132,100	\$2,800	\$165,200	\$168,300
18 mgd	\$155,500	\$3,000	\$191,300	\$202,200
Cross-Country Pipeline Alignments				
5 mgd	\$94,000	\$1,900	\$106,500	\$116,700
11 mgd	\$112,800	\$3,200	\$150,100	\$155,100
18 mgd	\$132,300	\$3,400	\$179,600	\$188,100

Source: Parsons Engineering Science July 1997

¹ In order to facilitate comparison with the cost estimates for the EIR/EIS Geysers Alternative, these present worth costs do not include inflation or salvage values. Refer to Table 6-3, 6-4, and 6-5 for more details.

If the Geysers operators and/or power plant owners pay for the pumping costs from the bottom of the Mayacamas Mountains up to the Geysers steamfield, annual operating costs borne by the City would decrease by an additional 70 percent to \$600,000 to \$900,000 per year, depending on the amount of reclaimed water delivered to the Geysers.

Public Revenues and Socio-economic Effects

Public revenues from a Geysers project would come from property taxes and royalties paid by the steamfield operators to the U.S. Bureau of Land Management and the State Lands Commission, a portion of which returns to the County of Sonoma. Average annual property taxes are estimated to range from \$51,000 to \$128,000; royalties would range from \$321,000 to \$771,000 depending on the amount of water delivered to the Geysers. The present value of the total public revenues is estimated to range between \$3.5 million and \$8.5 million for the 5 mgd and 18 mgd scenarios respectively over the 20-year period. Sonoma County should receive about 10 percent of these revenues.

For each of the cost reduction scenarios, the monthly service charge to ratepayers and the demand fee (hookup fee to new users) within the Subregional System would decrease compared to the EIR/EIS Geysers Alternative. Projected fees are shown in Table 1-2. Additional monthly service charges would be \$4 and \$10; additional demand fees would range from a \$20 increase to a \$980 decrease at project initiation depending upon the amount of water delivered to the Geysers. The cross-country pipeline alignment has lower service charges and demand fees than the Pine Flat Road alignment.

The cost reduction scenarios are projected to have a negative impact on Sonoma County income and employment levels, but less negative than the EIR/EIS Geysers Alternative. This is because the economic costs associated with the ongoing service charges outweigh the economic benefits associated with the ongoing operation and maintenance of the various scenarios.

Funding Sources

Sources of public and private funding exist outside of the City of Santa Rosa which could potentially contribute up to 100 percent of the capital and operating costs for a Geysers Alternative. For the Lake County Sanitation District project (LACOSAN), a project similar to the Geysers Recharge Alternative, 51 percent of the capital costs and 90 percent of the operating costs are funded by the geothermal field operators. The remainder of the capital costs were contributed by the U.S. Bureau of Land Management, the U.S. Department of Energy, the California Energy Commission, and others.

These same opportunities for funding exist for the Santa Rosa Geysers Recharge Alternative. In addition, new potential options for funding have been identified, namely AB 1890 funds from the California Energy Commission and royalty contributions from the State Lands Commission. While the cost of the Santa Rosa project is greater than the Lake County project, water injection would be greater with proportional benefits. Further definition of available funding will require that the City undertake negotiations with the geothermal operators and power plant owners and initiate discussions with public agencies regarding applications for grants and loans.

Table 1-2

Maximum Incremental Service Charges, Demand Fees, and Economic Effect (in 1995 \$)

	Maximum Additional Monthly Service Charge	Maximum Additional Demand Fee	Regional Economic Effect
EIR/EIS Geysers Alternative	\$15.80	\$1,220	<\$4,773,000>
Pine Flat Road Alignment			
5 mgd	\$5.70	<\$560>	<\$2,618,000>
11 mgd	\$8.10	<\$310>	<\$3,051,000>
18 mgd	\$9.70	\$20	<\$4,259,000>
Cross-Country Alignment			
5 mgd	\$5.30	<\$980>	<\$2,157,000>
11 mgd	\$7.60	<\$790>	<\$2,382,000>
18 mgd	\$8.90	<\$520>	<\$3,459,000>
Pine Flat Road Alignment - Shared Costs¹			
5 mgd	\$4.90	<\$560>	<1,916,000>
11 mgd	\$6.70	<\$310>	<1,826,000>
18 mgd	\$8.20	\$20	<2,894,000>
Cross-Country Alignment - Shared Costs¹			
5 mgd	\$4.30	<\$980>	<\$1,327,000>
11 mgd	\$5.90	<\$790>	<\$882,000>
18 mgd	\$7.10	<\$520>	<\$1,819,000>

Source: EPS July 1997

(1) Under the Shared Cost Scenarios, the geothermal industry would pay for the cost of pumping water from Highway 128 to the Geysers steamfield.

Future Environmental Documentation

The cost reduction opportunities described in this study, if utilized in connection with the Pine Flat Road alignment, are unlikely to require substantial additional environmental documentation in order to be incorporated in a preferred alternative selected by the City. If a preferred alternative were to utilize the cross-country alignment (Alternative Alignment A) described in this study, it is likely that some supplemental environmental documentation would be required before the City could select such an alternative. Such documentation may include additional biological surveys and cultural resource evaluations. However, it is a City objective that any alternative pipeline alignment avoid or minimize adverse environmental impacts through alignment changes or mitigation. It is also possible that a combination of the Pine Flat Road alignment and alternative pipeline alignment might optimize City objectives. It is the expectation of the City that the EIR/EIS can substantially address the potential environmental affects of any alignment being considered.

2 ALTERNATIVE PIPELINE ALIGNMENT/CONSERVATION EASEMENTS

PURPOSE

The purpose of this chapter is to present an alternative to the pipeline alignment described in the EIR/EIS and address the conservation easements that would be traversed if the alternative alignment is selected.

ALTERNATIVE PIPELINE ALIGNMENT

Introduction

Delta Pond, where recycled water produced from the Laguna Plant is stored for eventual disposal, is approximately 22 miles (on a direct line) from the nearest boundary of the Geysers geothermal steamfield recharge area. The proposed Geysers recycled water conveyance system presented in the EIR/EIS consisted of a series of four pump stations and a transmission pipeline that terminated in two 0.5-million gallon storage reservoirs located on a mountain ridge on the southeast side of the geothermal steamfield area. The principle criterion used in the EIR/EIS for selecting an alignment for the transmission pipeline was to place it in public roads or public road rights-of-way wherever possible. In satisfying this criterion, the actual length of the Geysers transmission pipeline was approximately 178,000 feet, or about 34 miles (see Figure 1-2).

This analysis to determine if a more direct pipeline alignment to the Geysers steamfield exists, a route that does not necessarily follow an existing public road. The presumption is that such an alignment would be shorter in length and therefore would have a lower capital cost than the alignment described in the EIR/EIS. This new alternative alignment has been known as the "cross-country" route. This section presents the results of the investigation into identifying a feasible, shorter route to the Geysers steamfield from the source of the recycled water at Delta Pond (see Figure 2-1).

Background

Any route from Delta Pond to the Geysers steamfield must traverse essentially three distinct terrain zones. These are: 1) the gently sloping Santa Rosa plain; 2) rolling foothills along Chalk Hill Road; and 3) the steep, rugged Mayacmas mountain range. There has been little or no concern on the part of City staff or the Geysers operators with regard to the selection of the alignment through the first two zones. General acceptance of the Geyser pipeline alignment through the first two zones as presented in the EIR/EIS is attributed to the fact that it is an alignment that is relatively easily constructed and is relatively direct. Furthermore, the pattern of existing commercial and residential development in the Santa Rosa plain and existing natural features in this area would make a more direct route much more disruptive to the public and the environment than the proposed alignment in this section. Therefore, in identifying alternative alignments for the Geysers pipeline, the

EIR/EIS alignment through the first two zones is considered common to all alternatives. Further discussion of the alignment through the first two zones, including the physical features significant to the actual design of a conveyance system, is provided below.

The focus of this study on alternative pipeline alignments and cost reduction is with regard to a route across the third terrain zone, the Mayacmas mountain range. There are a number of reasons for this, which will be discussed in further detail below. In summary however, these include the fact that conveyance of the reclaimed water across the Mayacmas Mountains requires three pump stations and more than 85 percent of the lifting head necessary for the entire system and that the relatively undeveloped nature of the area traversed in this section provides greater opportunity to find a more direct route to the Geysers steamfield. For the purposes of this study, two alternative alignments through the Mayacmas Mountains were evaluated, identified as Alternatives A and B. Alternative A is the "cross-country" route that is considered to be a more direct route than Alternative B. Alternative B is the route proposed in the EIR/EIS for the Geysers transmission pipeline and is an alignment that generally follows Pine Flat Road.

Potential alternative alignments north of Pine Flat Road (Alignment B) were also investigated. Using the available topographic mapping, a candidate alignment was laid out in this area. This northern alignment was about 4,000 feet shorter than Alternative B, which left it still about 17,000 feet longer than Alternative A. The northern alignment would have a high point in the profile between the second and third pump station, similar to Alignment A but at a slightly lower elevation. While it could not be confirmed from the available topographic maps, it appeared that the northern alignment crossed land currently developed for vineyards for much of its length between Highway 128 and Pine Flat, thereby making the land acquisition cost for easements considerable higher than the other two alignment alternatives. Pump station No. 3 for the northern alignment would also be a considerable distance from existing developed roads and from existing high voltage power lines. These factors would add cost to the project. The northern alignment did not appear to provide any distinct, significant advantage when compared to Alignment A and therefore Alignment A was selected for further evaluation in this study.

Common Alignment

The first pump station in the Geysers pipeline system would be located at Delta Pond, at about elevation 50 feet. This pump station is common to both alignment alternatives and is shown on the drawings included at the end of this section of the report as Pump Station A/B-1, signifying that it is common to Alternatives A and B. There is a slight difference in the hydraulic requirements for this pump station between Alternatives A and B because of the differences in the distance to the next respective pump station in the system. The common section of the alignment encompasses the first two terrain zones discussed above and described in further detail below.

Approximately the first third of the common alignment crosses the gently sloping Santa Rosa plain from Delta Pond to Chalk Hill Road. This section of the pipeline alignment follows a zigzag route along various public roads to reach the southern end of Chalk Hill Road (approximately elevation 170 feet). The rise in elevation from Delta Pond to Chalk Hill Road is approximately 120 feet. This section of the pipeline involves at least three stream crossings and as many as five cased crossings (tunneled crossings under streets, highways and railroad). There are no intermediate physical high points in the pipeline profile in this section that would affect the design of the first pump station at Delta Pond.

The common alignment then follows the moderately winding Chalk Hill Road over gently rolling hills to Highway 128. Although it can be considered a winding route, Chalk Hill Road does follow a route through the hills that involves gradual inclines and declines in grade, avoids the higher ridgelines in this hilly area and minimizes the number of elevation high points encountered compared to a more direct route. The rise in elevation from the beginning of Chalk Hill Road to Highway 128 is approximately 100 feet, but the alignment encounters at least three intermediate elevation high points in this section that will affect the design of the pumping system (Pump Station A/B-1). The highest of these intermediate high points is at elevation 460 feet. This is an unavoidable high point in the pipeline alignment. Tunneling through this ridge to minimize the elevation rise is not considered economically practical. This section of the pipeline alignment has two stream crossings: Maacama Creek and Franz Creek.

Highway 128 lies at the foot of the Mayacmas Mountains. It is at the intersection of Chalk Hill Road and Highway 128 that the pipeline alignment diverges into the two alternative alignments through the Mayacmas Mountains to the Geysers steamfields.

General Geotechnical Considerations

The geotechnical parameters considered in evaluating the constructability and stability of the alternative alignments for the Geysers pipeline, specifically in that section of the pipeline area from Alexander Valley to the Geysers steamfield are summarized below. Additional discussion and specific examples on these parameters pertinent to each of the respective alternative alignments is provided in the following paragraphs.

The Mayacmas Mountains are underlain by rocks of the Franciscan Complex including marine sedimentary rocks and melange consisting of coherent blocks of greenstone, chert, serpentinite, and other metamorphic rocks. The steep, rugged terrain is traversed by narrow, windy roads. Small and large landslides have been mapped in the area (California Division of Mines and Geology 1980). Ridge areas consisting of large blocks of rock within the Franciscan formation tend to be relatively more stable than side slope areas (California Division of Mines and Geology 1978).

The presence of the following geologic and slope stability related conditions could constrain design and construction of a Geysers pipeline alignment in the Mayacmas Mountains:

- Locations of active and potential landslide sites are discussed in the following text.
- Hard bedrock at shallow depth is a constraint since this condition could make trenching for the pipeline difficult and costly. Drill-and-blast excavations or heavy ripping equipment may be required to excavate the pipeline trench in areas where this condition is present.
- Steep topography with loose bedrock is susceptible to talus and debris slides, besides being difficult for construction.
- The presence of serpentinite bedrock affects structures in several ways. The soil derived from serpentinite bedrock is toxic to many plants. Therefore, these areas tend to be barren, devoid of trees, and prone to damage by gully erosion and landsliding. In addition, certain occurrences of this rock type may contain asbestos minerals. Generally, asbestos in serpentinite rock presents a risk only to construction workers who may briefly encounter the dust generated by excavating this rock. Exposure is routinely minimized by watering during the construction process and minimizing activities that generate fine dust.

In addition, areas underlain by serpentinite often have poor foundation strength properties due to weathering and non-homogeneity. Portions of serpentinite outcrops will have the properties of hard bedrock and other areas can be deeply weathered and unstable.

Alternative Alignment B

Alignment B is discussed first because it is the Geysers pipeline alignment presented in the EIR/EIS for the Santa Rosa Subregional Long-Term Wastewater Project. It is therefore considered to be the "existing" alignment, one which is familiar to those who have read the EIR/EIS.

The separation between Alignment B and Alignment A begins at the intersection of Chalk Hill and Highway 128 (Station 1025+74.72 of the common alignment). From this location, Alignment B continues northwesterly on Highway 128 approximately 3.4 miles to the intersection with Pine Flat Road. Pump Station B-2, the second pump station in the system and the first of three booster pump stations that will lift the flows to the Geysers area, is located near this intersection. From Pump Station B-2 the pipeline follows Pine Flat Road to the Geysers area, terminating at two half-million gallon steel water storage reservoirs at an elevation of about 3320 feet, on a ridgeline on the west side of the Geysers steamfield. Pine Flat Road is a steep, winding mountain road. It serves as the sole access route for scattered ranches and other residents in the Mayacmas Mountains and as a southwest entry to the Geysers area. The total rise in elevation from Pump Station B-2 to the proposed storage reservoirs is approximately 3,130 feet, occurring over a pipeline length of about 58,600 lineal feet (average slope of about 5.3%).

Pump Station B-3 ends the first leg of the alignment on Pine Flat Road. The pump station is located at about elevation 1220, south of Red Hill, and in a saddle on the ridge line running in a south-north direction from Highway 128 to Red Hill. Alignment B from Pump Station B-2 to Pump Station B-3 is approximately 4.7 miles long. There are no intermediate high points in the profile of this section of Alignment B that would affect the hydraulic design criteria for Pump Station B-2.

From Pump Station B-3, Alignment B continues along Pine Flat Road, winding around the east side of Red Hill and then on to Pump Station B-4, located in Pine Flat near the confluence of Little Sulphur Creek and Hurley Creek. Pump Station B-4 is at elevation 2106 and is about 4.4 miles from Pump Station B-3. There is one intermediate high point in the pipeline profile between these two pump stations that will affect the hydraulic design criteria for Pump Station B-3. Alignment B crosses both Little Sulphur and Hurley Creeks.

Short sections of Alignment B uphill of Pump Station B-3 appear to be exposed to hazards of landslides and erosion due to the combination of serpentinite bedrock and the presence of springs.

A considerable distance of Alignment B on Pine Flat Road between Stations 1510+00 and 1550+00 lies within a major landslide complex that extends to the southwest of Red Hill, encompassing much of the drainage of George Young Creek. Alignment B crosses several other major mapped landslides and a serpentinite rock area from Station 1400+00 to the southwest, along the south side of George Young Creek. For at least one mile the road is within mapped landslide areas, serpentinite, and steep topography. All of these factors add to erosion potential and the difficulty of road building and maintaining stability of the roadbed for any pipeline constructed in the roadbed.

Farther along the alignment, in the area of Station 1550+00 to 1570+00, the presence of hard bedrock at or near the ground surface would cause difficulty in the construction due to the need to bench the pipeline trench into hard bedrock in or beside a narrow roadway on very steep rocky slopes that are susceptible to slides.

Pump Station B-3 is located on a barren ridge top that appears to have eroded serpentinite bedrock and soil. Alignment B along Pine Flat Road below and to the west of this barren ridge avoids the serpentinite, but the alignment presents more difficulty for construction of the pipeline along or off the edge of the road because of the existence of very steep terrain from Station 1470+00 to 1500+00.

Alignment B along the entire eastern side of Red Hill from about Station 1560+00 to station 1650+00 exhibits evidence of hard bedrock at or near the ground surface.

From Pump Station B-4, Alignment B then continues uphill along Pine Flat Road toward the Geysers, occasionally going cross-country to avoid switchbacks in the road, where the contours or stability of the area permits this without endangering the stability of the pipeline. The steel storage reservoirs at the end of the pipeline are proposed to be located on a high spot near Socrates Mine and off Pine Flat Road. This requires Alignment B to depart from Pine Flat Road and go cross-country up a moderate slope for a distance of about 1,900 feet. This leg of the alignment, from Pump Station B-4 to the storage reservoirs, has a continuous slope upward, with no intermediate elevation high points in the pipeline profile.

An active landslide intersects Pine Flat Road in the vicinity of the Contact Mine site near the northern terminus of Alignment B. A section of the road about 1,000 feet long near Station 1540+00 shows evidence of recent repair work to restore the road as a consequence of concentrated surface runoff and landsliding. The pipeline in this section of Alternative Alignment B could be constructed in a position of the road so as to minimize damage and maintenance likely to occur from shallow debris sliding and erosion. The steep slopes in this area from Contact Mine to Socrates Mine are another example of where hard bedrock is present at or near the ground surface.

The potential geologic hazards of Alternative Alignment B are:

- A Geysers pipeline alignment along Pine Flat Road will traverse areas of unstable slopes in steep terrain. Based on the occurrence of unstable bedrock and the observation of existing landslides along the Alternative B alignment north of Pine Flat, this area is considered to have a high potential for slope instability. Slope instability could result in pipeline damage or rupture. Consequent release of water from a break in the pipeline could cause erosion and consequent damage to the road.
- The northern segment of the Alternative B alignment crosses the Maacama Fault Zone at the base of the Mayacmas Mountains. Surface fault rupture could occur on this fault during a major earthquake and cause pipeline damage or rupture.

Other geotechnical issues of concern along the alignment relate to the potential for liquefaction in alluvial soils in the Alexander Valley (California Division of Mines and Geology 1980) and expansive soils that occur throughout the length of the alignment. These soil conditions can be mitigated by standard engineering practices such as the use of engineering backfill, soil densification, and pipeline foundation design (City of Santa Rosa 1996).

Alternative Alignment A

The objective in seeking an alternative route to the Pine Flat Road alignment is to select one that is shorter in length and, therefore, has a lower construction cost. Such a route would not necessarily be constructed in an existing public road. A review of the topographic mapping of the Mayacmas Mountain area indicates that the shortest, direct line from Alexander Valley to the Geysers steamfield area must cross several steep-sided canyons or is along or parallel to steeply sloped hillsides. Such an alignment would be difficult to construct, subject to slope instability and landslide damage, require numerous air valve structures and could cause significant environmental damage during construction. Acknowledging that a completely straight line alignment is not feasible despite this being relatively open country, the search for another alignment looked for one that takes a generally direct line to the Geysers steamfield and that satisfies several criteria as follows:

- provide a work platform of adequate width for conventional pipe laying equipment and to stockpile some, albeit limited, materials;
- select of alignment corridors with geotechnical and slope formations that appear relatively stable to ensure longevity of the pipeline, including, if necessary, crossing steep slopes perpendicular to the slope to minimize damage due to landslides;
- minimize, to the extent possible, the number of peaks and valleys in the pipeline profile in order to reduce the number of air valve structures required;
- provide adequate access for bringing construction materials to the jobsite and, following construction, for maintenance and periodic inspection of the pipeline; and
- include adequate and relatively level areas at the appropriate locations along the alignment for construction of necessary pump stations.

Given the ruggedness of the terrain in the Mayacmas Mountains, it was not expected to find a cross country alignment that clearly satisfied all of these criteria. One of the key characteristics used in the search to identify a cross-country alternative Geysers pipeline alignment was the existence of jeep roads or similar dirt access roads. Such roads tend to follow grade slopes that are compatible with most construction equipment. The presence of such a road, particularly one that appears to have been in use for some time, also indicates that slopes along the used path are more stable than adjacent areas may be. A helicopter fly-over of the potential Alternative A alignment was conducted on 5 March 1997 (Loren Weinbrenner, PE; Fred Kintzer, RG and CEG; and Dan Carlson, Capital Project Coordinator for the City of Santa Rosa participated). The aerial reconnaissance of the alignment was conducted because of the ruggedness of the area and the unavailability of permission to access the area of interest. Observations made during this aerial reconnaissance resulted in some adjustments to the proposed Alternative A alignment from the initial "paper" concept, and form the basis for comments included in this report on the feasibility of this alignment.

Maps of this area of the Mayacmas Mountains also show an existing pair of PG&E 230kV power transmission lines constructed on or near a ridgeline that begins from near where Maacama Creek crosses Highway 128 and continues in a northerly direction to Red Hill. Although the power transmission lines continue in a northerly direction toward the Geysers steamfield, the backbone of this ridgeline appears to disappear at Red Hill, or at least veers in another direction not pertinent to this project. Jeep trails and less defined dirt roads follow much of the transmission line alignment along or near the ridgeline, beginning near the south end and continuing to where the ridgeline comes in close proximity to Pine Flat Road south of Red Hill and near Pump Station B-3. The alignment of the power

transmission lines and the parallel ridgeline appear to offer the most prudent choice for a cross-country Geysers pipeline alignment and form the backbone of Alternative A.

The intersection of Chalk Hill and Highway 128 marks the end of the common alignment section of the Alternatives A and B pipeline alignments. At this point the Alternative A pipeline alignment turns easterly to follow Highway 128 towards Calistoga. Pump Station A-2 would be located near the intersection of Chalk Hill and Alexander Valley (Highway 128) Roads. This site is in a comparable location for the Alternative A alignment as Pump Station B-2 is for Alternative B alignment. In both cases, the respective alignments begin to follow a steeper grade through the Mayacmas Mountains than the common alignment encountered from its beginning point at Delta Pond. The Pump Station A-2 site is about 100 feet higher in elevation than the Pump Station B-2 site.

Alternative A alignment follows Highway 128 for only about 0.6 mile, near Camp Maacama, where it proceeds off-road in a northeasterly direction toward the existing PG&E power transmission lines. The point of departure from Highway 128 (shown in Appendix A, drawing PG-A1) was selected to avoid an existing private residence to the west and the location provides a relatively gradual slope to cross in reaching the power transmission alignment. Upon reaching the west side of the power transmission lines, Alternative A alignment turns north, paralleling the power transmission lines along the backbone of the ridgeline as it rises in elevation toward Red Hill. This parallel alignment continues northerly for a distance of about one mile. At this point, the power transmission lines span across a steep canyon. Rather than continuing to parallel the transmission lines, Alternative A pipeline alignment follows a dirt road along the ridge line for a distance of approximately 1.1 miles, where it then meets a more developed jeep trail that continues to proceed northerly along the ridgeline. The section of alignment following the dirt road has a continuous upward grade toward its junction with the jeep trail, reaching an elevation of about 1640 feet.

A short section of Alignment A at about Station 1090+00 appears to be underlain by serpentinite and is considered susceptible to landsliding and erosion.

After its juncture with the jeep trail, the Alternative A alignment follows the jeep trail for about 1.5 miles as it passes under the power lines to the east side and then back to the west side of the power lines. In this section the pipeline drops in elevation about 290 feet to a saddle in the ridge before rising again to an elevation of about 1760 feet before crossing to the west side of the power lines.

The jeep trail continues to meander along the ridgeline toward an open high meadow area on a barren ridge south of Red Hill (shown on drawing PG-A2), while the pipeline would take a more direct route in the same general direction, paralleling the west side of the transmission lines.

The ridge top followed to this location is resistant to erosion and is likely to have hard bedrock exposures at shallow depth intermittently along the alignment between about Station 1250+00 northward to about Station 1325+00. In general, the proposed Alignment A from Alexander Valley northward to Red Hill is expected to encounter localized blocks of resistant rock.

The barren ridge top/high meadow location is about 1.5 miles north of where the alignment departs from the jeep road on the west side of the power transmission line at about elevation 1760. The high meadow location is at elevation 1200, and it is at this location that Alternative A alignment and Alternative B alignment are in close proximity to each other. This high meadow area is the proposed location for Pump Station B-3. It is a

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relatively flat, large open site, that is considered to have adequate area for constructing a pump building, small storage reservoir surge tank and other system accessories. The site is about 400 feet west of the PG&E power transmission lines, thereby providing excellent access to the needed electrical service. Its location adjacent to Pine Flat Road also provides accessibility for large tractor trailer vehicles needed to haul mechanical equipment, steel tank plates and building materials, in particular concrete.

There are no other large, open, relatively flat sites along the Alternative A alignment between Pump Station A-2 and the first high meadow discussed above, that appear adequate for locating a pump station facility. Furthermore, any other site along the Alternative A alignment is much more remote from Pine Flat Road, which is the only traveled way that provides reasonable access for drayage vehicles. Similar facilities have been constructed in areas more remote than presented here, but they typically require pioneering a new access road to the site and obviously the cost of work increases greatly when there is an increasing level of difficulty in accessing the site. It is therefore proposed that Pump Station A-3 be located at the same site as proposed for Pump Station B-3.

From Pump Station A/B-3, Alternative Alignment A heads in a northeasterly direction to return to the power transmission line alignment, rather than following Pine Flat Road up the mountains, as does Alternative Alignment B. Observations made during the aerial reconnaissance of the alignment in this area between the high meadow and Red Hill found that the slopes on the east side of the power transmission lines were much more gradual than on the west side of the power transmission lines. Therefore, the Alternative Alignment A in this section would cross under the transmission lines to the east side and then proceed north toward Red Hill, paralleling the transmission lines until it approaches intersecting with Pine Flat Road.

Pine Flat Road wraps around the south and east side of Red Hill before proceeding northwesterly toward Pine Flat and the Geysers steamfield. Red Hill presents a formidable obstacle to a direct line route in its rise in elevation and steep slopes that are subject to erosion. The search for an alternative alignment therefore focused on an area to the west side of Red Hill, which the topographic maps indicate has a more gently sloped hillside and the existence of a saddle in the ridgeline that appears to favor a pipeline crossing. The aerial reconnaissance of this area confirmed the existence of a broad, sparsely forested corridor on the west side of Red Hill that extends up the south slope of the ridge, through the saddle and then continues down the north slope of the saddle toward Little Sulphur Creek. The aerial reconnaissance also confirmed the existence of a jeep road leaving Pine Flat Road and continuing up the south slope of the hillside, following along the east side of the open grassy corridor toward the saddle.

On the basis of the observations described above, it was determined that the most prudent alignment for Alternative A should turn northwesterly before reaching Pine Flat Road on the south side of Red Hill, cross under the power transmission lines and head in a direction opposite to Alternative Alignment B toward the intersection of Pine Flat Road and the jeep road on the southwest side of Red Hill. Alternative Alignment A would then follow the jeep road for a short distance before heading directly up the south hillside of this ridgeline toward the saddle, through the saddle, down the north hillside and then across Little Sulphur Creek before intersecting with Pine Flat Road in another high meadow area identified on the drawings as Pine Flat (see drawing PG-A3). This alignment over the saddle rises to an elevation of 2250 feet before dropping down the hillside to Pine Flat. In comparison, Alternative Alignment B following Pine Flat Road around the east side of Red Hill rises to about elevation 2140 feet before reaching Pine Flat, but is about 2,000 feet longer to travel from common point to point on the respective alignments.

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An approximate 4,000-foot length of Alignment A, between Stations 1350+00 to 1390+00, lies on the aforementioned barren ridge top, which appears to consist of eroded serpentinite bedrock and soil. In the section immediately to the north of this area, between Stations 1390+00 and 1400+00, springs and related active soil landslides are present along the southern side of Red Hill. From about Station 1390+00 to the saddle at about Station 1432+00, Alignment A could be located to the side of the corridor closest to Red Hill to be less susceptible to landsliding, except for the small slides near Station 1400+00.

This latter referenced slide area is close to and associated with the major slide complex (discussed under Alignment B in this report) that extends southwest from this area and encompasses much of the upper drainage of George Young Creek.

The topographic saddle present at about Station 1432+00 and the area below Manganese Mine on Red Hill, at about Station 1410+00 to Station 1420+00, appear to be areas having hard bedrock present at or near the ground surface.

The peak elevation occurring in the above described saddle presents an intermediate high point in the profile for Alternative Alignment A between Pump Station A-3 and Pump Station A-4. It must be considered in designing the pumping system for Pump Station A-3.

Once Alternative Alignment A reaches Pine Flat, two general routes are possible: either turn northwesterly to follow Pine Flat Road toward the Geysers steamfield and parallel the Alternative Alignment B in this section, or, proceed in a northeasterly direction to follow a canyon or ravine on either the east or west side of Castle Rock and then continuing up the mountainside toward an entry gate to the Geysers steamfield. The easterly option of these two possible routes was considered at one time to be a strong candidate route. However, in evaluating the possible routes for this report the easterly route was rejected for two reasons. First, inspection of this area to the east of Pine Flat Road and around Castle Rock during the aerial reconnaissance did not reveal any likely route. There are no strong trails in this area leading up the mountain side other than Pine Flat Road; the canyons are narrow and steep sided and the final section up the mountainside to the Geysers steamfield entry gate is very steep and rocky. Secondly, because the connection between the Geysers transmission pipeline and the Geysers recharge wells distribution system at the "golden flange" is located on a peak near the Socrates Mine rather than close to the entry gate referenced above, as considered earlier in the development of the Geysers Project. Hence, an alignment along Pine Flat Road becomes a more direct route from Pine Flat than any possible route to the east of Castle Rock.

Since the alignment proposed for Alternative B is determined to be the best route from Pine Flat to the "golden flange" and the two storage tanks, the location of Pump Station A-4 will be the same as for Pump Station B-4. The attributes of this site are very similar to those described previously for Pump Station A/B-3. Therefore, this site is also a good selection for a pump station. Given this location of Pump Station A-4, Alternative Alignment A between Pump Station A-3 and A-4 requires two stream crossings, for Little Sulphur Creek and Hurley Creek.

The characteristics of the common alignment for Alternatives A and B from Pine Flat to the "golden flange" have been previously described under Alternative Alignment B. The "golden flange" indicates the change of ownership of the system from the City of Santa Rosa to the geothermal operators at the entrance of the pipeline into the geothermal leasehold. This alignment requires a stream crossing at Anna Belcher Creek. For clarification, this section of the alignment does not follow the road bed for the entire distance up the mountain side. There are a number of switchbacks in the road, which the

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pipeline alignment avoids by taking a more direct line up the hillside, but still following the general direction of the road. The ground contours in these areas of departure from the road appear to be favorable to this approach. Geologic conditions observed during the aerial reconnaissance did not cause this judgment to be changed. The aerial reconnaissance did show the existence of landslides in the road bed near the top of the grade, which are discussed under Alternative B. It is proposed that the pipeline be constructed as close to the upper side of the road as possible in these areas to maximize the opportunity for finding the most stable soil formations.

Information presented in the Soil Survey of Sonoma County (USDA 1972) indicates that a variety of soil types are present in the vicinity of the Alternative A pipeline alignment. The soil survey maps provide a general idea of the soils within a region. The information is useful for planning engineering works. However, small patches of distinct soil types may remain unmapped because they are limited in area. Therefore, information in the Soil Survey is not suitable for defining the exact location of a project component and additional geotechnical investigations must be conducted prior to undertaking detailed design of this project.

The Alternative A pipeline alignment is underlain chiefly by rocks of the Franciscan Complex. Soils vary in depth and may be underlain at shallow depths by rock. Hard rock members of the Franciscan are known to occur in the region and may be encountered during excavation. Some bedrock (particularly well indurated metamorphic rocks) may require blasting when excavating trenches to depths of 4 or 5 feet or deeper to accommodate the proposed pipeline diameters. Excavation of soils in other areas is expected to encounter weathered or unweathered rock material which should be removable by conventional equipment without blasting. Although a limited amount of excavated native material could be used for backfill, the majority of the soils contain significant amounts of expansive clay and may not be suitable for use as engineered fill (bedding and pipe zone backfill).

Table 2-1 lists the soil types that are mapped by the Soil Conservation Service (SCS) in the vicinity of Alternative Alignment A. The SCS ratings for shrink-swell potential, susceptibility to erosion, and the corrosivity to uncoated steel are also provided in Table 2-1.

In general, soils in the southern section of Alternative Alignment A have low to moderate shrink-swell potential, slight to high erosion potential, and moderate corrosivity. Soils in the ridge section of the alignment have low to moderate shrink-swell potential, high to very high erosion potential, and moderate corrosivity. In the vicinity of Red Hill the alignment is dominated by soils of the Yorkville and Los Gatos series. The Yorkville soils have high shrink-swell potential, high erosion potential, and high corrosivity. The Los Gatos soils have low to moderate shrink-swell potential, high to very high erosion potential, and low to moderate corrosivity. Soils in the Geysers area tend to be gravelly loams consisting of the Los Gatos, Sobrante, Stonyford, and Henneke series and have properties similar to the Los Gatos soils in the Red Hill section of the alignment.

Seismic Hazards

Both alternative pipeline alignments cross the Maacama Fault Zone, along the base of the Mayacmas Mountains on the northeast side of Alexander Valley. Pump Station A-2 is near the fault zone (within 150 feet). The Maacama Fault is considered to be an active (Holocene) fault and is designated as an Earthquake Fault Zone under the Alquist-Priolo

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FINAL GEYSERS COST REDUCTION STUDY**Table 2-1****Soil Types and Characteristics in the Vicinity of Alternative Alignment A**

Location	Symbol	Soil Name	Shrink/ swell	Erosion	Corrosivity
Southern Section	LgE	Laughlin Loam, 2 to 30%	moderate	slight- high	moderate
	LgF	Laughlin Loam, 30 to 50%	moderate	high	moderate
	CgE	Clough gravelly loam, 15 to 30%	low- moderate	moderate- high	moderate- high
	MoE	Montara cobbly clay loam, 2 to 30%	low	very high	moderate
Ridge Section	StF	Suther loams, 30 to 50%	moderate- high	high	moderate- high
	ShF	Sobranite loam, 30 to 50%	moderate	high	moderate
	SoG	Stonyford gravelly loam, 50 to 75%	low	very high	low- moderate
	SuG	Suther-Laughlin loams, 50 to 75%	moderate- high	very high	moderate- high
	LgG2	Laughlin loam, 50 to 75%, eroded	moderate	very high	moderate
	LkG	Los Gatos loam, 30 to 75%	low- moderate	high- very high	low- moderate
	McF	Maymen gravelly sandy loam, 30 to 50%	low	high	low
	BoG	Boomer loam, 50 to 75%	moderate	very high	low
	HnG	Hugo-Josephine complex, 50 to 75%	moderate	very high	moderate
	HkF	Hugo very gravelly loam, 30 to 50%	moderate	high	moderate
Red Hill Section	YuF	Yorkville clay loam, 30 to 50%	moderate- high	high	high
Geysers Section	LgG	Laughlin loam, 50 to 75%	moderate	very high	moderate
	ShG	Sobranite loam, 50 to 75%	moderate	very high	moderate
	SuF	Sobranite loam, 50 to 75%	moderate- high	moderate- high	moderate- high

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Table 2-1

Soil Types and Characteristics in the Vicinity of Alternative Alignment A

Location	Symbol	Soil Name	Shrink/ swell	Erosion	Corrosivity
	LmG	Los Gatos gravelly loam, 30 to 75%	low-moderate	high-very high	low-moderate
	HgG2	Henneke gravelly loam, 30 to 75%, eroded	low	high-very high	low

Act. Surface fault rupture could occur anywhere along the fault trace in the event of a major earthquake. Risks of fault rupture would be similar for any Geysers pipeline alignment that traverses the Maacama Fault.

Those portions of the alternative alignments considered in this study which are physically distinct from each other are located primarily in upland areas, with a major portion of Alternative A being along ridge tops. Alternative B traverses Alexander Valley for about 3.5 miles before crossing into the Mayacmas Mountains. The valley segment of the alignment has a moderate liquefaction potential (AMBAG). Along the major portion of both alignments within the Mayacmas Mountains, bedrock is near the surface and shallow groundwater is not present, except near stream crossings. Therefore, the risk of liquefaction is considered to be low.

Results

An investigation was conducted, using existing information (i.e., no additional on-site investigation) and an aerial reconnaissance (employing a helicopter), to identify an alternative, shorter alignment to that presented in the EIR/EIS for the Santa Rosa Subregional Long-Term Wastewater Project for the Geysers pipeline. A shorter, cross-country alignment that appears to be technically feasible, has been identified and is shown as Alternative Alignment A on the drawings in Appendix A. The Geysers pipeline alignment discussed in the EIR/EIS is shown on the same set of drawings as Alternative Alignment B.

Both alternatives use a common alignment at the beginning of the pipeline, from Delta Pond to Alexander Valley, and near the end of the pipeline, from Pine Flat to the Geysers steamfield. Alternative Alignment A is approximately 29.8 miles in length and Alternative Alignment B is approximately 33.8 miles in length, making Alternative Alignment A is about 4 miles shorter than Alternative B. About 60 percent of the difference in length between the two alternatives is in the section between Alexander Valley and Pump Station A/B-3, with the remaining 40 percent of the difference occurring in the section between Pump Station A/B-3 and Pine Flat.

Although Alternative Alignment A is shorter in length, it has a much greater static head pump lift, about 485 feet more, than Alternative Alignment B for the respective No. 2 pump stations. This higher static lift significantly impacts total project cost owing to higher power demand. These costs are presented and discussed in Chapter 6.

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Changing Alignment A to avoid the elevation high point was evaluated, but since the alignment in the subject area is located on a relatively narrow ridge line, shifting the alignment laterally to either side in order to achieve significant lowering of the elevation would place the pipeline on a steep cross slope. This would result in increased construction difficulty and possible long-term stability problems with the pipeline installation. The ridge line is wide enough to achieve some slight reduction in the elevation, on the order of 50 feet, and this opportunity should be closely reviewed during preliminary design when more accurate topographic information is available. Tunneling through the section in question at a lower elevation was also evaluated, but the estimated cost for a tunnel length that would be required to achieve a significant lowering of the pipeline elevation was determined to exceed the potential savings in energy costs.

The majority of the length of proposed Alternative Alignment A from Alexander Valley to Red Hill is located on a linear ridge top that appears to be stable. In general the width of the ridge is adequate for construction equipment, excavation of the trench and some stringing of pipe and other materials along the alignment, but there is one section about 4,000 feet long, near the peak of the ridgeline (see Station 1170+00 to 1210+00), that is much narrower and will undoubtedly cause the pipelaying productivity to slow. Benching or flattening of this section of narrow ridge may be necessary to provide an adequate work area and ensure long term stability of the pipe trench.

Pine Flat Road, which Alternative Alignment B follows, is also very narrow, steep and winding, with numerous switchbacks. The construction width available in the total roadway is not much, if any, greater than that on the ridge route and this alignment would probably also require considerable earthwork to ensure pipeline and road stability.

Another benefit of following the ridgeline is that it allows Pine Flat Road to be kept open to the public and for construction vehicles to access Alternative Alignment A from the north end as well as the south end until reaching Pump Station A-3. Construction of Alternative Alignment B in Pine Flat Road essentially renders the area above the construction work inaccessible from Alexander Valley. In this case, access to the area above the construction zone would have to occur during non-working hours or by using a long route into the area from the north and through the Geysers area.

Above ground installation of the pipeline on steel ring girders should be evaluated further during design for portions of Alignment A on the ridge line between Alexander Valley and Red Hill. This approach may be advisable to minimize the extent of blasting of rock required for pipe installation and to avoid disturbance of serpentinite formations.

Three of the four pump stations required for each of the alignment alternatives are located at sites common to both alternatives. The only pump station in each alternative that would not be on the same site would be the second pump station in the respective systems. For Alternative A, Pump Station A-2 would be located at the southern end of Alexander Valley, whereas for Alternative B Pump Station B-2 would be located about 3 miles farther north in Alexander Valley, near Jimtown. Access to the pump stations is therefore not an issue in comparing the feasibility of the two alignment alternatives studied or selection of the best alignment.

Additional surveying, mapping, geotechnical investigations, environmental studies and other detailed information gathering work would be required for both alignments to carry this project to the next level of planning and preliminary design. Additional environmental documentation would be needed for Alternative Alignment A, as discussed further in Chapter 9 of this report. For the purposes of this present study an alignment corridor is shown on the prepared drawings for Alternative Alignment A.

CONSERVATION EASEMENTS IN THE VICINITY OF ALTERNATIVE ALIGNMENT A

The Pine Flat Road alignment for the pipeline to the Geysers steamfield in the EIR/EIS was chosen because it occurred within the right-of-way of a public road. The more direct cross-country pipeline alignment would cross public and private lands. An identification of affected properties and property owners, as well as any conservation easements, was carried forth in order to assess the viability of the Alternative Alignment A.

Findings

John Mackie, of Marron Reid & Sheehy (attorneys) identified the conservation easements potentially affected and the methods for obtaining an overlapping easement for the pipeline.

Sixty properties may be affected by Alternative Alignment A; these properties are delineated in Figure 2-2, and the list of corresponding Assessor Parcel Numbers (APNs) is provided in Table 2-2. Of these 60 properties, nine are contained within or encumbered by conservation easements created in three recorded conservation easement agreements between various grantors and the Sonoma County Agricultural Preservation and Open Space District (Open Space District). The agreements and affected property APNs are presented in Table 2-3.

Each of the three conservation easement agreements limits the creation of new easements. Under the Maacama Agreement, any new easement requests must be approved by the Open Space District. The National Audubon Society Agreement and the McMicking Agreement both allow new easements only where they "remove and significantly lessen the impact of pre-existing easements on the protected values or purposes" of the respective agreements.

Table 2-2

Properties in the Vicinity of Alternative Alignment A

Map Number	Assessor Parcel Numbers	Conservation Easement Agreement
501	131-230-13	
502	132-160-25	
503	132-160-26	
505	132-160-29	
506	132-160-30	
512	131-230-09	
513	132-160-15	
519	141-070-41	
520	132-160-21	
525	141-080-14	
526	132-160-35	
527	131-140-12	The McMicking Agreement

Table 2-2

Properties in the Vicinity of Alternative Alignment A

Map Number	Assessor Parcel Numbers	Conservation Easement Agreement
528	141-070-35	
529	141-070-33	
530	140-070-40	
531	141-070-44	
532	132-160-16	
533	132-160-33	
533	132-160-33	
536	141-080-03	
537	141-080-04	
538	141-080-06	
539	141-080-12	
540	141-080-13	
542	132-160-22	
543	141-100-05	The National Audubon Society Agreement
544	141-100-10	The National Audubon Society Agreement
545	141-120-04	The National Audubon Society Agreement
546	131-130-08	The National Audubon Society Agreement
549	141-070-43	The National Audubon Society Agreement
550	141-040-10	
551	131-150-06	
552	132-160-36	
553	132-160-34	
554	131-130-07	The National Audubon Society Agreement
555	131-130-02	
556	141-080-02	
557	141-070-03	
558	141-070-04	
559	141-070-06	
560	141-070-18	
561	141-070-32	
562	141-070-38	
563	141-070-39	
564	141-040-02	
565	141-040-03	

Table 2-2

Properties in the Vicinity of Alternative Alignment A

Map Number	Assessor Parcel Numbers	Conservation Easement Agreement
566	141-040-04	
567	141-040-08	
568	141-040-09	
569	141-040-13	
570	141-040-14	
571	141-040-15	
572	141-040-16	
573	141-040-17	
574	141-040-18	
575	141-040-19	
576	141-040-21	
577	141-040-22	
578	131-140-09	The Maacama Agreement
579	131-140-10	The Maacama Agreement
580	131-150-32	The Maacama Agreement

Table 2-3

Conservation Agreements and Affected APNs
in the Vicinity of Alternative Alignment A

Agreement	Date	Instrument No. in Official Records of Sonoma County	Affected APNs
Deed and Agreement by and between Maacama Valley Partners and the Open Space District Conveying a Conservation Easement and Assigning Development Rights (the Maacama Agreement)	December 8, 1994, recorded December 30, 1994	1994-0143084-1	131-140-08 131-140-09 131-140-10 (part) 131-150-32
Deed and Agreement by and between National Audubon Society and the Open Space District Conveying a Conservation Easement and Assigning Development Rights (the National Audubon Society Agreement)	December 14, 1994, recorded December 30, 1994	1994-0143082-1	131-130-07 131-130-08 141-120-04 141-100-10 141-100-11 141-100-05 141-070-43

Table 2-3

Conservation Agreements and Affected APNs
in the Vicinity of Alternative Alignment A

Agreement	Date	Instrument No. in Official Records of Sonoma County	Affected APNs
Deed and Agreement by and between Henry A McMicking and Doris B. McMicking, trustees of the Henry A. McMicking and Doris B. McMicking Trust, U.D.T., dated August 14, 1969 and the Open Space District Conveying a Conservation Easement and Assigning Development Rights (the McMicking Agreement)	January 2, 1996, recorded January 3, 1996	1996-0000364	131-140-12 (part)

Feasibility of Acquiring Pipeline Easements across Open Space Easements

The identified conservation easements could have an impact on the viability of Alternative Alignment A. It appears that any easement, except those in clear furtherance of the conservation purposes of the easements, might be considered an impermissible granting of property rights unless several specific procedures are followed. These procedures are embodied in California Public Resources Code Section 55440 and require a vote of the Board of the Open Space District and either a vote of the people of Sonoma County or a vote of the Legislature.

Another approach to dealing with the conservation easements is to obtain easements for the proposed route of Alternative Alignment A by condemnation carried out by an agency that has the power to condemn Open Space District property. This action has implications for the ownership of the pipeline, and there are a number of specific rules that apply to condemnation by one public agency of the property of another public agency (if, for example, the condemning agency were the City of Santa Rosa). These rules are specified below.

Pursuant to California Civil Procedures Code Section 1240.125, a local public entity "may acquire property by eminent domain outside its territorial limits for water, gas, or electric supply purposes, or for airports, drainage or sewer purposes if it is authorized to acquire property by eminent domain for the purposes for which the property is to be acquired." The City of Santa Rosa's general eminent domain authority includes the authority to acquire "(r)ights of way for drains, sewers, and aqueducts" (California Government Code Section 40404[b]). The nexus between municipal sewage management and the proposed conveyance of reclaimed water under the Geysers Recharge Alternative would appear to be sufficient to support the City of Santa Rosa's extra-territorial exercise of eminent domain to acquire rights-of way for the necessary pipeline.

Santa Rosa

Geysers Cost Reduction Study

CONSERVATION EASEMENTS

PARSONS
HARLAND BARTHOLOMEW
and ASSOCIATES, INC.

Figure 2-2

Relevant to the condemnation of property already appropriated to public use, such property may be acquired by eminent domain "if the proposed use will not unreasonably interfere with or impair the continuance of the public use as it then exists or may reasonably be expected to exist in the future" (California Civil Procedures Code Section 1240.510). There does not appear to be any general statutory impediment to findings by the City of Santa Rosa that the construction, operation, and maintenance of an underground pipeline for the public purpose of the Geysers Recharge Alternative would not "unreasonably interfere with or impair" the basic conservation easement purpose of retaining land "predominantly in its natural, scenic, historical, agricultural, forested, or open-spaced condition" (California Civil Code Section 815.1). It would be necessary, however, to examine the particular provisions of the relevant conservation easement grants, as noted above, in order to ascertain whether any express restrictions go beyond the basic statutory requirements.

Under circumstances where the City of Santa Rosa cannot support the findings necessary for condemnation action pursuant to California Civil Procedures Code Section 1240.510, the City may still be able to undertake the condemnation action pursuant to California Civil Procedures Code Section 1240.610. That section authorizes acquisition by eminent domain of property, and interests therein, already appropriated to public use "if the use for which the property is sought to be taken is a more necessary public use than the use to which the property is appropriated."

Moreover, the state Legislature has specified that: "Nothing in this chapter shall limit the power of ... any county, city, ... or any other local public district, agency or entity, or any other person authorized by law, to acquire land subject to an open-space easement by eminent domain" (California Government Code Section 51058).

A number of other restrictions, lien holders or owners of some rights in the potentially affected properties could be entitled to a right to approve of an easement. For example, a bank holding a deed of trust to secure repayment of a loan may require its consent to any easements across the affected parcel. If there were condemnation proceedings, it is likely that the condemning power would obviate the necessity to get these consents.

Based on the above findings, it would be difficult to obtain easements for pipelines crossing existing open space easements for the Alternative Alignment A option of the Geysers Recharge Alternative. However, it would be legally feasible for the City of Santa Rosa to exercise eminent domain authority on behalf of the Subregional System to acquire the pipeline easement by condemnation.

CONCLUSIONS

An alternative alignment (Alternative Alignment A) southeast of Pine Flat Road exists which appears to be technically feasible. Potential alternative alignments north of Pine Flat Road were investigated, but offered no significant advantages which would be expected to decrease construction or operational costs.

Alternative Alignment A is about four miles shorter than the Pine Flat Road alignment. The new alignment, however, has an intermediate high point which requires an additional 485 foot lift and traverses extremely rugged topography. Alternative Alignment A avoids unstable geological areas along the Pine Flat Road alignment. The final segment of Alternative Alignment A is coincident with the Pine Flat Road alignment, as no benefits were found from selecting a different route.

A new pump station location is required at the bottom of the Mayacamas Mountains. However, the remaining two uphill pump stations and the terminal storage tanks are located on the same properties as in the Pine Flat Road alignment.

Alternative Alignment A traverses nine properties which are encumbered by three different Conservation Easements owned by the Sonoma County Agricultural Preservation and Open Space District. The Conservation Easements do not appear to allow new easements for pipelines.

The Conservation Easements can be amended only by agreement of the Board of the Open Space District and either a vote of the people of Sonoma County or a vote of the State Legislature. In lieu of these approvals, the City of Santa Rosa does have the authority to condemn an easement for the pipeline on behalf of the Subregional Reclamation System.

3 WATER BALANCE ANALYSIS

PURPOSE

The original Geysers water balance analysis performed for the EIR/EIS established a range of average monthly flows to the Geysers of 16 to 23 million gallons per day (mgd). The 23 mgd maximum figure was used to design the conveyance facilities. Additional water balance analyses are performed as part of this Geysers Cost Reduction Study to determine if other flow scenarios exist that result in lesser design flows than presented in the EIR/EIS, thereby reducing the cost of facilities. Another objective of the analyses is to determine if a steady or constant flow to the Geysers could be developed by adjustment of other controlling parameters. The design flow may be reduced by decreasing the overall flow to the Geysers or by narrowing the range of monthly average flows. The EIR/EIS Geysers water balance included only minimal river discharge and did not allow for revision of the target storage curve. Both of these elements are introduced in this analysis with the objectives of reducing the maximum design flow and equalizing the distribution of monthly average flows to the Geysers.

INTRODUCTION

The Geysers water balance allocates reclaimed water produced at the Santa Rosa Wastewater Treatment Plant (Laguna Plant) to various uses including agricultural irrigation, river discharge, and delivery to the Geysers steamfield for aquifer recharge injection. There is a storage component for storing reclaimed water for later discharge to any of the various uses. The Geysers water balance determines reclaimed water flows to be delivered to the Geysers on a monthly basis, under a number of different scenarios including those for project timeline, reclaimed water production, irrigation use and allowable river discharge.

Some of the assumptions and data used in the construction of the Geysers water balance were used in the construction of previous water balance models for the Santa Rosa Subregional Long Term Wastewater Project EIR/EIS. References to previous water balance models are made and differences and similarities are noted below.

SCENARIO CONDITIONS

Water balance analyses were performed for a variety of different scenarios. The following conditions define the scenarios:

- **Timeline.** Project Initiation and Project Buildout conditions determine reclaimed water production levels and irrigation attrition scenarios. Average Dry Weather Flows (ADWF) of 18 and 21 mgd are utilized for Project Initiation and Buildout, respectively.
- **Flow Percentiles.** 95th, 50th, and 5th percentile reclaimed water production rates and river flows are used. Over the 70-year period of record, the annual reclaimed water production that corresponds most closely to the desired percentile flow was selected for analysis. The corresponding annual Russian River flow for the same year was also chosen.

- **Storage Curves.** A storage curve was designed for the 95th percentile flow condition and was revised in response to 50th and 5th percentile flow conditions. The target storage curve for the 95th percentile flow condition is "bimodal"; the curves for the 50th and 5th percentile flows are "bimodal response."
- **Irrigation Attrition.** Irrigation attrition refers to the reduction in existing land area that is available for irrigation. Ten percent attrition of existing irrigation capacity is used for Project Initiation conditions. Twenty-five and 50 percent attrition rates are used for Project Buildout conditions.
- **Russian River Discharge Rates.** Discharge rates of 1, 2, and 5 percent of Russian River flow are used.

Underlying assumptions for flow percentiles, storage curves, irrigation attrition, and Russian River discharge rates are discussed in more detail below.

Flow Percentiles

Reclaimed water production data were determined based upon the results of two models:

- **Sonoma County Water Agency's (SCWA) Russian River Flow Model.** The SCWA model determines monthly Russian River flows under projected development and diversion conditions for the year 2010 using precipitation records for 70 years (1923-1992).
- **Daily Water Balance Model.** This model, developed for the EIR/EIS, estimates reclaimed water production based on the SCWA-estimated Russian River flows using linear regression techniques.

Reclaimed water production results are also based upon an Average Dry Weather Flow (ADWF) of 21 mgd for the Project Buildout condition determined for the EIR/EIS. Monthly reclaimed water production estimates over a 70-year period of record from the Daily Water Balance Model were summarized as annual production (for Project Buildout). The annual production data were sorted and a reclaimed water production frequency curve was prepared. The 21 mgd ADWF-based annual production data were adjusted for an ADWF of 18 mgd (reflecting reclaimed water flows for Project Initiation), and a second reclaimed water production frequency curve was prepared. The frequency curves for Project Initiation and Project Buildout are shown in Figures 3-1 and 3-2, respectively.

As determined from Figures 3-1 and 3-2, reclaimed water production flows (MG/annually) were determined as shown in Table 3-1.

Table 3-1

Projected Annual Reclaimed Water Production

Flow Percentile	Project Initiation (MG/annum)	Project Buildout (MG/annum)
95th	10,416	11,511
50th	8,860	9,955
5th	7,478	8,576

Reclaimed water production data for the Geysers water balance analysis were obtained from the results of the daily water balance model, which is used to support the water quality modeling of discharge impacts on the Laguna de Santa Rosa and the Russian River as part of the EIR/EIS. The daily water balance model was constructed subsequent to the monthly water balance model developed for the same project. Several improvements are incorporated in the daily water balance model, including more accurate estimates of reclaimed water production. For this reason it was decided to use daily water balance estimates of reclaimed water production in this updated Geysers water balance analysis. Further explanation for using the daily model estimates in place of the monthly model estimates is provided in *Analysis of Estimated Wastewater Flows from Daily and Monthly Water Balance Models* (Parsons ES, 13 March 1997).

Monthly water balance estimates of reclaimed water production are used for the Geysers water balance analysis in the EIR/EIS. Because the reclaimed water production estimates based on the daily water balance model are substantially greater than those generated by the monthly water balance model, it was thought that the increase in estimated production might increase the flows to the Geysers under the present analysis. However, introduction of the river discharge element and improved management of the reclaimed water system through target storage adjustment actually decreases Geysers delivery flows. Target storage adjustment is discussed in more detail below.

Storage Curves

Target storage is defined as the series of monthly storage volume objectives anticipated to meet future reclaimed water demands. The monthly and daily water balance models developed for determining the EIR/EIS system requirements include a monthly target storage curve, termed a "conventional" storage curve. In the Geysers water balance for the EIR/EIS, the target storage curve was borrowed from the monthly water balance model. Preliminary review of this target storage curve indicated that the curve could be refined to more uniformly distribute reclaimed water flows to the Geysers.

Minor adjustments to the conventional target storage curve brought about significant improvements to the monthly distribution of flows to the Geysers (i.e., a more uniform distribution). It was also observed that river discharge capacity was underutilized (river discharge rates were substantially less than the allowance) and that an increase in allowable river discharge did not impact the magnitude of flows to the Geysers. Therefore, target storage was more closely scrutinized to determine if a change in the target storage approach might better utilize river discharge.

The conventional target storage curve took a standard approach to storage: water was saved through the high production/low irrigation use period (wet season) for later discharge during the low production/high irrigation use period (dry season). The shape of the conventional storage curve has a single peak (around May) and a single valley (around September). An alternative target storage approach was studied, utilizing two peaks, one for discharge during the irrigation season, the other for discharge during the river discharge period (with highest potential in January and February). Theoretically, this "bimodal" approach should increase utilization of river discharge capacity by storing water expressly for that purpose. The operators of the existing Santa Rosa reclaimed water system presently utilize the bimodal approach.

Figure 3-1
Wastewater Flow Frequency Curve-Project Initiation
Santa Rosa WWTP (1923-1992)

Figure 3-2
Wastewater Flow Frequency Curve-Project Buildout
Santa Rosa WWTP (1923-1992)

Both conventional and bimodal target storage curves were used for the Project Buildout/50 percent irrigation attrition/1 percent river discharge scenario. These are shown in Tables 1 and 2 in Appendix B for the conventional and bimodal curves, respectively. Replacing the conventional target storage curve with the bimodal curve reduces the average daily Geysers flow from 21 to 18 mgd and increases annual discharge to the river from 2,110 million gallons (MG) to 3,184 MG. However, this method does result in a more constant month-to-month flow than presented in the EIR/EIS. Because of the increased river discharge utilization (within the allowance) and the ability to reduce Geysers flows, the bimodal target storage approach was used for additional water balance analysis for other scenarios.

Irrigation Attrition

Irrigation demand estimates are based upon the following conditions:

- Annual irrigation demand of 24-inches of reclaimed water (based on typical annual demand for the existing system).
- Existing irrigation area of 5,500 acres.
- The same monthly hydraulic loading distribution that is used in the Daily Water Balance Model (based on historical monthly distributions for the existing irrigation system).
- Ten percent attrition of existing irrigation capacity is used for Project Initiation conditions. Twenty-five and 50 percent attrition rates are used for Project Buildout conditions.

Russian River Discharge Rates

Monthly Russian River flows were obtained from the SCWA Russian River flow model for the 95th, 50th, and 5th percentile Russian River flow conditions corresponding to the appropriate reclaimed water production rates. Allowable reclaimed water discharges to the Russian River are calculated based upon a percentage of Russian River flow. The percentages are 1, 2, and 5 percent. For the water balance analyses presented here, the actual river discharge does not exceed the allowable. Storage capacity is designed to absorb flows that may not be discharged to the river under drought conditions. This approach is different from that taken for the daily and monthly water balance models for the EIR/EIS, where discharges in excess of the allowable or “design” occurred periodically under drought conditions.

Under the terms of the present NPDES permit, the City of Santa Rosa is not allowed to discharge reclaimed water to the Laguna de Santa Rosa during the summer months of June, July, August, and September. Because of this limitation, Russian River flows for these months are zero in the water balance tables.

The actual river discharge is variable and depends upon other demands (e.g., irrigation, target storage, Geysers flow) for calculation. Actual river discharge is determined after other priority conditions for irrigation, target storage, and Geysers delivery are met. These priorities are explained in more detail in the Operational Guidelines section below.

OPERATIONAL GUIDELINES

The objective of adjusting the target storage curve is to equalize monthly flows to the Geysers. An “optimum” target storage curve may be designed to evenly distribute monthly

flows to the Geysers throughout the year for a given set of conditions. However, reclaimed water production and river discharge capacity are weather dependent and may require that more or less water than the designed target be sent to storage under different conditions. For example, drought conditions may require additional water be held in storage if river discharge capacity is substantially less than normal. Target storage and river discharge capacity require a certain amount of flexibility to accommodate these weather dependent conditions. Consequently, employing a variable target storage approach requires operational guidelines be developed to assist the operator in allocating reclaimed water flows under changing conditions.

Design flow for the Geysers was determined under the 95th percentile reclaimed water production condition. This assumption is conservative because it results in maximum production of flows to the Geysers and thereby requires the largest conveyance capacity. However, the target storage curve designed for this condition may not optimize the monthly distribution of flows to the Geysers under other production and river flow conditions. Therefore, system operation under different reclaimed water production conditions, e.g., 5th and 50th percentile flows, is also examined to ensure system flexibility. The target storage curve that was designed under the 95th percentile reclaimed water production condition was modified under 5th and 50th percentile flows (i.e., the "bimodal response" storage curve). General operational guidelines are established to guide operators in adapting storage flows to different production and river flow conditions. More specific guidelines would need to be developed in the next stage of the design process. The general guidelines are as follows:

- Maximize river discharge during the early wet season months of November and December. This strategy maximizes discharge early in order to maximize available storage for January and February should a drought condition occur and additional storage be required.
- Under the design (95th percentile) condition, no river discharge is utilized during the "shoulder" months of May and October because river flows are highly variable and generally small during these months. However, under other response conditions (50th and 5th percentile), river discharge may be utilized during these months if needed.
- Under the design (95th percentile) condition, target storage should not exceed 1,170 MG (approximately 90 percent of the 1,300 MG maximum) to allow a buffer for drought years. An exception to this guideline may be taken for Project Initiation/10 Percent Irrigation Attrition scenarios. Because of the relatively high irrigation demand and smaller production flows under these scenarios, this limit may be increased to 1,300 MG for the month of May due to the dependable and large irrigation demand in June and July.

These operational guidelines were used to develop the bimodal target storage curves under each of the irrigation/river discharge scenarios for the 95th percentile reclaimed water production condition. Then, for 50th and 5th percentile reclaimed water production and Russian River flow, the target storage curve was revised to accommodate different production/river discharge conditions, as if an operator were responding to changing weather conditions, without any foresight of future reclaimed water flows or river discharge capacity. In this manner, the flexibility of the target storage curve is checked to ensure that a drought condition may be accommodated without exceeding river discharge limitations. Also, the impact of drought conditions on the distribution of monthly Geysers flows is determined.

Concern has been raised over daily peak river discharges within a month in which the actual river discharge is equal to the allowable river discharge. The specific concern is that variation in daily discharges may result in flows exceeding the allowable rate on a daily basis while equaling the limit on a monthly basis. Prior experience with the daily and monthly models (1 percent and 5 percent discharge rates) created for the EIR/EIS shows that daily river discharges exceeding the allowable rate do not occur when 10 percent of the maximum storage is available for contingencies. Because the operating guidelines leave 10 percent of the maximum storage available for drought periods, daily river discharges should not exceed the allowable rate, even when the actual rate is equivalent to the allowable rate on a monthly basis.

RESULTS

Project Buildout/50 Percent Irrigation Attrition

The first series of analyses determine Geysers flows at 50 percent irrigation attrition at Project Buildout. Scenarios for these conditions (Scenarios 1-10 shown in Tables 1-10 in Appendix B, respectively) are summarized and compared in Table 3-5. The first four scenarios (one percent river discharge rate) compare the results using different types of storage curves.

Variation of Storage Curves

Scenario 1 uses a conventional storage curve to achieve monthly average flows to the Geysers of 20-21 mgd. This storage curve is modified from the original used in the EIR/EIS (Parsons ES, 10 October 1995). The EIR/EIS Geysers water balance analysis (using the storage curve and reclaimed water production data from the monthly model) is compared to the revised analysis (using reclaimed water production data from the daily model and a modified target storage curve) below. Revising the original storage curve results in a more even distribution of monthly flows, a lower maximum design flow, and a greater annual delivery.

Alternative	Annual Geysers Flow	Monthly Flow Range
EIR/EIS Results	7,100 MG	16-23 mgd
Scenario 1	7,609 MG	20-21 mgd

Average monthly Geysers flows (and the variation in monthly flows) were reduced further using a bimodal storage curve (Scenario 2). The bimodal approach stores reclaimed water in the fall for winter discharge, increasing river discharge utilization. Under the 95th percentile production and river flow conditions a bimodal target storage curve is designed for a uniform monthly distribution of flows to the Geysers. The bimodal target storage curve developed in Scenario 2 was revised in response to 50th and 5th percentile production and flow conditions (Scenarios 3 and 4, respectively). These scenarios were evaluated to ensure that the target storage distribution developed for Scenario 2 would be adequate for lower river flow scenarios, without exceeding river discharge allowances. These annual flows and monthly flow ranges for these scenarios are as follows:

Alternative	Annual Geysers Flow	Monthly Flow Range
Scenario 2:	6,535 MG	uniform 18 mgd
Scenario 3:	6,078 MG	12-18 mgd
Scenario 4:	5,849 MG	7-18 mgd

The distribution of monthly flows and the total annual Geysers flow are affected by the revised storage targets. Distribution becomes more variable with some months falling below the uniform target Geysers delivery rate of 18 mgd. The lower flows generally occur in the 3-4 months of the spring and early summer.

The target storage curves for each of the four scenarios described above are shown in Figure 3-3. The conventional target storage is shown as Scenario 1. The peak maximum storage of 1,300 MG is achieved in May for discharge to irrigation. The bimodal target storage curve is shown as Scenario 2. It has two peaks, one each in January and May for river discharge and irrigation discharge, respectively. The target storage curve is modified to respond to different production and river flow conditions in Scenarios 3 and 4 and begins to more closely resemble the conventional curve.

In Scenarios 3 and 4, target storage decreases in the wet season (December, January, and February). This is contrary to an expected increase in target storage because of reduced discharge capacity for 50th and 5th percentile river flow conditions. Figure 3-4, Allowable River Discharge for Scenarios 2 through 4, explains why the storage curves do not behave as expected. Scenario 2, with 95th percentile Russian River Flow, actually has smaller allowable river discharge rates in November and December than for the other two scenarios at 50th and 5th percentile flows. This means that more reclaimed water may be discharged during these months (under the 50th and 5th percentile flows) with less flow going to storage. Also, Geysers demand does not change and reclaimed water production goes down. This means that less flow is allocated to storage in the late fall/early winter than would be expected. Allowable river discharge rates behave more predictably during the other months of the year. This anomaly demonstrates that the distribution of river flows for each year is unique and that even a year with high total river flows may contain some months with flows that are less than average.

Geysers Allocation

Geysers flows decrease as reclaimed water production decreases, although not at the same rate.

A greater percentage of reclaimed water production is delivered to the Geysers during the 5th percentile year (68 percent) than during the 95th percentile year (57 percent). This indicates some flexibility in the management of the reclaimed water system to redistribute production to Geysers according to weather conditions and to maintain a relatively uniform delivery to the Geysers.

Figure 3-3
Storage Curves

50% Ag Attrition, 1% River Discharge

Figure 3-4
Allowable River Discharge (One Percent)
Scenarios 2 - 4

Table 3-2

Relationship between Reclaimed Water Production and Annual Geysers Flow

	95th Percentile (MG/annum)	5th Percentile (MG/annum)	Percent Decrease
Reclaimed Water Production	11,511	8,576	34
Annual Geysers Flow	6,535	5,849	12

Variation of Allowable Discharge Rates

Scenarios 5, 6, and 7 are the 95th, 50th, and 5th percentile flows, respectively, for the 2 percent allowable river discharge rate. Scenarios 8, 9, and 10 are the 95th, 50th, and 5th percentile flows, respectively, for the 5 percent allowable river discharge rate. As expected, an increased discharge rate reduces the Geysers delivery flows. For both discharge rates, the 50th and 5th percentile "bimodal response" curves confirm that storage is sufficiently flexible to accommodate reduced river discharge and at the same time maintain Geysers deliveries at a relatively stable level. As river discharge capacity increases (i.e., increasing system flexibility), the variation in monthly flows for the 5th percentile scenarios decreases. The range of monthly average flows for Scenario 7 is 4-15 mgd and the range of flows for Scenario 10 is 5-10 mgd. Again, the low flow months are limited to the spring and early summer.

Project Buildout/25 Percent Irrigation Attrition

The second series of analyses determine Geysers flows based on 25 percent irrigation attrition at Project Buildout (i.e., maintaining more of existing irrigation acreage). Scenarios for these conditions (Scenarios 11-19 shown in Tables 11-19 in Appendix B, respectively) are summarized and compared in Table 3-6. The results follow trends similar to those described above for the 50 percent irrigation attrition scenarios (Scenarios 1-10), including:

- **Flow Percentiles.** As production and river flows decrease, flow distribution shifts towards Geysers delivery and away from river discharge.
- **Storage Curves.** Revision to the bimodal target storage curve (95th percentile) accommodates decreased river discharge capacity under 50th and 5th percentile river flow conditions without exceeding the discharge rate.
- **Irrigation Attrition.** The reduced attrition rate (i.e., maintaining more of existing irrigation acreage) decreases flows to the Geysers. Also, the reduced attrition rate increases reliance on storage to meet summer irrigation demands. For example, maximum design storage required under the 95th percentile condition for 1 percent discharge under 50 percent attrition (Scenario 2) is 1,000 MG. Maximum design storage required under the 95th percentile condition for 1 percent discharge under 25 percent attrition (Scenario 11) is 1,170 MG. Both of these values are less than the available storage of 1,300 MG.
- **River Discharge Rates.** Average monthly Geysers flows range from 5 to 14 mgd as the allowable river discharge rate declines from 5 to 1 percent. Also, variability of

monthly distribution of flows to the Geysers decreases with increased river discharge capacity.

Project Initiation/10 Percent Irrigation Attrition

The third series of analyses determine Geysers flows at 10 percent irrigation attrition at Project Initiation. Scenarios for these conditions (Scenarios 20-28 shown in Tables 20-28 in Appendix B, respectively) are summarized and compared in Table 3-7. The results follow trends similar to those described above for the 25 and 50 percent irrigation attrition scenarios. There is one important difference, however, regarding irrigation demand and maximum storage capacity. Because irrigation demand is greatest and production is lowest (ADWF = 18 mgd) for these scenarios, there is a greater need for storage to meet the reclaimed water system's summertime demands. Therefore, an exception was made to the maximum target storage objective of 1,170 MG (90 percent of available) to fill the storage system completely (1,300 MG) in May to carry the demand throughout the summer.

Despite utilizing all of the available storage capacity, the system cannot store enough water to meet both irrigation demand and maintain an even distribution of flow to the Geysers with a 1 percent allowable river discharge. Scenario 20 shows that during the peak irrigation months of June through August, Geysers delivery is reduced significantly from 11 to 7 mgd. Conversely, Geysers delivery cannot be continued at the summer level (about 7-8 mgd) during the non-irrigation season to provide an even distribution of flows on an annual basis because of river discharge limitations. These two opposing requirements result in a variable monthly Geysers flow distribution for this scenario. This variation is exacerbated during median flow and drought conditions (Scenarios 21 and 22).

Table 3-3

Effect of Weather (Percentile Flow) on Monthly Geysers Flow

Scenario	Percentile Flow	Minimum Monthly Flow (mgd)	Maximum Monthly Flow (mgd)
20	95th	7	11
21	50th	3	11
22	5th	3	11

The variation in monthly distribution is decreased by increasing the allowable river discharge rate. Summer flows to the Geysers are fixed by irrigation requirements and storage capacity, but winter flows to the Geysers may be reduced by increasing allowable river discharge, as shown below.

Table 3-4

Effect of River Discharge Rates on Monthly Geysers Flow

Scenario	Discharge Rate (percent)	Minimum Monthly Flow (mgd)	Maximum Monthly Flow (mgd)
20	1	7	11
23	2	7	9
26	5	5	5

Table 3-5

Water Balance Summary Project Buildout/50% Irrigation Attrition Results

Scenario	Timeline	Recycled Water Production Percentile	Annual Recycled Water Flow (MG)	Irrigation Attrition ² (percent)	Storage Curve	Allowable Discharge Rate ³ (percent)	Annual Irrigation Volume (MG)	Annual Irrigation Volume (percent)	Annual Discharge Volume (MG)	Annual Discharge Volume (percent)	Annual Geysers Volume (MG)	Annual Geysers Volume (percent)	Geysers Monthly Flow (mgd)	Monthly Flow Range (mgd)
1	Project Buildout	95	11,511	50	Conventional	1%	1,792	16%	2,110	18%	7,609	66%	21	20 to 21
2	Project Buildout	95	11,511	50	Bimodal	1%	1,792	16%	3,184	28%	6,535	57%	18	18
3	Project Buildout	50	9,955	50	Bimodal Response	1%	1,792	18%	2,085	21%	6,078	61%	17	12 to 18
4	Project Buildout	5	8,576	50	Bimodal Response	1%	1,792	21%	935	11%	5,849	68%	16	7 to 18
5	Project Buildout	95	11,511	50	Bimodal	2%	1,792	16%	4,240	37%	5,479	48%	15	15
6	Project Buildout	50	9,955	50	Bimodal Response	2%	1,792	18%	3,090	31%	5,073	51%	14	9 to 15
7	Project Buildout	5	8,576	50	Bimodal Response	2%	1,792	21%	1,869	22%	4,915	57%	13	4 to 15
8	Project Buildout	95	11,511	50	Bimodal	5%	1,792	16%	6,044	53%	3,675	32%	10	10
9	Project Buildout	50	9,955	50	Bimodal Response	5%	1,792	18%	4,810	48%	3,353	34%	9	4 to 10
10	Project Buildout	5	8,576	50	Bimodal Response	5%	1,792	21%	3,349	39%	3,435	40%	9	5 to 10

¹ Represents the percent the recycled water production value is less than the stated percentile for a 70-year period of record.

² Reduction in existing irrigation acreage (5,500 acres) in use at project buildout.

³ Allowable discharge rate of recycled water to Russian RI

Table 3-6

Water Balance Summary Project Buildout/25% Irrigation Attrition Results

Scenario	Timeline	Recycled Water Production Percentile	Annual Recycled Water Flow (MG)	Irrigation ² Attrition (percent)	Storage Curve	Allowable Discharge ³ Rate (percent)	Annual Irrigation Volume (MG)	Annual Irrigation Volume (percent)	Annual Discharge Volume (MG)	Annual Discharge Volume (percent)	Annual Geysers Volume (MG)	Annual Geysers Volume (percent)	Geysers Monthly Flow (mgd)	Monthly Flow Range (mgd)
11	Project Buildout	95	11,511	25	Bimodal	1%	2,688	23%	3,758	33%	5,065	44%	14	14
12	Project Buildout	50	9,955	25	Bimodal Response	1%	2,688	27%	2,584	26%	4,683	47%	13	9 to 14
13	Project Buildout	5	8,576	25	Bimodal Response	1%	2,688	31%	961	11%	4,927	57%	13	9 to 15
14	Project Buildout	95	11,511	25	Bimodal	2%	2,688	23%	4,830	42%	3,993	35%	11	11
15	Project Buildout	50	9,955	25	Bimodal Response	2%	2,688	27%	3,570	36%	3,697	37%	10	5 to 11
16	Project Buildout	5	8,576	25	Bimodal Response	2%	2,688	31%	1,921	22%	3,967	46%	11	10 to 11
17	Project Buildout	95	11,511	25	Bimodal	5%	2,688	23%	7,004	61%	1,819	16%	5	5
18	Project Buildout	50	9,955	25	Bimodal Response	5%	2,688	27%	5,774	58%	1,513	15%	4	0 to 5
19	Project Buildout	5	8,576	25	Bimodal Response	5%	2,688	31%	3,961	46%	1,927	22%	5	5

¹ Represents the percent the recycled water production value is less than the stated percentile for a 70-year period of

² Reduction in existing irrigation acreage (5,500 acres) in use at project buildout.

³ Allowable discharge rate of recycled water to Russian River.

Table 3-7

Water Balance Summary Project Initiation/10% Irrigation Attrition Results

Scenario	Timeline	Recycled Water Production Percentile	Annual Recycled Water Flow (MG)	Irrigation ² Attrition (percent)	Storage Curve	Allowable Discharge ³ Rate (percent)	Annual Irrigation Volume (MG)	Annual Irrigation Volume (percent)	Annual Discharge Volume (MG)	Annual Discharge Volume (percent)	Annual Geysers Volume (MG)	Annual Geysers Volume (percent)	Geysers Monthly Flow (mgd)	Monthly Flow Range (mgd)
20	Project Initiation	95	10,416	10	Bimodal	1%	3,226	31%	3,618	35%	3,572	34%	10	7 to 11
21	Project Initiation	50	8,860	10	Bimodal Response	1%	3,226	36%	2,444	28%	3,190	36%	9	3 to 11
22	Project Initiation	5	7,478	10	Bimodal Response	1%	3,226	43%	950	13%	3,302	44%	9	3 to 11
23	Project Initiation	95	10,416	10	Bimodal	2%	3,226	31%	4,004	38%	3,186	31%	9	7 to 9
24	Project Initiation	50	8,860	10	Bimodal Response	2%	3,226	36%	2,810	32%	2,824	32%	8	3 to 9
25	Project Initiation	5	7,478	10	Bimodal Response	2%	3,226	43%	1,787	24%	2,465	33%	7	0 to 9
26	Project Initiation	95	10,416	10	Bimodal	5%	3,226	31%	5,334	51%	1,856	18%	5	5
27	Project Initiation	50	8,860	10	Bimodal Response	5%	3,226	36%	3,985	45%	1,649	19%	5	0 to 5
28	Project Initiation	5	7,478	10	Bimodal Response	5%	3,226	43%	2,567	34%	1,685	23%	5	2 to 5

¹ Represents the percent the recycled water production value is less than the stated percentile for a 70-year period of record.

² Reduction in existing irrigation acreage (5,500 acres) in use at project bu

³ Allowable discharge rate of recycled water to Russian River.

Drought conditions for the 2 and 5 percent allowable discharge rates (Scenarios 25 and 28, respectively) yield some months (May and/or June) where the average monthly Geysers flow drop to 0 or 2 mgd, respectively.

CONCLUSIONS

Flow Percentiles

Reclaimed water production data for Geysers water balance analyses were taken from the daily water balance model constructed for the EIR/EIS, replacing the original data from the monthly water balance model, also constructed for the EIR/EIS. The daily model reclaimed water projection data are a refinement of the monthly analysis and are considered a more accurate estimate of supply to the reclaimed water system.

Storage Curves

- The bimodal target storage curve more efficiently allocates reclaimed water to the various disposal options of irrigation, river discharge, and Geysers delivery. For this reason the bimodal approach was chosen over the conventional approach previously used in the EIR/EIS and used for the analyses included here.
- Target storage curves were designed under the 95th percentile reclaimed water production and river flow scenario to determine Geysers flows under high production conditions. These curves were then tested under the 50th and 5th percentile scenarios to ensure that the reclaimed water system (and target storage curve) could accommodate these flows without exceeding the allowable river discharge rate.
- Revising target storage (i.e., "bimodal response") for changing reclaimed water production and river flow conditions required the development of new operational guidelines that would aid the system operators in selecting flow allocations while retaining flexibility. Operational guidelines for river discharge rates and storage targets were established and followed for the bimodal response scenarios (under 50th and 5th percentile conditions).

Irrigation Attrition

- Irrigation attrition rates affect storage requirements and summer Geysers flows. Under the 25 and 50 percent attrition scenarios, the 1,300 MG maximum storage was found to be sufficient to support both irrigation and a steady summer distribution of flows to the Geysers. At the 10 percent attrition rate, in combination with lower production at Project Initiation, the storage capacity would be insufficient to maintain uniform Geysers flows throughout the year and meet irrigation requirements.

Russian River Discharge Rates

- The distribution of river flows for each year is unique and a year with high annual flows may contain some months with flows that are less than average. This variability in weather conditions requires additional flexibility in the management of reclaimed water.

Geysers Flow Distribution

- Monthly variability in Geysers flows would generally be limited to the spring and summer (2-3 months) when irrigation demands must be met and reclaimed water production flows are at their lowest. This situation was found to be particularly pronounced for the Project Initiation (10 percent irrigation attrition) and low discharge rate (1 and 2 percent) conditions.

Reclaimed Water System Flexibility

- System flexibility built into the operational guidelines and target storage procedures ensure that river discharge allowances are not exceeded under any of the scenarios. However, bimodal response scenarios introduce variability to the monthly Geysers flow distributions. Variability decreases as allowable river discharge increases.
- Reclaimed water system flexibility (storage buffers) would allow greater percentage of flow to be distributed to the Geysers and less to river discharge during dry years to prevent substantial decreases in flow to the Geysers.
- The Geysers flows presented for each scenario are not definitive. The average Geysers flows summarized in Tables 3-5 and 3-6 are the minimum flows that can be sent to the Geysers given the scenario conditions and the target storage curves that were developed. In most cases it was determined that less flow could be discharged to the river and more flow sent to the Geysers. Geysers flows for Project Initiation scenarios were found to be more constrained than those for Buildout due to greater irrigation demand at that point in the project timeline.

4 SYSTEM COMPONENTS

PURPOSE

The purpose of this chapter is to size the pipeline, identify the capacity and number of pumps for Alternative Alignments A and B under three selected flow scenarios and to present the results of a preliminary surge analysis of Alternative Alignment A.

SELECTED FLOW SCENARIOS

In selecting the flows to be used in this analysis, the first objective was to define the upper and lower limits of flows that could reasonably be delivered to the Geysers steamfields on a consistent basis. The prudent choice of a third flow rate would then be a value near the mid-point of the defined flow range. Estimates of the total construction and operating costs, based on this distribution of project sizes (i.e., flow scenarios) and the pipe sizes recommended from this analysis, will facilitate subsequent interpolation of project costs for other flow scenarios, if so desired. The results of the water balance analyses showed the maximum and minimum uniform average monthly flows, converted to a daily rate, available for delivery to the Geysers steamfields to be 18 and 5 mgd, respectively. These values were therefore used as the maximum and minimum flow scenarios respectively for this pipe sizing analyses. An average monthly flow rate, converted to a daily rate, equal to 11 mgd was used as the mid-point value for this range and for subsequent cost analyses. The flow scenarios selected for further analysis are defined in Table 4-1.

Table 4-1

Flow Scenarios Selected for Analysis

Average Daily Flow to the Geysers	Irrigation Attrition	Discharge to the Russian River	Flow Scenario at Project Buildout
18 mgd	50%	1%	2, 3, and 4
11 mgd	25%	2%	14, 15, and 16
5 mgd	25%	5%	17, 18, and 19

a. Refer to Tables 3-5, 3-6, and 3-7 and Tables 1-28 in Appendix B.

ANALYSIS ASSUMPTIONS

Pipe Material

The material of choice for the Geysers pipeline is steel pipe because:

- It is available in a broad range of sizes;
- It can be economically designed to accommodate high operating pressures and resist hydraulic transients and fatigue failure caused by repeated cycles of pump starts and stops;

- Although it is a prefabricated material, it can be relatively easily modified in the field to accommodate unforeseen changes in alignment or grade.

These are all situations or conditions to which the Geysers pipeline will be subjected. For Segments A-1 and B-1 (generally flat with less difficult construction required), alternative pipe materials such as ductile iron pipe and concrete cylinder pipe (the former material was used as a portion of the LACOSAN project, while the latter material was used on Rohnert Park Reuse System) could be bid as an alternate. For purposes of this analysis, cost savings are considered insignificant. For comparison purposes, LACOSAN is using steel pipe in similar steep areas.

Friction Factor

The proposed steel pipe will have a dense cement mortar lining to provide a smooth interior lining (that will result in lower friction losses) and to protect the steel cylinder from corrosion from the conveyed fluid, that is, reclaimed water. The most frequently used method for determining energy or head losses in pressure pipe flow is the Hazen-Williams formula. The Hazen-Williams formula employs a friction factor "C" value that is indicative of the smoothness of the pipe interior in contact with the conveyed fluid, with an increasing value of C indicating a smoother pipe interior. Values for the friction factor C have been empirically determined for a broad range of different pipe materials and service conditions and these values are published in engineering manuals. Studies have shown C values in the range of 140 to 145 are common for new cement lined steel pipe. As the pipe ages tuberculation (corrosion and metallic salt deposits), slime buildup, and solids deposition occur in the pipe interior, resulting in increased friction or resistance to flow and a decrease in the C value. C values of 100 and lower have been determined for older pipelines in poor condition. For this analysis an average C value of 120, representative of a cement mortar lined pipe in "fair" future (aged) condition, was used to calculate the energy friction losses occurring in the range of pipe sizes and flows included in this analysis.

Flow Velocity

A flow velocity range of not less than 2.5 to not more than 7 feet per second was used in selecting the family of candidate pipe sizes for the flow rates included in this analysis. The upper limit was intended to minimize the impacts of friction loss in the pipeline and the severity of hydraulic transients that generally result as the flow velocity increases. The lower limit was selected to minimize the deposition of solids in the pipeline and to maximize re-suspension of material when flow resumes after a shut down of the pumping system. Pipe sizes that resulted in flow rates either greater or less than this range, for each of the three respective flow scenarios, were therefore not included in this analysis.

Electric Power Costs

The electric power costs used were the estimated rates forecast to be in effect after deregulation in the year 2002. (Refer to the discussion on electrical rates presented in Chapter 5 for additional background on the components that are included in this average rate). It is estimated that a design period of 1 to 1-1/2 years will be required for this project, followed by a construction period of about 2 years. Beginning from mid-1997, this would result in a system start-up occurring sometime in the year 2001. Given the close proximity to the year 2002 targeted for deregulation, it was concluded that use of current regulated schedule for only one year would not materially affect the results of the analysis. Therefore, to simplify the calculations, only the estimated deregulated electrical rate was

used. The estimated average rate takes into account the demand, energy, and customer charges and was determined to be 4.1 cents per kWh (refer to Chapter 5).

Efficiencies

Pump and motor efficiencies of 82 and 90 percent, respectively, were used.

Present Worth Analysis

The factors used in the present worth analyses of different pipe sizes for each of the three flow scenarios were as follows:

- A present worth period of 20 years was used. This period corresponds to the length of time allotted for funding mechanisms and also to the average life expectancy of the pumping facilities.
- Annual interest rate of 6.5 percent. This value was based on extensive work performed by Parsons ES on other current projects.
- Annual inflation rate of 2.5 percent was used for increases in electrical energy cost. Similar to the interest rate, this value was based on extensive work currently conducted by Parsons ES on other projects.²
- Design life of the pipeline was taken to be 40 years.
- Salvage value of the pipeline was based on linear depreciation over the 40-year life expectancy. Therefore, the pipeline would have a 50 percent value at the end of the 20-year study period, which was then converted to a present worth value in 1997 dollars.

SIZE OF PIPE

Both Geysers pipeline alternative alignments A and B were included in this analysis. Both alternative alignments were divided into four segments, corresponding to the portions of each alignment between consecutive pumping stations. These segments are designated A-1 through A-4 and B-1 through B-4. The fourth segment in both alignments was from the fourth, and last, pumping station, to the storage reservoir at the connection to the Geysers steamfield distribution system (Refer to Chapter 2 for additional discussion on the two alternative alignments and the distinctive characteristics of each of the pipeline segments). There are actually only seven different pipeline segments since A-4 and B-4 are identical, having the same pump station location, the same length and profile and the same discharge location (storage reservoirs). For this reason the remaining discussion of the analyses will often only refer to seven pipeline segments, although results are provided for all four segments of both alignment alternatives.

Based on the velocity range and the flow scenarios discussed above, an original field of seven standard sizes for fabricated steel pipe was considered as the basis for this analysis. Within each flow scenario the analyses focused on those pipe sizes that resulted in distinctive (however, not extreme) changes in the total dynamic pumping head (TDH) compared to the results for the next smaller or larger pipe size. If use of a smaller pipe size

² A rate of 2.5% was used as the inflation rate for this pipeline size analysis. Subsequent to this analysis, the inflation rate was increased to 3.4% for the present worth value calculated in Chapter 6. A sensitivity analysis of inflation rates varying between 0 and 3.4% showed that the present worth values were not markedly sensitive to inflation.

resulted in significantly greater TDH at the same flow rate, then it was considered unlikely that the resulting increase in energy costs would offset the lesser material costs for the smaller diameter. Similarly, going to the opposite end of the size spectrum, increasing the pipe size would have to result in a material decrease in the TDH, and consequently the energy costs, to offset the increased cost of the larger pipe diameter. This process was intended to narrow the family of pipe sizes considered for each of the respective flow scenarios to three from the total original group of seven.

However, this process was not necessarily taken as the final judgment. If the results of the analyses on the three sizes preliminarily selected indicated a continued beneficial cost trend in using either a larger or smaller pipe size, then the family of pipe sizes analyzed was expanded, as appropriate. In fact, the analysis for the 5 mgd flow scenario indicated that expanding the family of sizes to include 16-inch diameter, not one of the original group of seven pipe sizes, could show that size to be a best apparent choice for some segments and it was therefore added to the analyses. The pipe sizes included in the analyses for the respective flow scenarios are presented in Table 4-2.

Table 4-2

Pipe Sizes Considered for Analysis

Flow Rate	Pipe Diameters Considered (Velocity in ft/sec)			
5 mgd	16" (5.5)	18" (4.4)	20" (3.6)	24" (2.5)
11 mgd	24" (5.5)	30" (3.5)	36" (2.4)	
18 mgd	30" (5.7)	36" (3.9)	42" (2.9)	

System head-flow curves were prepared for each of the seven different pipeline segments and respective pump stations based on the corresponding pipeline alignment profile and using a Hazen-Williams friction coefficient (C value) of 120. System curves were prepared for each of the seven original incremental pipe sizes. No system curve was prepared for the 16" pipe. The system curves for the seven different pipeline segments are shown on Figures 1 through 7 in Appendix C-1. The system curves for segment A-4 and B-4 are identical because pipeline alignment and pumping systems are identical and therefore only the system curve for segment B-4 is presented. However, in determining the costs for selecting the best size, a line is included in all the tables for segment A-4 in order to provide a total alignment cost for material and energy.

Analysis to Determine Apparent Best Pipe Size

The apparent best pipe size for each flow scenario and pipeline segment was determined by conducting a present worth analysis, in 1997 dollars, of the total estimated cost, including pipeline construction and energy use.

Pipeline Construction Cost Estimates

To simplify the analysis, the pipeline construction cost consisted of only the pipe material cost and the estimated cost of installing and joining the pipe in a prepared trench. The pipeline construction costs did not include excavation or trenching, bedding and backfill materials, backfilling and compaction operations, line valves, surface restoration (paving or landscaping), contingencies or contractor's overhead

and profit. These elements would be included in a final estimated cost of the complete project. It was presumed that in comparing a limited range of pipe sizes for a particular flow scenario that these cost components would not be materially different between the smallest and largest pipe size in each family and would therefore essentially cancel each other. If anything, this approach would appear to favor the larger pipe sizes in each family because if there was a material difference the larger size would generally have a greater construction or capital cost. If the results of the analyses consistently favored the largest pipe size in each family of sizes, then these presumptions would be reevaluated.

Material costs for each of the pipe sizes and required pressure classes were obtained from Northwest Pipe Company. A pipe segment may have a different cost for the same pipe size if its pressure requirements differed greatly. Since the pipe wall thickness are generally fabricated in incremental values, slight differences in pressure requirements may not result in different price material costs. The installed unit cost was determined by applying a multiplier appropriate to the respective pipe size. The resulting costs are therefore considered to reflect accurately the distinctive characteristics of each pipeline segment.

Annual Energy Cost

Estimated energy costs were based on a constant daily flow rate at buildout, equal to the respective flow scenario, operating every day throughout the year on a 24-hour basis. This is achievable given the manner in which the water balance analyses were prepared and their use of reservoir storage management and discharge to the Russian River. The total dynamic head for each respective flow scenario and pipeline segment was then determined from the system curves in Appendix C-1 and used in the energy requirement formula with the pump and motor efficiencies and average power costs discussed previously in this chapter.

Present Worth Analysis

To properly compare the relative impact of the construction or installed pipe cost component, occurring in current dollars, with the estimated energy costs, occurring on an annual basis over a 20-year period, a present worth analysis was made of the individual cost components. For each flow scenario, the total present worth of each specific pipeline segment was determined by the sum of the installed pipe cost, the present worth of the installed pipe salvage value at the end of the 20-year analysis period (this being a negative or deductive value in the computation) and the present worth of escalated annual electricity costs.

The calculation of the salvage value and the interest and inflation values used in the calculations were discussed previously under the discussions on the assumptions for present worth analysis. Based on the values assumed, the present worth factor for calculating the present worth value of the annual electricity cost is 13.7415.

The results of the present worth analysis for the 5, 11 and 18 mgd flow scenarios for pipeline segments A-1 through A-4 and B-1 through B-4 for various pipeline sizes are presented in Tables 1 through 10 in Appendix C-2. Table 4-3 compares the present worth values for each of the pipe sizes considered for a particular flow scenario and pipeline segment. Table 4-4 summarizes the recommended pipe size for each alignment.

Table 4-3

Present Worth of Pipe at Various Diameters

Flow Rate (mgd)	Segment	Present Worth (in \$1000s)						
		16"	18"	20"	24"	30"	36"	42"
5	A-1	8,632	6,955	6,810	6,400	-	-	-
5	A-2	8,675	8,588	8,754	8,966	-	-	-
5	A-3	5,530	5,517	5,528	5,599	-	-	-
5	A-4	6,162	6,008	6,063	6,071	-	-	-
5	B-1	9,509	7,578	7,498	7,100	-	-	-
5	B-2	6,471	6,122	6,083	6,159	-	-	-
5	B-3	5,673	5,671	5,674	5,786	-	-	-
5	B-4	6,162	6,008	6,063	6,071	-	-	-
11	A-1	-	-	-	13,720	12,145	12,687	-
11	A-2	-	-	-	18,913	19,401	20,727	-
11	A-3	-	-	-	12,383	12,491	12,884	-
11	A-4	-	-	-	13,871	13,868	14,198	-
11	B-1	-	-	-	14,715	13,254	13,996	-
11	B-2	-	-	-	13,376	13,247	13,932	-
11	B-3	-	-	-	12,370	12,422	12,868	-
11	B-4	-	-	-	13,871	13,868	14,198	-
18	A-1	-	-	-	-	18,599	16,796	17,388
18	A-2	-	-	-	-	27,894	28,734	37,725
18	A-3	-	-	-	-	18,393	18,512	19,217
18	A-4	-	-	-	-	20,628	20,690	21,275
18	B-1	-	-	-	-	19,892	18,215	19,039
18	B-2	-	-	-	-	19,627	19,576	20,472
18	B-3	-	-	-	-	18,140	18,246	19,003
18	B-4	-	-	-	-	20,628	20,690	21,275

Table 4-4

Recommended Best Pipe Size

Pipeline Segment	Flow Scenario		
	5 mgd	11 mgd	18 mgd
A-1	24"	30"	36"
A-2	18"	24"	30"
A-3	18"	24"	30"
A-4	18"	24" ⁽¹⁾	30"
B-1	24"	30"	36"
B-2	20"	30"	36"
B-3	18"	24"	30"
B-4	18"	24" ⁽¹⁾	30"

- (1) For the 11 mgd flow scenario, the total present worth's for the A-4 and the B-4 pipeline segments were essentially the same for both the 24" and 30" pipe sizes. Consequently, the 24" pipe size was selected because of its lower capital cost.

NUMBER AND CAPACITY OF PUMPS

Based on the results of the hydraulic analyses and the selection of pipe size, the number of pumps and approximate capacity at each of the four pump stations was determined. Results are shown in Table 4-5.

Table 4-5

Proposed Pump Station Capacities

Flow Scenario	Number of Pumps	Pump Capacity, Each Unit
5 mgd	3 ^a	1800-1900 gpm
11 mgd	4 ^b	2700-2850 gpm
18 mgd	4 ^b	4300-4450 gpm

- a. 2 duty units and 1 standby unit
b. 3 duty units and 1 standby unit

Table 4-6

Pump Station Summary

Pumps							
Pipeline: Recommended				Design			
Pump Station	Flow Scenario	Best Pipe Size inches	Duty No.	Standby No.	Capacity Each gpm	HP/Each	TDH ft
A1	5	24	2	1	1800-1900	300	561
A2	5	18	2	1	1800-1900	1000	1858
A3	5	18	2	1	1800-1900	700	1308
A4	5	18	2	1	1800-1900	800	1495
B1	5	24	2	1	1800-1900	300	561
B2	5	20	2	1	1800-1900	700	1308
B3	5	18	2	1	1800-1900	600	1121
B4	5	18	2	1	1800-1900	800	1495
A1	11	30	3	1	2700-2850	450	573
A2	11	24	3	1	2700-2850	1300	1656
A3	11	24	3	1	2700-2850	1000	1274
A4	11	24	3	1	2700-2850	1100	1401
B1	11	30	3	1	2700-2850	450	573
B2	11	30	3	1	2700-2850	1000	1274
B3	11	24	3	1	2700-2850	1000	1274
B4	11	24	3	1	2700-2850	1100	1401
A1	18	36	3	1	4300-4450	700	545
A2	18	30	3	1	4300-4450	2200	1713
A3	18	30	3	1	4300-4450	1500	1168
A4	18	30	3	1	4300-4450	2000	1557
B1	18	36	3	1	4300-4450	700	545
B2	18	36	3	1	4300-4450	1500	1168
B3	18	30	3	1	4300-4450	1500	1168
B4	18	30	3	1	4300-4450	2000	1557

PRELIMINARY SURGE ANALYSIS OF ALTERNATIVE ALIGNMENT A

The purpose of the preliminary surge analysis was to determine the maximum and minimum surge pressures occurring in each of the four segments of the Geysers Pipeline when subjected to the maximum delivery flow of 18 mgd (12,500 gpm), so that the construction cost estimates presented in Chapter 6 could reflect these system requirements.

A surge analysis was conducted on the Alternative Alignment A pipeline from Delta Pond to the termination reservoirs at the Geysers steamfield. Each pipeline segment was analyzed for two upset conditions: (1) failure of electrical power to the pump station; and (2) closure of a downstream isolation valve. For each pipeline segment, two pipeline diameters 30-inch and 36-inch were evaluated. The results of the analysis, which are provided in Appendix C-3, are summarized below.

Results

For each of the pipeline segments, the maximum pressures (ranging from 325 to 923 psig) occur immediately downstream of the pump station. In the case of a power failure to the pumps, the maximum pressure is caused by the rejoining of the water column following the collapse of vapor cavities. In the case of valve closure, this maximum pressure is caused by the surge pressure adding to the pump zero-flow head. These increases in pressure can

be alleviated by the installation of surge relief or anticipation valves at the pump station which permit the liquid in the pipeline to be discharged into the storage reservoir located at each pump station (or Delta Pond at Pump Station No. 1).

The minimum pressure conditions (-14.7 psig) that occur in the system following a power failure indicate that extensive vapor pockets have formed in the liquid. The detrimental consequence of this event is the possible collapse of the pipe in the segments where the vapor pockets are formed. These decreases in pressure can be alleviated by the installation of vacuum relief valves, in combination with air relief valves, at the high intermediate elevation points.

Also required will be instrumentation on the pump discharge to monitor if zero flow head conditions occur and power actuated operators on the pump discharge isolation valves to enable the pump to automatically stop against a closed valve.

CONCLUSIONS

- For each pump station, the recommended best pipe size, number of pumps and approximate capacity of each, and estimated total dynamic design head are listed in Table 4-6.
- The recommended best pipe size, as evidenced by the lowest total present worth, differed for the four segments of each alternative alignment.
- Only the 5 mgd flow scenario indicated the largest pipe size in the study group as the best choice for most of the pipeline sections. Therefore, these results substantiate the use of only the pipe material and placement costs in determining a comparative pipeline construction cost.
- The indication of the largest pipe size (24-inch diameter) as the best apparent choice for two segments of the 5 mgd flow scenario does not necessarily imply that a larger diameter would be even more cost effective in these cases. Increasing the pipe diameter to 30 inches would decrease the flow velocity of about 1.6 ft/sec., which would not meet the minimum velocity criteria and would cause increased solids deposition and increased maintenance costs.
- On the basis of lowest present worth, the apparent best pipe size for each of the flow scenarios and alternative pipeline alignments are listed in Table 4-3. It should be noted that the present worth values presented do not include all costs, either capital or operations, as discussed previously.
- The preliminary surge analysis shows that pressures ranging from -14.7 to 928 psig can be created in the pipeline, and that these pressure ranges can be mitigated by installing surge valves downstream of each pump station, combination air relief/vacuum relief valves at high elevation points, instrumentation to monitor for zero-head flow conditions, and power actuated operators to control pump operation in the event of sudden valve closure.

5 ELECTRIC POWER RATES

PURPOSE

The purpose of this analysis is to determine the most likely electric rate the City will pay during the course of project operation, so that the present worth analyses presented in Chapter 4 and 6 would accurately reflect, to the extent possible, future electric rate conditions.

INTRODUCTION

In accordance with State Assembly Bill 1890 (AB 1890), which was signed by Governor Wilson in September 1996, and a December 1995 California Public Utilities Commission (CPUC) policy decision, the electric industry in California is being restructured (deregulated) in order to allow electrical generation to become a competitive business. PG&E literature describing the anticipated resulting impacts is provided in Appendix D-1.

For purposes of comparing the cost of alternatives presented in the EIR/EIS, the average cost assumed for purchasing electricity from PG&E was \$ 0.055 per kilowatt hour (kWh), which was based on a Firm service level. However, lower PG&E rates are currently available. PG&E anticipates even further decreases in electricity rates after 2001 due to electric industry deregulation.

Consequently, for purposes of evaluating opportunities for reducing operation and maintenance costs for the Geysers Recharge Alternative, updated costs for purchasing electricity are presented herein. The following comments and recommendations are based on discussions with PG&E representatives Craig Kennedy and Mark Bramfitt, and our review of additional PG&E information and other relevant literature.

CURRENT RATES (NOW THROUGH DECEMBER 2001)

The PG&E E-20 Rate schedule is the only schedule offered by PG&E which applies to the size of electrical services required for the Geysers pumping facilities (i.e., having maximum demands exceeding 1000 kW). Due to enactment of AB 1890, the current E-20 Rate schedule (which is contained in Appendix D-2 is frozen and will remain in effect through December 2001, and can be used to conservatively estimate costs for electrical power in the interim. The E-20 Rate schedule summarized in Appendix D-3 is based on the assumption that PG&E will deliver electricity in the vicinity of each of the Geysers pumping facilities at transmission service voltage levels (i.e. that Geysers project facilities will include all necessary substations, transformers, and electrical distribution facilities to convey power from the PG&E meter to the pumping facilities). As shown in Appendix D-3, the E-20 rates consist of:

- Demand Charges (variable based on maximum monthly electrical demands during the specified time periods);
- Energy Charges (variable based on monthly energy use during the specified time periods); and

- Customer Charges (flat monthly fee per meter irrespective of demands or energy use).

The existing PG&E E-20 schedule includes a Non-Firm service level option which would allow for reducing the average electricity cost of \$0.055/kWh, noted in the EIR/EIS (which was based on the Firm service level) to between \$0.050/kWh (time weighted average based on the energy requirements for average monthly deliveries of 5.0 mgd) and \$0.046/kWh (time weighted average based on the energy requirements for average monthly deliveries of 18.0 mgd). The electricity cost reductions would range between 9 and 16 %, respectively.

The Non-Firm service level option requires customer acceptance of PG&E service interruptions of up to 6 hours duration per event and up to 100 hours per year. Apparently this service level option was previously used successfully at the Laguna Plant. Because of the City's capability to store reclaimed water (1300 MG capacity), the Non-Firm service level is an acceptable option for the Geysers project. Although PG&E no longer offers the Non-Firm service level option for existing facilities (including the Laguna Plant), this option is available for new services.

In accordance with a May 6, 1996 CPUC decision, beginning January 1, 1998 all PG&E customers will be able to select their own energy supplier. Once PG&E customers are able to select their own supplier, lower charges for energy (below those based on the E-20 Rate schedule) may be available to some customers, especially those having substantial continuous 24-hour per day energy demands.

Whether or not PG&E remains a customer's energy supplier, PG&E will continue to collect CTCs (Competition Transition Costs) until January 2002 from all existing and future customers within its present service area. The collection of CTCs over this period is not affected by the May 6, 1997 CPUC decision. The purpose of the CTCs is to allow existing electric utilities to cover the accelerated depreciation of non-competitive high cost generating and transmission facilities and recover costs for uneconomic power purchase contracts which they were previously required to enter.

Based on current filings with the California Public Utility Commission (CPUC), PG&E estimates that CTCs amount to about 39% of the current average monthly bill for each customer (Interim CTCs). The Commission is expected to adopt final CTCs shortly after January 1, 1998. AB 1890 requires that PG&E complete recovery of all CTCs before January 2002, except for some residual costs (estimated at 5% of the current average monthly bill) related primarily to ongoing power purchase contracts which will diminish over time.

FUTURE RATES (BEGINNING JANUARY 2002)

Based on PG&E staff projections regarding anticipated electricity cost impacts after CTCs are essentially eliminated, beginning in January, 2002, the cost for electricity will decrease between 19% and 32% (or about 25% average) below the cost of electricity which is currently delivered by PG&E at a Firm service level. PG&E staff are not willing to make a similar projection regarding impacts on Non-Firm service level rates since the availability of such rates after December 2001 is not certain. However, assuming a 25% reduction in Firm service level rates, in January 2002 electricity costs would decrease to about \$0.041/kWh.

CONCLUSIONS

Based on the current PG&E rate schedule options available for providing service to the Geysers project and estimated electrical rate reductions beginning January 2002, we recommend the following rates for use in estimating operating costs for the Geysers Cost Reduction Study:

Use of electrical rates of between \$0.050 to \$0.046/kWh, (time weighted averages based on average monthly reclaimed water flow and the PG&E E-20 Rate schedule, and the Non-Firm service level option) for project startup through December 2001.

Use of electrical rates averaging about 25% below current PG&E Firm service level rates (or about \$0.041/kWh on average) for January 2002 and beyond.

6 ESTIMATED CONSTRUCTION AND OPERATING COSTS

PURPOSE

The purpose of this analysis is to estimate costs of the various cost reduction scenarios for comparison with the cost of the Geysers Recharge Alternative in the EIR/EIS.

ASSUMPTIONS USED IN DEVELOPMENT OF COST ESTIMATES

This estimate of construction costs and operation and maintenance costs for the alternative cost reduction scenarios was prepared at a feasibility level of detail to identify the major costs associated with the alternative alignments and three flow scenarios and to enable a relative cost comparison to be made among the various alternative projects. Because of the uncertainty at this stage of design for the projects, the cost estimate is preliminary and subject to revision once a specific project is selected.

This analysis includes the same cost mark-ups as the project cost estimates in the EIR/EIS. The cost estimate includes a 25 percent contingency provision to account for miscellaneous cost items (including mitigation), unforeseen project components, and for components which could not be completely quantified or evaluated at this stage of project development. The American Association of Cost Engineers attributes a range of +50 percent to -30 percent to the accuracy of cost estimates prepared for feasibility study level of project development.

The total project costs also include a 15 percent mark-up for construction contractor's overhead and profit, which is within the normal range of costs for projects of this cost magnitude.

An additional 15 percent is included for professional fees for engineering, geotechnical, legal, administrative services, and other minor technical services which would be necessary for the design, property acquisitions, and contract administration necessary for the projects considered in this study.

The cost estimate includes construction costs, salvage value, annual operations, and annual maintenance costs calculated to a present worth value based on annual cost of borrowed money at 6.5 percent interest and escalation (i.e., inflation) of annual operation and maintenance, including electricity, costs at a rate of 3.4 percent per annum over a period of 20 years. Neither salvage value nor inflation rates were considered in the EIR/EIS cost estimates.

The cost estimates are based on several assumptions, many of which are listed as footnotes in the tables. The significant assumptions used in preparing the estimated costs are included below for convenient reference:

Construction Costs

- Costs are based on project components, facilities, and alignments identified in Chapters 2 and 4.

- The pipeline sizes used in each of the alternative projects are based on the recommended selections for best pipe size presented in Chapter 4.
- The cost estimates are based on the Engineering News Record (ENR) Construction Cost Index (CCI) for San Francisco as of 31 March 1997 (6646.13).
- The unit costs used for pipeline construction were taken from cost curves prepared specifically for this project and presented in Appendix E-1 of this report. Unit prices obtained from the curves were rounded to the nearest \$5 for use in the cost tables. The presumptions made in preparing these tables are:
 - For alignments A-1 and B-1:
 - Average depth of cover over the pipe of 5 feet.
 - Excavation is in normal soft ground conditions, no blasting.
 - Pipelines are installed near or along the edge of pavement in public rights-of-way to the maximum extent possible. Therefore, sawcutting of pavement is required on one side only of the trench for 85 percent of the total pipeline length and along both sides of the trench for 15 percent of the total pipeline length.
 - Dewatering is required for 25 percent of the pipeline length.
 - Pavement restoration and associated trench backfill and compaction are constructed to County of Sonoma Standards.
 - For alignments A-2 through A-4 and B-2 through B-4:
 - Average depth of cover over the pipe of 5 feet.
 - Excavation of pipe trench in rock requiring blasting occurs in 40 percent of the pipeline length.
 - Sawcutting on both sides of the pipe trench was assumed for 15 percent of the total segment (e.g., A-2) length.
 - No dewatering is required for any part of the work.
 - Native material is used in the trench above the pipe zone, to the surface or, where applicable, to any pavement base material.
- The estimates utilized surge anticipation valves and increased size of storage tanks to accommodate "blow back" as discussed in Chapter 4 and Appendix C-3 on Surge Analysis.

O & M Costs

- The annual O&M cost for the pipelines was based on the assignment of a two-person crew, full time, to maintain the Geysers pipeline. Labor costs for the crew were assumed to be \$70,000 per person per year, including employee benefits and other overhead costs. An additional markup of 10 percent of the labor costs per annum was included to account for repair and replacement costs and other direct costs (ODCs). Costs were distributed to each pipeline section in proportion to its length of the total pipeline. These costs are higher than those presented in the EIR/EIS for maintenance activities due to use of different methodologies.

- The annual O&M costs for the pump stations were based on a three-person crew (one laborer, one mechanic, and one electrician) assigned full time to maintain the Geysers pump stations. The pump station maintenance crew would also be responsible for routine inspection and maintenance of the cathodic protection system installed in the reservoirs. Average labor costs for the crew were assumed to be \$80,000 per person per year, including employee benefits and other overhead costs. An additional markup of 20 percent of the labor costs per annum was included in the 5 mgd flow scenario to account for repair and replacement costs and other direct costs. This markup for materials and parts was increased to 25 percent for the 11 and 18 mgd flow scenarios to reflect their increased size and number of units, etc., and consequently their increased needs compared to the 5 mgd pumping stations. In addition, the labor cost for the 11 and 18 mgd flow scenarios was increased 20 percent over that used for the 5 mgd flow scenario to reflect the installation of four pumping units at each of the stations for the larger flow scenarios compared to only three pumping units at each station for the 5 mgd flow scenario. The annual costs were distributed equally among all four pump stations in each alternative. In summary, the pump station O&M costs were assumed to be equal for the 11 and 18 mgd flow scenarios, equal for both alignments for the same flow scenario, and equal for all pump stations in the same flow scenario.
- Electrical costs for operation of the pump stations are based on the rate forecast to be in effect after deregulation in the year 2002, which results in an average unit power cost of \$ 0.041 per kWh. Annual electrical operating costs were determined based on a linear incremental increase in power consumption per year from project initiation to project buildout as a function of the increase in generated average daily flows. For the 5 mgd flow scenario used, average daily flow (and electrical cost) was similar at project buildout and project initiation. For the 11 mgd flow scenario, the flows increased from 9 mgd at initiation to 11 mgd at buildout. For the 18 mgd flow scenario, the values were 10 and 18 mgd, respectively. The electrical costs presented in Chapter 4 were based on project buildout flows, and consequently electric demand. Electrical consumption and costs at project initiation were assumed to be in direct proportion to the flows. For example, electrical costs at project initiation for the 11 mgd flow scenario were assumed to be 9/11 of the costs presented in Chapter 4 for the same system element.
- The annual O&M cost for the steel storage reservoirs was based on a three-person crew at the same rates per person as for the pipeline, but for a period of only 1 week per tank per year. The cost includes \$5,000/ year per reservoir for painting every ten years and a markup for parts, materials and other ODCs calculated at 10 percent of the labor costs. The O&M costs for the 2 storage reservoirs located at the terminus of the Geysers Pipeline, were included in the reservoir O&M costs associated with Pump Station A/B-4.
- The cost estimates include no off-setting revenue income from the sale of reclaimed water or from the value of electric power produced at the Geysers as a result of injection of recycled water from this project. However, there are scenarios that show a present worth value if the Geysers steamfield and/or power plant operators pay for electric costs for pumping at pump stations A/B-2, A/B-3, and A/B-4.

Present Worth Analysis

- Using the total project costs from the above mentioned tables and the O&M costs, derived as discussed above, a present worth economic analysis was prepared to

compare the two alignments (A and B) for the three flow scenarios (5, 11 and 18 mgd). The parameters used for the Present Worth analysis are:

- Time Period - 20 years
- Interest rate - 6.5%
- Inflation Rate - 3.4% annually
- Depreciation - Straight line
- The useful life of the project components was assumed to be:
 - Pipelines and appurtenances - 40 years
 - Pump station structural - 40 years
 - Pump station electrical, mechanical and ICM - 20 years
 - Water storage reservoirs (steel) - 40 years
- Salvage values were based on estimated construction costs, including the 25 percent contingency. In determining the salvage value for pipeline, reconstruction of Pine Flat Road was excluded. The salvage value of pump station mechanical, electrical and ICM components at 20 years is zero. Utility service fees, pipeline and road easements, pump station sites, and the headworks were assumed to have no salvage value after 20 years. Similarly, no salvage value was taken at the end of the 20 year project study period for the distribution pipeline system within the Geysers steamfields.
- An evaluation of the sensitivity of the present worth values to different inflation rates was performed, using rates of 0, 2.5 and 3.4 percent per annum. The results showed the present worth value of the alignments was not markedly sensitive to inflation in this range.

RESULTS OF PRESENT WORTH ANALYSIS

The construction cost estimates, operation and maintenance cost estimates, and present worth calculations for combined costs are presented in the following tables which are located at the end of this chapter.

Table 6-3. Total Costs, Including Present Worth Values

Table 6-4. Construction Costs

Table 6-5. Operation and Management Costs.

The tables in Appendix E-1 provide more detailed summaries of the construction cost, the annual cost for operation and maintenance and present worth values for the Geysers pipeline alignment Alternatives A and B and for each of the three selected flow scenarios of 5, 11 and 18 mgd, respectively. Also included in Appendix E-1 are tables that detail the costs for pipelines, pump stations, storage reservoirs. Engineering and administrative costs are also presented in these tables and included in the total project costs. Also, included with these tables are the City's share of costs if the Geysers steamfield and/or power plant operators pay for pumping at the last three pump stations in each alternative alignment.

Table 5.0 in Appendix E-1 shows "Land and Easement" costs; these are estimated costs for property (pump stations) and easement (pipelines) acquisition. The cost of an easement is assumed to be the same as the cost per acre for purchase.

Lastly, Appendix E-2 includes a series of cost tables taken from Appendix D-30 of the Draft EIR/EIS to show the original cost estimates for the Geysers Recharge Alternative.

CONCLUSIONS

- As shown in Table 6-3, each of the scenarios listed therein is less costly than the EIR/EIS Geysers Recharge Alternative. The scenario closest in cost to the EIR/EIS Alternative is the "B-18" scenario, with 18 mgd flow along the Pine Flat route; even this has a Total Present Worth of \$191 million compared to \$282 million for the EIR/EIS Alternative (both costs based on 0% inflation without consideration of salvage values).
- The primary cost savings are in pipeline and pump station costs and decreased electric rates; storage reservoir costs and maintenance costs actually increased.
- As shown in Table 6-5, the annual electricity cost for pumping decreased about 60% from the EIR/EIS Alternative to the "B-18" scenario, but this savings has been offset slightly by an increased estimate for maintenance and other non-electric O&M costs.
- Based on the total present worth costs in Table 6-3, the cost, for scenarios using Alignment A (cross-country alignment) is less than for the scenarios using Alignment B (Pine Flat Road). As shown in Table 6-1, the differences in all cases, however, are relatively small, and, for the flow scenarios studied, are not considered significant.

Table 6-1

Cross-Country Alignment Savings

Flow Rate	Savings of Cross-Country Alignment over Pine Flat Road Alignment ¹
5 mgd	8.9%
11 mgd	7.4%
18 mgd	7.0%

1. Present Worth Values based on 3.4% inflation with salvage

- If the Geysers steam field and power plant operators pay for pumping costs from the base of the Mayacamas to the Geysers steamfields, annual O&M costs for the City would decrease by about 70%.
- As shown in Table 6-2, the Alignment A (cross-country) scenarios are estimated to cost less on a present worth basis per 1000 gallons of reclaimed water delivered over the life of the project. Also, the lower flow scenarios are estimated to cost more per gallon of

water than the higher flow scenarios. These data should be considered rough indicators only; differences of less than 15% should not be considered significant at this stage of project development.

Table 6-2

Comparison of Scenarios by Cost per Gallon

Scenario	Millions of Gallons over 20 years	Present Worth (3.4% inflation with salvage values; in \$1,000s)	Present Worth Cost per 1,000 Gallons over 20 years
A-5	32,000	\$116,700	\$3.65
A-11	65,000	\$155,800	\$2.40
A-18	93,000	\$188,100	\$2.02
B-5	32,000	\$128,100	\$4.00
B-11	65,000	\$168,300	\$2.59
B-18	93,000	\$202,200	\$2.17

Table 6-3

Geysers Cost Reduction Project Cost Estimate Present Worth Analysis Total Costs

All Costs are in \$1,000's

Alternative/Scenario ¹	Capital Costs				Present Worth w/Salvage ²	O&M	Total Present Worth Costs		Present Worth Savings to City from Industry Contribution ⁵
	Construction Costs ²	Engineering and Technical ³	Land ⁴	Total		Annual O&M ^{2,7}	@ 3.4% inflation w/Salvage ²	@ 0% inflation w/o Salvage ²	
EIR/EIS Alternative:									
"B-23"	\$180,907	\$27,136	\$209	\$208,252	NA	\$6,683	NA	\$281,885	NA
Project Costs borne entirely by City:								\$106,500	
A-5	\$81,200	\$12,200	\$600	\$94,000	\$89,200	\$1,900	\$116,700	\$115,100 ⁸	NA
A-11	\$97,600	\$14,600	\$600	\$112,800	\$106,600	\$3,200	\$155,800	\$150,100	NA
A-18	\$114,500	\$17,200	\$600	\$132,300	\$124,600	\$3,400	\$188,100	\$179,600	NA
B-5	\$94,500	\$14,200	\$200	\$108,900	\$103,300	\$1,700	\$128,100	\$127,900	NA
B-11	\$114,700	\$17,200	\$200	\$132,100	\$124,600	\$2,800	\$168,300	\$165,200	NA
B-18	\$135,000	\$20,300	\$200	\$155,500	\$146,100	\$3,000	\$202,200	\$191,300	NA
Shared Project Cost Scenario- City's Contribution:⁶									
A-5	\$81,200	\$12,200	\$600	\$94,000	\$89,200	\$600	\$98,600	\$101,200	\$18,100
A-11	\$97,600	\$14,600	\$600	\$112,800	\$106,600	\$900	\$119,600	\$122,700	\$36,200
A-18	\$114,500	\$17,200	\$600	\$132,300	\$124,600	\$900	\$139,500	\$143,500	\$48,600
B-5	\$94,500	\$14,200	\$200	\$108,900	\$103,300	\$600	\$112,500	\$116,000	\$15,600
B-11	\$114,700	\$17,200	\$200	\$132,100	\$124,600	\$900	\$137,500	\$141,900	\$30,800
B-18	\$135,000	\$20,300	\$200	\$155,500	\$146,100	\$900	\$160,800	\$165,800	\$41,400

¹ Alternatives are described by alignment and flow rate. For example, A-5 represents alternative alignment A and an average flow rate of 5 mgd.

² Detailed costs are found on Tables 6-4 and 6-5. Assumes zero salvage value for land, headworks and Geysers distribution system after 20 years.

³ Engineering, Technical, Legal, and Administrative costs are projected to be 15% of construction costs.

⁴ Detailed land cost estimates are found on Table 6.0 in Appendix E-1.

⁵ Industrial (geothermal operators) contributions to project cost represent the present worth cost of electricity for all pump stations except for either A-1 or B-1, including inflation (3.4%).

⁶ The shared project cost scenario assumes that the geothermal operators will pay for all electric costs related to pumping except for pump stations A-1 or B-1.

⁷ Annual O&M costs are at buildout for the EIR/EIS alternative and at initiation for cost reduction scenarios.

⁸ Correction.

Table 6-4

Geysers Cost Reduction Project Cost Estimates Construction Cost

All costs are in \$1,000s

Alternative/Scenario	Pipeline	Pump Station	Storage Reservoirs		Geysers Distrib. System ⁽²⁾	Utility Services ⁽³⁾	Headworks	Total	Total with +25% contingency
			Pump Sta.	Terminus ⁽¹⁾					+15% overhead
EIR/EIS Alternative:									
"B-23"	59,199	35,190	1,800		17,200	15,045	790	129,200	180,900
Alternative Alignment A									
A-5	24,190	6,550	970	430	10,000	15,045	790	58,000	81,200
A-11	31,760	8,400	1,040	640	12,000	15,045	790	69,700	97,600
A-18	39,500	9,120	1,480	850	15,000	15,045	790	81,800	114,500
Alternative Alignment B									
B-5	33,610	6,500	1,130	430	10,000	15,045	790	67,500	94,500
B-11	43,510	8,380	1,520	640	12,000	15,045	790	81,900	114,700
B-18	53,720	9,270	1,690	850	15,000	15,045	790	96,400	135,000

(1) Cost of terminus reservoirs (@end of Geysers transmission pipeline) in EIR/EIS alternative included in cost for Geysers distribution system.

(2) Costs for all flow scenarios provided by Unocal Corp.

(3) Communication w/ PG&E indicates negligible savings for smaller flow scenarios.

Table 6-5

Geysers Cost Reduction Project Cost Estimate Operation & Maintenance Costs

All costs are in \$1,000's

Alternative/Scenario	Annual Non-Electric Costs	Annual Electric Costs ¹	Annual Total ¹	Present Worth 3.4% Inflation	Present Worth 0% Inflation
EIR/EIS Alternative:					
"B-23"	100	6,583	6,683	N.A.	83,633
Project Costs borne entirely by City:					12,400
A-5	490	1,420	1,910	27,500	21,060 ³
A-11	570	2,580	3,150	49,220	37,300
A-18	570	2,830	3,400	63,520	47,250
B-5	480	1,240	1,720	24,760	18,970
B-11	560	2,240	2,800	43,670	33,100
B-18	560	2,460	3,020	56,140	35,750
Shared Project Cost Scenario- City's Contribution:²					
A-5	490	160	650	9,360	7,170
A-11	570	300	870	12,990	9,900
A-18	570	340	910	14,860	11,210
B-5	480	160	640	9,220	7,060
B-11	560	300	860	12,850	9,790
B-18	560	340	900	14,720	10,270

¹ Costs are at buildout for the EIR/EIS alternative and at initiation for cost reduction scenarios.

² If geothermal industry partners pay pumping costs for pump stations A/B-2, A/B-3, and A/B-4.

³ Correction.

7 PUBLIC REVENUES AND SOCIO-ECONOMIC EFFECTS

PURPOSE

The purpose of this chapter is to estimate the type and scale of public revenues to be derived from the Geysers scenarios and to estimate the service charges, demand fees, and regional socio-economic costs and benefits associated with the scenarios.

PUBLIC REVENUES

Introduction

The reclaimed water injected into the steamfield will be converted to steam which in turn will generate energy. The energy will be sold to PG&E at contractual prices. The gross value of the steam power produced will determine the amount of royalties paid by UNOCAL to the owners of the mineral or sub-surface rights in the Geysers field. The Sonoma County Assessor's office estimates the annual property taxes owed by UNOCAL based on an income approach applied to the net operating revenue. The following sections describe the assumptions behind the public revenue calculations.

Assumptions Regarding Energy Production

Determining how a given amount of reclaimed water injection is converted to steam power involves a complex set of assumptions. These assumptions include how many wells are injected, how the reservoir responds to the injected water, how long it takes to receive a benefit from the injection, what the net mass recovery rate is (percentage of water that is converted to steam power), how the benefit is distributed over the Geysers field and many other factors related to geothermal science. For the purposes of this analysis, assumptions provided by UNOCAL regarding these relationships were used. While there is no certainty that these assumptions will prove to be accurate, they represent a reasonable basis for analysis and comparison of the three injection scenarios.

Conversion Rates for Injected Water to Steam

UNOCAL has prepared estimates of the anticipated average potential generating capacity that results from the three injection flowrates. UNOCAL used their geothermal energy production model to estimate that on average over the 20-year study period a 5 mgd injection rate could produce 50 MW of power, an 11 mgd injection rate could produce 85 megawatts (MW) of power, and an 18 mgd injection rate could produce 120 MW of power.³ UNOCAL's estimates assume conversion rates that range between 40 and 60 percent for the three injection scenarios.

A similar study prepared as part of the Lake County Sanitation District (LACOSAN) Southeast Geysers EIR used an average mass recovery rate of 37 percent based on an injection rate of 7.78 mgd and a production increase averaging

³ Letter from Doug Hackley of UNOCAL Corporation dated April 24, 1997.

50 MW.⁴ Therefore, the implied UNOCAL recovery rates for the central and northwest portion of the Geysers field in Sonoma County are consistent with the assumptions for the LACOSAN project.

According to staff with the State Lands Commission Mineral Resources Management Division, field experience and industry studies suggest that there are risks associated with large scale injection projects. Specifically, that under the wrong conditions, injected water can flood producing wells before boiling and converting the injected water to steam. However, field operators are now confident of being able to control these conditions. "They know the tremendous heat energy in the reservoir has hardly been tapped -- though reservoir pressures have fallen over the past 35 years of production, reservoir temperatures have not. Depending on the rock porosity, the steam in a reservoir, may contain just one percent of the heat present in the system, while the other 99 percent is in the rock itself. By comparison, in hot water reservoirs 20 percent of the heat is in the water and 80 percent is in the rock. Therefore, the prospects for heat mining at The Geysers through supplemental water injection appear to be very good."⁵

The results of this study are highly dependent on several key assumptions. Specifically the following issues should be considered when reviewing the results of the public revenue analysis.

Average Increase in Power/Recovery Rates. The Geysers operators have reported that the rate of energy production from the Geysers is declining over time. Reclaimed water injection is expected to reduce the rate of decline and allow the Geysers to remain productive for a longer period of time. To the extent that the actual recovery rates vary from those projected by UNOCAL, actual net potential energy production may also vary.

Economic Life of the Geysers. This analysis assumes that under all three scenarios it remains economic to keep operating the wells at the Geysers field for the entire 20-year study period. The point at which it will become uneconomic to operate the Geysers will depend on a variety of factors including energy prices, Geysers production rates without the reclaimed water injection, and the maintenance and operating costs of the pump stations. The production rates provided by UNOCAL suggest that there are diminishing returns as more water is injected. If, for whatever reason, the economic life of the Geysers fields under one of these scenarios terminates before all the capital costs of building pipelines and pump stations are fully amortized, it would significantly reduce or eliminate the public benefits derived from that scenario.

Energy Pricing and Curtailment Assumptions. The price that PG&E, the current Geysers power plant operator, pays UNOCAL for the steam power is based on a contractual agreement that uses a formula tied to average annual changes in the Consumer Price Index (CPI), the Producer Price Index (PPI) for crude oil and the PPI for natural gas. PG&E pays UNOCAL based on the amount of electricity actually produced using the delivered steam. The agreement between PG&E and UNOCAL allows PG&E to curtail electrical generation (hence also steam production) up to a maximum of 75 percent per month or 60 percent per year. PG&E curtails energy generation when the market prices for electricity are lower than the current PG&E-UNOCAL price (\$19.19 per MWh in 1997).

4 Letter from Doug Hackley of UNOCAL Corporation dated May 21, 1997.

5 Royalty and Other Issues Related to Geysers Recharge Alternative, prepared by the State Lands Commission Mineral Resources Division, May 1, 1997.

Recently, UNOCAL and PG&E have negotiated a contract that offers an incentive for PG&E not to curtail energy production. Specifically, energy sold by UNOCAL to PG&E beyond the contract minimum of 25 percent per month is offered at a discount, while all steam up to the contract minimum is priced at the full contract price. So lower average prices may be made up by higher steam production levels.⁶ For the purposes of this analysis it was assumed that on average PG&E will purchase 65 percent of the steam power produced from the reclaimed water injection. The 1997 PG&E contract price for steam power was used to project future revenues, thereby assuming that steam prices do not change more or less than the CPI over time⁷. Significant changes in steam prices and in the curtailment factor could significantly alter the results of the public revenue study.

The Effects of Public Utility Deregulation. Beginning in January 1998, PG&E may no longer be the sole purchaser or retailer of energy in northern California. Lower cost producers will be able to compete for customers throughout PG&E's customer service area. The effect of deregulation on the price paid to UNOCAL for their steam power is very difficult to predict. For the purposes of this study the current relationship with PG&E is assumed to continue throughout the 20-year study period. In reality UNOCAL may negotiate entirely different contracts with other power companies in the future which could alter the results of this public revenue study.

Results

For the purposes of providing order of magnitude estimates, and to enable a comparison to be made among the three injection scenarios, a number of simplifying assumptions were made as described above regarding energy production, energy pricing, and amounts of energy actually sold over the 20-year study period (Table 7-1). The following sections describe the methodology used to estimate property tax and royalty revenues.

Property Taxes

According to the Sonoma County Assessor's Office the valuation of Geysers properties for the purposes of assessing property taxes is a complex process. Under Proposition 8 the assessed valuation of energy producing property, which includes Geysers, is based on the lower of either (1) the base year valuation or selling price, or (2) the current market value. The base year valuation is the selling price. Since most of the Geysers land was sold/purchased when energy prices were much higher than they are currently, the current market value is generally used to assess property value, using the income approach. The base year valuation acts as an assessment ceiling.

A sophisticated economic model, relying on a complex set of assumptions and data, is required to ascertain the discounted net future earnings of Geysers property. Factors such as energy prices, changing technology and operating costs, the active life-span and declining yield rates of the Geysers, and contractual agreements with steam purchasers (e.g., currently PG&E), are used to determine annual net income. In order to provide an order of magnitude range of possible public revenues

⁶ Royalty and Other Issues Related to Geysers Recharge Alternative, prepared by the State Lands Commission Mineral Resources Division, May 1, 1997.

⁷ While PG&E retail energy prices are assumed to decline over time as described in Chapter 5, the price of steam is established through a contractual relationship between PG&E and UNOCAL. Since there is currently no evidence to suggest how this contractual relationship could change in the future, the existing contractual relationship is assumed to remain constant for the purposes of this public revenue analysis.

generated by the reclaimed water recharge scenarios a number of simplifying assumptions have been made.

The net increase in generating capacity based on UNOCAL's estimate for the three injection scenarios was multiplied by an estimate of the number of producing hours in a year, based on a 65 percent curtailment rate, to determine the average annual number of megawatt hours (MWh) resulting from the reclaimed water injection. The number of MWh are multiplied by the current contract price for energy to derive the average annual gross value of steam power (Table 7-2).

UNOCAL estimates that the operating costs for the injection wells will range between \$200,000 and \$500,000 per year for well and pipeline maintenance within the Geysers field.⁸

Since reclaimed water will be injected into the wells by gravity, annual operating costs for injection do not include pumping. Net annual income from steam power produced from the reclaimed water injection was estimated assuming annual operating expenses of \$350,000.

The annual income derived from the steam power produced is then multiplied by the property tax rate of one percent to derive annual property taxes. Sonoma County receives approximately 32 percent of all property taxes collected in the Geysers field (Table 7-2).

Royalties

A variety of contractual relationships exist between Geysers operators, Geysers property owners, and geothermal energy producers. State, federal or private entities hold ownership rights to the subsurface mineral rights and they collect royalties from Geysers operators. The royalties or rents paid to private owners do not directly generate tax revenue for the County, State or federal governments. Federal royalties are shared with the State Energy Resources Conservation and Development Commission (50 percent of gross royalty revenues) of which 40 percent are paid by the State to the local County of origin. Therefore, the County receives 20 percent of the federal royalty revenue generated in the Geysers field in Sonoma County. The remaining 50 percent of federal royalties are collected by the U.S. Treasury. The royalties generated on State leases are paid directly into the State Teachers Retirement Fund.

In the central and northwest portion of the Geysers field where most reclaimed water from a Santa Rosa pipeline would be injected, the majority of the ownership is private, with the remainder being held by the State of California (the State Lands Commission), and the federal government (the Bureau of Land Management). UNOCAL and Calpine combined hold nearly all the leases. It is estimated that on a field-wide basis that UNOCAL pays on average a 12 percent royalty on every pound of steam produced from the private, state and federal leases.⁹ While it is difficult to describe the precise relationship between where the reclaimed water is injected and where the benefit of the injection is actually produced, UNOCAL has estimated that steamfield production benefits will be approximately in the same

⁸ Letter from Doug Hackley of UNOCAL Corporation dated May 21, 1997.

⁹ Royalty and Other Issues Related to Geysers Recharge Alternative, prepared by the State Lands Commission Mineral Resources Division, May 1, 1997.

Table 7-1

Summary of Public Revenues

Flow/Injection Rate (mgd)	Factor	5 mgd	11 mgd	18 mgd
Avg. Increase in Power (MW)		50	85	120
Avg. Annual Value of Steam Power		\$5,463,393	\$9,287,768	\$13,112,143
Avg. Annual Property Taxes		\$51,134	\$89,378	\$127,621
Avg. Annual Public Royalties		\$321,248	\$546,121	\$770,994
Total Avg. Annual Public Revenues		\$372,381	\$635,498	\$898,615
Total Property Taxes over 20-year Study Period		\$1,022,679	\$1,787,554	\$2,552,429
Total Public Royalties over 20-year Study Period		\$6,424,950	\$10,922,415	\$15,419,880
Total Public Revenues over 20-year Study Period		\$7,447,629	\$12,709,969	\$17,972,309
PV of Total Public Revenues	8.50%	\$3,523,971	\$6,013,936	\$8,503,901
County's Share of Property Taxes (over 20-years)		\$327,257	\$572,017	\$816,777
County's Share of Royalties (over 20-years)		\$445,813	\$757,882	\$1,069,951
County's Share of Total Public Revenues (over 20-years)		\$773,070	\$1,329,899	\$1,886,728
PV of County Share of Public Revenues	8.50%	\$365,791	\$629,264	\$892,737

Sources: Bureau of Land Management, State Lands Commission, Sonoma County Assessor's Office and Auditor's Office, and UNOCAL.

Table 7-2

Estimate of Property Tax Revenues (Constant \$1997)

Flow/Injection Rate (mgd)		5 mgd	11 mgd	18 mgd
Avg. Increase in Power (MW) (1)		50	85	120
Hours per Year	8,760			
Curtailment Factor (2)	65.00%			
Price of Energy (MWh) (3)	\$19.19			
Avg. Annual Value of Steam Power		\$5,463,393	\$9,287,768	\$13,112,143
Avg. Annual Operating Expenses		\$350,000	\$350,000	\$350,000
Avg. Net Income from Steam		\$5,113,393	\$8,937,768	\$12,762,143
Avg. Annual Property Taxes (4)		\$51,134	\$89,378	\$127,621
Tax Rate Allocation for Sonoma County	32.00%			
Avg. County Share of Property Taxes		\$16,363	\$28,601	\$40,839
Total Property Taxes over 20-Year Study Period		\$1,022,679	\$1,787,554	\$2,552,429
Total County Share of Property Taxes over 20 years		\$327,257	\$572,017	\$816,777
PV of Total Property Taxes	8.50%	\$483,898	\$845,811	\$1,207,725
PV of County Share of Property Taxes	8.50%	\$154,847	\$270,660	\$386,472

(1) Average increase in power provided by UNOCAL (letter dated April 24, 1997).

(2) PG&E is obliged under their contract to purchase a minimum of 40 percent of power produced per year by UNOCAL. Historically PG&E has curtailed about 25 to 40 percent of the capacity.

(3) The 1997 sales price of steam which PG&E is required to buy from UNOCAL.

(4) Property taxes are estimated on the net operating income derived from the steam power.

The property tax rate is equal to 1.00 percent of the Assessed Value.

Sources: UNOCAL, State Lands Commission, Sonoma County Auditor's Office and Assessors Office.

Table 7-3

Estimate of Royalty Revenues (Constant \$1997)

Flow/Injection Rate (mgd)		5 mgd	11 mgd	18 mgd
Avg. Increase in Power (MW) (1)		50	85	120
Hours per Year	8,760			
Curtailment Factor (2)	65.00%			
Price of Energy (MWh) (3)	\$19.19			
Avg. Annual Value of Steam Power		\$5,463,393	\$9,287,768	\$13,112,143
Avg. Royalty Rate (4)	12.00%			
Avg. Annual Royalty Revenues		\$655,607	\$1,114,532	\$1,573,457
Distribution of Royalty Payments				
Federal	17.00%	\$111,453	\$189,470	\$267,488
State	32.00%	\$209,794	\$356,650	\$503,506
Private	51.00%	\$334,360	\$568,411	\$802,463
Total Avg. Annual Royalties		\$655,607	\$1,114,532	\$1,573,457
Avg. Annual Public Royalty Revenues		\$321,248	\$546,121	\$770,994
Sonoma County's Share of Federal Royalties	20.00%			
Average Annual County Share of Royalties		\$22,291	\$37,894	\$53,498
Total Public Royalties over 20-Year Study Period		\$6,424,950	\$10,922,415	\$15,419,880
Total County Share of Royalties over 20 years		\$445,813	\$757,882	\$1,069,951
PV of Total Public Royalties	8.50%	\$3,040,073	\$5,168,125	\$7,296,176
PV of County Share of Royalties	8.50%	\$210,944	\$358,605	\$506,265

(1) Average Increase in power provided by UNOCAL (letter dated April 24, 1997).

(2) PG&E is obliged under their contract to purchase a minimum of 40 percent of power produced per year by UNOCAL. Historically PG&E has curtailed about 25 to 40 percent of the capacity.

(3) The 1997 sales price of steam which PG&E is required to buy from UNOCAL.

(4) Average royalties paid by UNOCAL over the entire steam field as estimated by State Lands Commission.

Sources: Bureau of Land Management, State Lands Commission, UNOCAL.

proportion as the current royalty split in this portion of the Geysers field. According to UNOCAL the current royalty split is as follows: federal 17 percent; State 32 percent; and private 51 percent.¹⁰

The above assumptions were used to estimate the potential royalty public revenues that may be generated by the three reclaimed water injection scenarios for the County, State and federal governments (Table 7-3). All amounts are expressed in constant 1997 dollars unless otherwise stated.

ECONOMIC EFFECTS

This section identifies the effect of the cost reduction scenarios on monthly service charges and demand fees; it analyzes the socio-economic impacts of the change in service charges on the Sonoma County economy; and estimates the employment benefits associated with the various cost reduction scenarios.

Cost Estimates

Table 7-4 presents the assumptions regarding the costs associated with each of the scenarios. As shown, there are three different types of costs; (1) operations and maintenance costs (O&M), (2) disposal costs, and (3) plant improvement costs. The O&M costs refer to the ongoing expenditures associated with operating the geyser alternatives and consist primarily of the electrical expenses to operate the reclaimed water pump stations. The disposal costs are one-time construction costs associated with the required infrastructure, including pipelines, pump stations, and reservoirs. The plant improvement costs are for additional improvements to the existing Laguna Plant to accommodate the disposal needs of new users and are common to each of the EIR/EIS alternatives.

As shown in Table 7-4, the capital and operating costs differ for each of the scenarios. Overall, the one-time disposal costs are higher for Alignment B scenarios than the Alignment A scenarios and increase with the flow rate. The annual operations and management costs (O&M), in contrast, are higher for each of the Alignment scenarios. In addition, the O&M costs are reduced when the geothermal operators pay for a portion of the electricity costs related to the pumping of the reclaimed water. The one-time plant improvement costs for increasing headworks capacity are constant at about \$1.3 million.

The disposal costs and O&M costs are lower for each of the scenarios as compared to the disposal costs of the Geysers Recharge Alternative in the EIR/EIS. It is assumed that development phasing is the same for each scenarios based on the development schedule contained in the EIR/EIS.

Methodology

This analysis uses an economic and financial model that translates the costs described above into estimates of the demand fee (one-time development fee) and monthly service charges required to finance the various scenarios. The model also uses economic input/output factors to assess the relative impact of each alternative on the Sonoma County economy. A detailed print-out of the model is provided in Appendix F.

¹⁰ Letter from Doug Hackley of UNOCAL Corporation dated April 24, 1997.

Table 7-4

Project Cost Data

	Capital Costs			O&M Costs
	Disposal Costs	Plant Costs	Total	
EIR/EIS Geysers Alternative	\$206,982,000	\$1,270,000	\$208,252,000	\$6,683,000
Cross-Country Alignment				
5 mgd	\$92,700,000	\$1,270,000	\$94,000,000	\$1,900,000
11 mgd	\$111,500,000	\$1,270,000	\$112,800,000	\$3,200,000
18 mgd	\$131,000,000	\$1,270,000	\$132,300,000	\$3,400,000
Pine Flat Road Alignment				
5 mgd	\$107,600,000	\$1,270,000	\$108,900,000	\$1,700,000
11 mgd	\$130,800,000	\$1,270,000	\$132,100,000	\$2,800,000
18 mgd	\$154,200,000	\$1,270,000	\$155,500,000	\$3,000,000
Shared Cost Scenarios				
Cross-Country Alignment				
5 mgd	\$92,700,000	\$1,270,000	\$94,000,000	\$600,000
11 mgd	\$111,500,000	\$1,270,000	\$112,800,000	\$900,000
18 mgd	\$131,000,000	\$1,270,000	\$132,300,000	\$900,000
Pine Flat Road Alignment				
5 mgd	\$107,600,000	\$1,270,000	\$108,900,000	\$600,000
11 mgd	\$130,800,000	\$1,270,000	\$132,100,000	\$900,000
18 mgd	\$154,200,000	\$1,270,000	\$155,500,000	\$900,000

O&M Costs are annual costs at project buildout for the EIR/EIS alternative and at project initiation for the cost reduction scenarios.

Calculation of Service Charge and Demand Fee

The methodology used to evaluate the impact of the cost reduction scenarios on monthly service charges and demand fees is identical to that used in the EIR/EIS. The demand fee and service charges are determined by the capital and O&M costs associated with each scenario. The demand fees are based on the costs attributable to new users; the service charges are based on the costs attributable to existing users.

Disposal Costs

The disposal costs are allocated between new and existing users based on each groups' contribution to system-wide disposal need. Table 7-5 illustrates how this allocation is determined. As shown, the system-wide disposal need varies from 3.6 to 5.1 billion gallons annually, based on the amount of reclaimed water that is discharged into the Russian River. The share of the disposal need attributable to existing users, in turn, varies from 45 percent to 54 percent. Likewise, future users generate between 46 and 55 percent of the total disposal need. Disposal costs are allocated accordingly.

As in the EIR/EIS, it is assumed throughout the analysis that the disposal infrastructure is financed with a municipal bond at an interest rate of 6.5 percent. To the extent that outside funding sources are available, such as those discussed further in the following chapter, actual disposal costs may be reduced accordingly.

Operation and Maintenance Costs

The operation and maintenance costs associated with the scenarios are funded through service charges paid by the ratepayers. In addition, costs to be paid by the City have been estimated, should the geothermal operators pay for electrical costs associated with pumping reclaimed water at pump stations A/B-2, A/B-3, and A/B-4.

Plant Improvement Costs

The plant improvement costs are allocated to new users and are thus funded through one-time demand fees.

Income and Employment Calculation

As in the EIR/EIS, the economic impacts associated with reclaimed water are assessed using an input/output (I/O) model. An I/O model tracks the linkages that exist within a local economy to assess the total effect on income and employment from a given economic activity or project. In this analysis, economic multipliers were developed which calculate the impact of a \$1 increase in expenditures for each scenario on total income and employment in Sonoma County.

Table 7-5

Distribution of Project Costs to Demand Fees and Service Charges (in gallons)

	EIR/EIS Geysers Alternative	5 mgd	11 mgd	18 mgd
Distribution of Added Disposal Costs				
Projected Volume of Disposal Need (no conservation)	10,652,000,000	10,652,000,000	10,652,000,000	10,652,000,000
Existing Volume of Disposal Capacity	3,800,000,000	5,000,000,000	4,300,000,000	3,800,000,000
Volume Reduction for Conservation	1,894,000,000	1,894,000,000	1,894,000,000	1,894,000,000
Total Disposal Need	4,958,000,000	3,758,000,000	4,458,000,000	4,958,000,000
Existing Volume of Wastewater in System	7,044,000,000	7,044,000,000	7,044,000,000	7,044,000,000
Existing Users Share of Increased Disposal Capacity	3,800,000,000	4,674,000,000	4,164,000,000	3,800,000,000
Existing Users Volume Reduction from Conservation	1,362,000,000	1,362,000,000	1,362,000,000	1,362,000,000
Existing Users Prior Conservation	700,000,000	700,000,000	700,000,000	700,000,000
Existing Users Disposal Need	2,582,000,000	1,708,000,000	2,218,000,000	2,582,000,000
Projected Volume of Disposal from Growth (no conservation)	2,908,000,000	2,908,000,000	2,908,000,000	2,908,000,000
Future Users Share of Increased Disposal Capacity	0	326,000,000	136,000,000	0
Reduction in Disposal due to Conservation by New Users	532,000,000	532,000,000	532,000,000	532,000,000
Future Users Disposal Need	2,376,000,000	2,050,000,000	2,240,000,000	2,376,000,000
Share to Service Charges (existing users)	52%	45%	50%	52%
Share to Demand Fees (new users)	48%	55%	50%	48%

Table 7-5

Distribution of Project Costs to Demand Fees and Service Charges (in gallons)

Distribution of O&M Costs				
Share to Service Charges	0%	0%	0%	0%
Share to Demand Fees	100%	100%	100%	100%
Distribution of New Treatment Costs				
Share to Service Charges	100%	100%	100%	100%
Share to Demand Fees	0%	0%	0%	0%
Distribution of Nitrogen Removal Costs				
Share to Service Charges	73%	73%	73%	73%
Share to Demand Fees	27%	27%	27%	27%

Benefits:

- The ongoing operation and maintenance expenditures associated with each scenario are calculated as an economic benefit since they generate income and employment in the County.

Costs:

- The reduction in personal expenditures among residents within the service area as a result of the increase in service charges is calculated as a cost. In addition, the reduced agricultural production resulting from the diversion of reclaimed water from the agricultural sector is recorded as an ongoing cost.

Neither the capital costs nor the corresponding demand fees are included in the I/O model's overall assessment of costs and benefits in this analysis. This is because both of these items occur on a one-time basis and therefore will not have an ongoing impact on Sonoma County income or employment.

Impact on Monthly Service Charges

The monthly service charge is determined by O&M costs and by the proportion of disposal need attributable to existing users. As a result, alternatives with higher O&M costs will generate higher monthly service charges. Likewise, alternatives in which existing users generate a high proportion of the total disposal need will also have higher monthly service charges. The disposal need of existing users will vary depending upon the amount of reclaimed water that is discharged into the Russian River, with higher discharge rates corresponding to reduced disposal need and lower charges among existing users.

Table 7-6 shows the additional monthly service charges for the cost reduction scenarios. The EIR/EIS Geysers Alternative generates the highest monthly service charge increment, which is to be expected based on its high O&M costs. Monthly service charges for both pipeline alignments are relatively equal. The monthly service charge declines for each scenario as the discharge level increases. In addition, monthly service charges are reduced substantially if geothermal operators pay for a portion of the electric costs related to the pumping of the reclaimed water. Finally, the estimated monthly service charge increment is highest for the Geysers Recharge Alternative evaluated in the EIR/EIS.

Impact on Demand Fees

Demand fees (one-time hook-up fees) are determined by capital costs and are paid for by new users. The higher the capital costs associated with each alternative the higher the demand fee. In addition, the larger the proportion of disposal need that is attributable to new users the higher the demand fee. Consequently, scenarios in which a higher proportion of reclaimed water is discharged into the Russian River will tend to generate higher demand fees because new users bear a larger responsibility for the total disposal need.

Table 7-7 shows the additional demand fees for selected years. The demand fee decreases for each alignment and flow scenario, except for the EIR/EIS Alternative. This is because the existing demand fee in Santa Rosa is designed to cover the costs associated with a \$180 million reclaimed water disposal project. Specifically, the existing Santa Rosa demand fee includes approximately \$3,650 per equivalent dwelling for such a project. Thus, the

Table 7-6

Incremental Monthly Service Charges (in 1995 \$)

	2000	2005	2010	2017
EIR/EIS Geysers Alternative	\$15.80	\$14.80	\$12.50	\$11.30
Pine Flat Road Alignment				
5 mgd	\$5.70	\$5.50	\$4.60	\$4.30
11 mgd	\$8.10	\$7.60	\$6.40	\$6.00
18 mgd	\$9.70	\$8.90	\$7.50	\$6.90
Cross-Country Alignment				
5 mgd	\$5.30	\$5.00	\$4.30	\$4.10
11 mgd	\$7.60	\$7.10	\$6.10	\$5.80
18 mgd	\$8.90	\$8.20	\$7.00	\$6.50
Pine Flat Road Alignment - Shared Costs				
5 mgd	\$4.90	\$4.60	\$3.80	\$3.50
11 mgd	\$6.70	\$6.10	\$5.00	\$4.50
18 mgd	\$8.20	\$7.30	\$5.90	\$5.20
Cross-Country Alignment - Shared Costs				
5 mgd	\$4.30	\$4.10	\$3.30	\$3.10
11 mgd	\$5.90	\$5.40	\$4.40	\$3.90
18 mgd	\$7.10	\$6.40	\$5.10	\$4.60

negative demand fees shown in Table 7-7 imply that the existing demand fee is more than what would be required under each of the cost reduction scenarios.

A comparison among the cost reduction scenarios shows that the EIR/EIS Alternative generates the highest demand fees, followed by Alignment A and Alignment B scenarios, respectively. This ranking corresponds to the disposal costs associated with each alternative, with higher disposal costs leading to higher demand fees. As mentioned, the demand fees are non-recurring and do not generate additional revenue after the build-out date of 2017.

Table 7-7

Incremental Demand Fees (in 1995 \$)

	2000	2005	2010	2017
EIR/EIS Geysers Alternative	\$1,220	\$750	\$360	<\$100>
Pine Flat Road Alignment				
5 mgd	<\$560>	<\$890>	<\$1,180>	<\$1,510>
11 mgd	<\$310>	<\$650>	<\$930>	<\$1,270>
18 mgd	\$20	<\$340>	<\$630>	<\$980>
Cross-Country Alignment				
5 mgd	<\$980>	<\$1,270>	<\$1,510>	<\$1,800>
11 mgd	<\$790>	<\$1,080>	<\$1,330>	<\$1,610>
18 mgd	<\$520>	<\$830>	<\$1,080>	<\$1,380>
Pine Flat Road Alignment - Shared Costs				
5 mgd	<\$560>	<\$890>	<\$1,180>	<\$1,510>
11 mgd	<\$310>	<\$650>	<\$930>	<\$1,270>
18 mgd	\$20	<\$340>	<\$630>	<\$980>
Cross-Country Alignment - Shared Costs				
5 mgd	<\$980>	<\$1,270>	<\$1,510>	<\$1,800>
11 mgd	<\$790>	<\$1,080>	<\$1,330>	<\$1,610>
18 mgd	<\$520>	<\$830>	<\$1,080>	<\$1,380>

Note: These demand fees include a credit for new users who may pay their demand fee early in the buildout period and have to pay service charges as well.

Combined Socio-Economic Impacts

The implementation of a Geysers alternative will result in a variety of economic costs and benefits. In this analysis, the ongoing economic impacts of the cost reduction scenarios have been combined into a measure that can be used to compare their positive and negative effects on the Sonoma County economy. Table 7-8 describes the primary economic factors relevant to this analysis and the rationale for including or excluding them in a combined economic measure.

Table 7-8

Economic Factors

Cost/Benefit Category	Direct Effect	Included/Excluded from Analysis
O&M costs	Ongoing investment in the operation and maintenance of the project.	Included as a positive effect.
Disposal and plant costs	One-time investment to build the project.	Not included, because it is a one-time expense and will require importing a large share of materials and labor from outside the County. Will also include a shift of labor from other activities.
Reuse of water in steamfields	Expected to result in increasing longevity of steamfields.	Not included. Any monetary value of energy derived from the reuse of the water will first accrue to the steamfield operators and then to the power plant operator (currently PG&E). The value could be passed onto rate payers through lower electrical rates. The benefit of lower rates would accrue to ratepayers in the PG&E service area, unless special rebates are provided to Sonoma County residents.
Attrition of existing agricultural irrigation	Ongoing reduction in crop value from ceasing distribution of water to farmers.	Included as a negative effect. It is assumed that attrition of existing agricultural irrigation will reduce agricultural value in the local economy.
Service charges	Ongoing payments by rate payers to finance the project.	Included as a negative effect. As with any tax, the increase will shift dollars from expenditures and savings. Analysis assumes that 90% of the increased service charge will come from expenditures. As a result, ratepayers will have fewer dollars to purchase goods and services in the local economy.
Demand fees	One-time payment for right to connect to the system	Not included. The cost of the demand fees will be shared among land owners, real estate developers and new homeowners. The degree to which the fee is passed on to new homeowners could result in a negative impact. However, any increase in home prices would also create a windfall for existing homeowners. Overall, due to the one-time nature of demand fees and the changing incidence of the fee, the demand fees are excluded from the analysis.

To measure a combined economic impact of project costs and benefits, economic multipliers for O&M costs, service charges, and agricultural production were developed.

These multipliers estimate the change in both income and employment brought about by a \$1 change in either service charges, O&M costs, or crop production. Because of the variety of economic factors at play, the results are not intended to provide precise estimates of the actual employment or income effects of the cost reduction scenarios.

Income Effects

The impacts of the various scenarios on Sonoma County income are primarily a function of service charges and O&M costs. While increased O&M expenditures generate added income in the County, which are assessed as a benefit, they also generate higher service charges, which are assessed as an economic cost.

Table 7-9 compares the income-related costs and benefits of the scenarios. The impact generated from decline in household expenditures is substantially higher than the impact generated by the increase in O&M costs for each alignment and flow scenario. This result is due to the fact that total service charge payments are higher than total O&M costs (the service charge covers a portion of the debt service for the capital costs as well as O&M costs). The net income effect of the scenarios are calculated by subtracting total costs from total benefits. The total benefits have been adjusted to account for the reduction in economic value that results from the reduction in agricultural irrigation.

The findings illustrated in Table 7-9 suggest that the cost reduction scenarios result in a negative economic impact to Sonoma County. Alignment B scenarios are the most desirable in terms of net economic impact within Sonoma County, followed by Alignment A scenarios and the EIR/EIS Alternative, respectively. However, the difference between the Alignment A and Alignment B scenarios is relatively minor, with the higher O&M costs associated with the former partially offset by the higher capital costs of the latter.

The results shown in Table 7-9 also suggest that the total economic costs associated with each of the scenarios can be reduced if the geothermal operators pay for a portion of the electricity costs related to pumping of the reclaimed water. Specifically, if the geothermal operators pay for electricity costs except for those incurred at pump stations A/B-1, the total economic costs will be cut between 50 and 75 percent for both the Alignment A and Alignment B scenarios.

Employment Impacts

The calculation of the Countywide employment impacts of the scenarios mirror the calculation of the Countywide income impacts. Separate employment multipliers for O&M costs and household expenditures were developed which estimate the change in employment brought about by a \$1 change in either service charges or O&M costs. Increased O&M expenditures generate additional employment in the County, which are recorded as a benefit. However, increased O&M expenditures also lead to higher service charges which reduce household expenditures and ultimately Countywide employment.

Table 7-9 compares the employment impact of the geyser alternatives. As with the income impacts described above, the reduction in Countywide employment generated by the decline in household expenditures is greater than the increased employment resulting from the O&M activities for each alignment and flow scenario. Overall, a negative employment impact is projected for each scenario.

Table 7-9

Regional Economic Effects and Employment (in 1995 \$)

	Regional Economic Effect	Employment
EIR/EIS Geysers Alternative	<\$4,773,000>	<150>
Pine Flat Road Alignment		
5 mgd	<\$2,618,000>	<70>
11 mgd	<\$3,051,000>	<90>
18 mgd	<\$4,259,000>	<120>
Cross-Country Alignment		
5 mgd	<\$2,157,000>	<60>
11 mgd	<\$2,382,000>	<70>
18 mgd	<\$3,459,000>	<100>
Pine Flat Road Alignment - Shared Costs		
5 mgd	<\$1,916,000>	<50>
11 mgd	<\$1,826,000>	<60>
18 mgd	<\$2,894,000>	<80>
Cross-Country Alignment - Shared Costs		
5 mgd	<\$1,327,000>	<40>
11 mgd	<\$882,000>	<30>
18 mgd	<\$1,819,000>	<50>

As is the case for total income, the absolute employment estimates are less reliable than the relative impacts across alternatives. The Geysers Recharge Alternative in the EIR/EIS appears to have the largest negative impact on Countywide employment, followed by Alignment A and Alignment B scenarios respectively. Again, the negative employment impact is substantially mitigated when geothermal operators pay for a portion of the O&M costs.

CONCLUSIONS

- Based on all the assumptions described herein, average annual projected property tax revenues from the reclaimed water injection scenarios are estimated to range from \$51,000 to \$128,000 for the 5 mgd and the 18 mgd injection scenarios respectively. Over the 20-year period property tax revenues are estimated to range from \$1.0 million to \$2.6 million for the 5 mgd and the 18 mgd injection scenarios respectively, before discounting.

- Average annual royalties paid to the federal, State, and County governments are estimated to range between \$321,000 and \$771,000 for the 5 mgd and the 18 mgd injection scenarios respectively. Over the 20-year period total public royalty revenues are estimated to range between \$6.4 million and \$15.4 million for the 5 mgd and the 18 mgd injection scenarios respectively, before discounting.
- The present value of the total projected public revenues, assuming a discount rate of 8.5 percent, are estimated to range between \$3.5 million and \$8.5 million for the 5 mgd and the 18 mgd injection scenarios respectively over the 20-year period.
- Sonoma County's share of estimated projected public revenues ranges from \$773,000 to \$1.9 million over the 20-year study period depending on the scenario. Sonoma County should receive about 32 percent of property taxes generated in the Geysers field and about 20 percent of the federal royalties collected. The present value, assuming a discount rate of 8.5 percent, of the County's share of revenues projected from the Geysers under the three injection scenarios range from \$366,000 to \$893,000 for the 5 mgd and the 18 mgd injection scenarios respectively over the 20-year period.
- The maximum additional monthly service charge was estimated to be \$16 for the EIR/EIS Geysers Alternative. Maximum additional service charges are estimated to range from \$6 to \$10 for the 5 mgd and the 18 mgd injection scenarios respectively. If geothermal operators share a portion of the O&M costs, these same additional monthly service charges would range from \$4 to \$8.
- The maximum additional demand fee is estimated to be \$1,220 for the EIR/EIS Geysers Alternative. The maximum additional demand fee is estimated to range from (\$980) to \$20 for the 5 mgd and the 18 mgd scenarios respectively.
- The cost reduction scenarios are projected to have a negative impact on Sonoma County income and employment levels. This is because the economic costs associated with the ongoing service charges outweigh the economic benefits associated with the ongoing operation and maintenance of the various scenarios. The cross-country alignment scenarios are the most desirable in terms of its net economic impact, followed by the Pine Flat Road scenarios and the EIR/EIS Geysers Alternative respectively.

8 FUNDING SOURCES

PURPOSE

The purpose of this chapter is to identify potential sources of public and private funding, the approximate amount available, and possible limitations associated with each source.

INTRODUCTION

Potential outside sources for funding both the capital and the operation and maintenance (O&M) costs for the Geysers project are described in this chapter. The sources consist of contributions from the geothermal industry and grants, loans, and diverted royalties from state and federal agencies.

A similar project, the Lake County Sanitation District (LACOSAN) Southeast Geysers project is first described, along with the sources used to fund the capital and O&M costs. The Southeast Geysers project, which is under construction and scheduled for completion by August 1997, is designed to convey about 7.8 mgd (5,400 gpm) of a mixture of reclaimed water and surface water approximately 29 miles from the LACOSAN Southeast Regional Wastewater Treatment Plant and Clear Lake to the southeasterly portion of the Geysers field.

The potential sources for funding the City of Santa Rosa Geysers project are subsequently addressed. For purposes of comparison, current conceptual planning for the City's project is based on conveying a range of 5 to 18 mgd (3,500 to 12,500 gpm) of reclaimed water approximately 30 to 34 miles from Delta Pond to the northwesterly portion of the Geysers field.

COMPARISON TO LACOSAN SOUTHEAST GEYSERS PROJECT

Project facilities consist of wastewater collection system improvements, improvements at the LACOSAN Southeast Regional Treatment Plant, and reclaimed water disposal system improvements. The disposal facilities consist of 154,000 lf (29 miles) of 20-inch pipeline (ductile iron and welded steel), six pump stations, one 250,000-gallon flow control tank, steamfield distribution pipelines, and a control system. Facility construction is scheduled to be completed by August 1997.

The pipeline is designed to deliver approximately 5,400 gpm (7.8 mgd) of a mixture consisting of reclaimed water and Clear Lake makeup water (950 acre-feet per year maximum) to the Southeast Geysers for injection; however deliveries up to 6,400 gpm may occur periodically. The pipeline construction required acquisition of easements for traversing 200 parcels. LACOSAN was not successful in obtaining permits for longitudinal encroachment of State Highway 29 right-of-way.

The six pump stations included in the project are located as follows: 1) Clear Lake Intake; 2) Southeast Regional Wastewater Treatment Plant; 3) Middletown Wastewater Treatment Plant (minor 100 gpm discharge into main pipeline); and 4), 5), and 6) between Middletown vicinity and the Southeast Geysers steamfield (1,600 ft combined static lift).

The intake for the pump station at the treatment plant is an open reservoir which has 30 to 45 days of storage capacity.

Approximately 1,800 gpm is to be delivered to each steamfield operator (Northern California Power Agency, UNOCAL, and Calpine) for placement into 16 injection wells. The geothermal operators have constructed the pipelines and improvements within the steamfield.

Funding

The Lake County project cost is approximately \$45 million: \$10 million for the wastewater collection system and treatment plant improvements and \$35 million for the reclaimed water disposal system improvements. In addition the geothermal industry participants funded the construction of improvements within the steamfield. The funding sources are identified below:

- \$18.0 million (\$6.0 million each) from the following geothermal industry participants:
 - Northern California Power Agency (NCPA) (steamfield operator, power plant operator, and pipeline control system operator)
 - UNOCAL/ (steamfield operator-UNOCAL, and the power plant operator-PG&E)
 - Calpine/PG&E (steamfield operator-Calpine, and the power plant operator-PG&E)

Note: The industry paid for approximately 51% of the capital costs (not including improvements within the steamfield, for which they paid 100% of the cost).

- \$16.7 million from the following federal agencies:
 - \$3.5 million from diversion of about 10 percent of the NCPA royalty revenues from Bureau of Land Management to the project. This revenue was made possible by an up front contribution of NCPA to the project for which they will be repaid by reduced royalties of about 10% (or about \$350,000 to \$450,000 per year currently). The diversion of BLM royalty revenues will begin when reclaimed water is first delivered for injection and will continue until deliveries cease. BLM estimates that the injection of reclaimed water will provide the BLM with an additional \$60 million in royalty revenues through 2029.
 - \$7.2 million from Department of Energy geothermal budget through the earmarking of DOE funds by Congress.
 - \$2.0 million grant from Environmental Protection Agency because infrastructure served needy community.
 - \$4.0 million grant from Economic Development Agency because facilities served low income community.
- \$8.0 million from State Water Resources Control Board through a low interest (2.8 percent) State Revolving Fund Loan. The loan is to be repaid by LACOSAN sewer users.

- \$2.0 million from a California Energy Commission (CEC) grant from the Geothermal Resources Development Account; however LACOSAN anticipates that the CEC will be converting a portion of the grant into a loan since the project is being constructed.

Although the State Lands Commission did not participate in project funding, it did provide political support.

Once project facilities are placed into service, annual O&M costs (almost entirely the cost of electricity for pumping), estimated at \$2.2 million, will be shared between the geothermal industry (90 percent) and LACOSAN (10 percent).

POTENTIAL FUNDING FOR CITY OF SANTA ROSA GEYSERS PROJECT

The potential funding sources for the Geysers project considered below are similar to those used in financing the LACOSAN project, excepting the Environmental Protection Agency and Economic Development Agency. Grants from these agencies are not considered likely for the City's Geysers project since, in general, the Laguna Plant service area would not qualify as low income or needy.

Geothermal Industry

Power Plant Operator (Pacific Gas and Electric)

PG&E is currently, the major electrical generator in the area which would benefit most from the injection of reclaimed water. However, PG&E has recently announced that it is intending to sell all of its geothermal facilities. Irrespective, potential power plant operator (whether PG&E or some other entity) participation in a Geysers project could include:

- Sharing in the payment of capital and O&M costs for facilities to convey reclaimed water from the Laguna Plant to the storage tanks above the steamfields.
- Paying (together with the steamfield operators) the capital and operating costs for the steamfield facilities required to distribute the reclaimed water from the storage tanks to the injection wells.

U-N-T

U-N-T¹¹ is the steamfield operator in the area where reclaimed water will be injected. UNOCAL is responsible for managing the steamfields for U-N-T to supply steam to the power plant operator. Potential U-N-T participation in the Geysers project could include:

- Sharing in the payment of capital and O&M costs for facilities to convey reclaimed water from the Laguna Plant to the storage tanks above the steamfields.

¹¹ U-N-T is a partnership between UNOCAL, NEC Acquisition Company, and Thermal Power Co. UNOCAL is the majority stockholder in NEC. Thermal is owned by Calpine. UNOCAL is the managing partner of U-N-T.

- Paying (together with the power plant operator) the capital and O&M costs for the steamfield facilities required to distribute the reclaimed water from the storage tanks to the injection wells.

Potential Contribution

If U-N-T and the power plant operator were to contribute to capital costs the same amount per gallon of water over a 20-year life of the project as the geothermal industry participants do at LACOSAN (\$.00061 per gallon), their contribution would be:

Table 8-1

Potential U-N-T and Power Plant Operator Contributions Based on Delivered Flow

Flow Scenario	Comparable Contribution
5 mgd	\$11,000,000
11 mgd	\$25,000,000
18 mgd	\$41,000,000

There are a number of reasons why industry contributions would differ from those from LACOSAN, including productivity of the geothermal field, size of the project, and others. These calculations provide only a rough scale of potential contribution.

State

California Energy Commission

The California Energy Commission (CEC) offers grants and loans (about \$2 to \$3 million annually) from its Geothermal Resources Development Account for geothermal project planning and implementation. Historically, the maximum grant or loan amount has been \$1 million. Applications for grants or loans can be submitted at any time.

CEC has also been directed by the California Legislature (Assembly Bill 1890) to develop and implement a Renewables Program to support financially existing, new, and emerging electricity generation technologies. As noted in a report which was recently submitted to the legislature, about \$17 million per year will be available in the form of subsidies (\$0.015/kWh maximum; \$1.3 to \$5.3 million for the 5-18 mgd scenarios) for new or expanded existing geothermal, small hydro, digester gas, municipal solid waste, and landfill gas projects. The projects must begin operation by December 31, 2001. The subsidies will be awarded by CEC through a competitive RFP process. The RFP will be issued before January 1, 1998, when initial Program funds become available. Potential CEC participation in the Geysers project could include:

- Providing a grant or loan from the Geothermal Resources Development Account to fund partially the capital costs for facilities required to convey reclaimed water to the steamfields.

- Providing a subsidy from funds authorized by Assembly Bill 1890 to fund partially the capital costs for facilities required to convey reclaimed water to the steamfields.

State Lands Commission

The State of California owns approximately 32 percent of the mineral rights in the leasehold area. The State Lands Commission (State Lands) administers the leases and collects royalties from the sale of either the steam produced or the electricity generated on those leases (depending upon the lease arrangement) for the benefit of the State Teachers Retirement System.

Potential State Lands participation in the Geysers project could consist of approving a reduction in the royalties paid by U-N-T to State Lands to allow U-N-T to partially fund the capital costs for facilities required to convey reclaimed water to the steamfields to extend the longevity of the steam reservoir. The potential level of funding from reduced State Lands royalties would depend on the size of the City's Geysers project and the value that U-N-T and State Lands place on the increased steam production and electricity generation. Such a reduction would require approval of the State Lands Commission (which consists of the State Lt. Governor, Controller, and Director of the Department of Finance), but not the State Teachers Retirement System.

- Potential contributions through royalty reductions.
- Providing political support in securing loans, grants, and geothermal royalty reductions from state and federal agencies, and assisting the City by encouraging financial participation in the project by the geothermal industry.

State Water Resources Control Board, Division of Clean Water Programs

In California, the State Water Resources Control Board (State Water Board) is responsible for implementing the State Revolving Loan Fund (SRF) Program. The purposes of the program include assisting public agencies in financing the construction of facilities necessary to prevent water pollution.

Approximately \$243 million is currently available from the State Water Board in Federal Fiscal Year 1997 (ending September 30, 1997) for low interest (about 3 percent) SRF loans. Although the amount available for loans this year will diminish as projects are approved by the State Water Board, additional loan funds will also become available during each of the next several years.

Although the State Water Board commits loan funds after conceptual approval of the project, loan funds are only distributed when needed up to a current federal fiscal year maximum of \$50 million per year per agency. The maximum annual amount that can be distributed was recently raised from \$5 million to \$50 million per agency and is subject to change annually by the State Water Board based on the availability of loan funds. In order to receive conceptual approval, the City must submit and receive State Water Board approval of a project Facilities Plan (consisting of the CEQA/NEPA documents, a draft Revenue Program, and a Project Report).

Even though the estimated capital cost for the Geysers project could be approximately \$180 million (EIR/EIS estimate), SRF loan funding is still possible. Recently, the State Water Board provided conceptual approval for two large wastewater projects for the following agencies: City of San Jose (\$130 million project, \$50 million distributed this year) and County Sanitation Districts of Los Angeles County (\$206 million project, \$5 million distributed this year).

The City of Santa Rosa Treatment Plant Effluent Disposal project (Project No. 4062-13), which could include the facilities required to implement the Geysers project, is already listed as an eligible project on the FY 1997 SRF Loan Project Priority List. The list, which was adopted by the State Water Board on September 19, 1996, indicates an estimated project cost of \$150 million.

Potential State Water Board participation in the Geysers project could consist of:

Providing a low interest loan to fund, at least a portion of the capital cost of facilities required to convey reclaimed water to the steamfields to enhance electrical generation. Probably a level of funding in similar proportion (flow basis) to the LACOSAN project could be anticipated.

Federal

U.S. Department of Energy

The Department of Energy (DOE) is interested in encouraging projects which would allow for continued electricity generation utilizing a relatively low cost source of alternative energy at existing power plants. The Department has provided the grant for this Cost Reduction Study: \$400,000 was appropriated by Congress; \$335,000 is being utilized by the City of Santa Rosa. Potential DOE participation in the Geysers project could consist of:

- Providing a grant through a Congressional appropriation to partially fund the capital cost of facilities required to convey reclaimed water to the steamfields to enhance electrical generation.

Since DOE does not have an established application process for obtaining grants, the first step in initiating the process is to obtain local Congressional support for an appropriation to partially fund the capital cost of the facilities required to implement a Geysers project.

U.S. Bureau of Land Management

The Bureau of Land Management (BLM) owns approximately 17 percent of the mineral rights in the leasehold area. Consequently, the BLM receives royalties from the sale of steam produced on those leases. Potential BLM participation in the Geysers project could include:

- Approving a reduction in the royalties paid by U-N-T to BLM to allow U-N-T to partially fund the capital costs for facilities required to convey reclaimed water to the steamfields to extend the longevity of the geothermal reservoir. The potential level of funding from reduced BLM royalties would depend on the size of a Geysers project and the value that U-N-T and BLM place on that water.

- Potential contributions through royalty reductions.

CONCLUSIONS

For the LACOSAN project, a project similar to the Geysers Recharge Alternative, 51% of the capital costs and 90% of the O&M costs are funded by the geothermal field operators. The remainder of the capital costs were contributed by the BLM, DOE, CEC, and others.

These same opportunities for funding exist for the Santa Rosa Geysers Recharge Alternative. In addition, new potential options for funding have been identified, namely AB 1890 funds from the CEC and royalty reductions from the State Lands Commission. While the cost of the Santa Rosa project is much greater than the Lake County project, water injection could be substantially greater. More water would be more beneficial to the geothermal industry and should engender proportional increased support and funding from both private and public participants.

RECOMMENDATIONS

- Enter into discussions with interested geothermal industry representatives regarding potential participation in funding the project capital and operating costs.
- Confer with and enlist the support of the State Lands Commission in encouraging the geothermal industry and the interested federal and state agencies to participate in project funding.
- Prepare and submit a State Revolving Loan Fund Facilities Plan to the State Water Board to obtain preliminary loan commitment for up to the full estimated project cost.
- Request Congressional support for grants and/or low interest loans from DOE.
- Request grants and/or loans from the CEC funded from both the Geothermal Resources Development Account and the AB 1890 Renewables Program.
- Request that U-N-T apply to the BLM and State Lands for a royalty reduction to allow diversion of the reduced royalties to a Geysers project to fund capital costs.

9 FUTURE ENVIRONMENTAL DOCUMENTATION

PURPOSE

The purpose of this chapter is to identify future environmental documentation which would be necessary to select one of the cost reduction scenarios discussed in this report as part of the preferred alternative for the Santa Rosa Long-Term Wastewater Project.

ENVIRONMENTAL DOCUMENTATION

Alternative Alignment B along Pine Flat Road is the Geysers Recharge Alternative in the EIR/EIS; no further environmental documentation is required to select a scenario using Alternative Alignment B, because the only difference is smaller diameter pipelines with slightly less environmental effects.. Portions of Alternative Alignment A, the cross-country route, have not been subjected to environmental review, and would require both biological and cultural resources work in order to prepare supplemental environmental documentation for the new alignment. As noted in Chapter 2, a portion of Alternative Alignment A is coincident with Alignment B, so no additional work would be required from pump station A/B-3 to the terminal tanks.

Site Access

For Alternative Alignment A, site access would be necessary for biological surveys. Research into easements in the area has identified 60 properties potentially affected by Alternative Alignment A. An average of about four hours per property owner is assumed for obtaining access. Some property owners may grant access readily, but others will require a greater degree of persuasion, including meetings to make special arrangements for access. It is assumed that formal legal processes will not be required for site access, but there could be additional cost if such a step is necessary.

Biological Surveys

Existing biological surveys, evaluation, and mitigation for the Pine Flat Road alignment will be utilized wherever they overlap with the cross-country alignment. Existing biological resources occurring within the impact area of the new cross-country alignment will be identified and described. Potential impacts, direct and indirect, due to project implementation will be quantitatively defined. Mitigation measures will be developed to reduce the level of identified impacts to less-than-significant. Cumulative impacts of this project with others will be described and mitigation will be developed where necessary.

The area of potential biological impact (project area) of the alignment will be defined. The project area will encompass identified potential direct and indirect impacts for biological resources, known or expected, in the vicinity of the alignment.

Existing documentation pertinent to the biological resources in the vicinity of the alternative alignments will be compiled, reviewed and analyzed. The EIR/EIS will provide the basis for evaluation of Alternative Alignment A where the impact areas overlap. Records of the California Natural Diversity Database will be searched to identify known sensitive species

occurrences within the project area which were not previously identified in existing documentation. Requests will be sent to the U.S. Fish and Wildlife Service, the California Department of Fish and Game and the U.S. Bureau of Land Management to identify resources of concern within the project area.

Field studies will be conducted within the segment of Alternative Alignment A not previously evaluated (approximately eight miles of new cross-country alignment). Sensitive wildlife and plant occurrences and/or potential habitat will be mapped and recorded. A preliminary jurisdictional wetlands determination will be conducted. Plant surveys will be conducted during the appropriate blooming periods. In addition, vegetation will be mapped. Any specialized methodologies recommended by resources agencies that require multiple site visits or specialized equipment are not included within this survey and will be identified and discussed with the City if and when they become necessary. All new resources mapping will be processed through ArcCad and placed in an ArcInfo format for analysis.

A Draft Preliminary Jurisdictional Wetland Determination Report in accordance with U.S. Army Corps of Engineers (Corps) requirements will be prepared and submitted for City review and Corps verification. Changes recommended by the City and the Corps will be addressed in the Final Jurisdictional Wetland Determination.

Additional field studies may be required for project permitting for either Geysers alignment and as an element of impact mitigation. In the event that impacts to Federal or State-listed species are determined to potentially occur due to the project, additional field studies and analysis will be necessary to complete a Biological Assessment.

Cultural Resource Studies

The purpose of the cultural resources studies is to achieve the same level of analysis for Alternative Alignment A that has been completed for Alternative Alignment B as part of the EIR/EIS. The following tasks follow the guidelines and requirements of the California Environmental Quality Act (CEQA, as amended), the National Environmental Policy Act (NEPA), and Sections 106 and 110 of the National Historic Preservation Act (NHPA) of 1966 (as amended), but are intended primarily for CEQA compliance. Detailed field surveys or other studies necessary for Section 106 compliance would be required for either Geysers alignment and are not included here.

A review of site records, reports, and maps kept at the California Historical Resources Information System, Northwest Information Center at Sonoma State University, will be reviewed for the pertinent project area. Information about previous studies and known prehistoric and historic resources in the project area will be gathered, and historic maps examined for evidence of historical use. The National Register of Historic Places, the California Register of Historic Places, the California Points of Historic Interest, and California Historic Landmarks listings will be consulted. Documentation such as histories, historical maps, reports, and overviews will be consulted in order to construct the natural and cultural setting of the project area. In-house sources will be used, and if necessary, research will be conducted at the California Room, California State Library and the Sonoma State University Library. If necessary, records at the Sonoma County Assessor's and Recorder's offices will be consulted.

Contact letters will be sent to interested agencies, groups, and individuals in order to solicit additional information pertaining to the cultural resources of the area. Letters will be sent to the State Historic Preservation Officer, the Native American Heritage Commission,

interested Native American individuals and groups, the Sonoma County Historical Society, and other identified interested parties.

Mitigation developed as part of the EIR/EIS requires detailed preconstruction cultural resources surveys to complete Section 106 compliance requirements, which would be necessary for either Pine Flat Road or the new cross-country route. Costs for this work are included as part of the contingency in the construction cost estimates for both alignments, and are not presented here.

Supplemental Environmental Review

Alternative Alignment B was covered by the EIR/EIS, but should Alternative Alignment A be selected, supplemental environmental review would be required. An Initial Study would be prepared pursuant to CEQA and NEPA to assess environmental impacts associated with the new alignment. The Initial Study/Environmental Assessment would include a project description and identification of impacts associated with the new alignment. Analysis would focus on differences in impacts as compared to the EIR/EIS. A CEQA checklist would be prepared based on the biological and cultural resource studies described above. Results of those studies would be presented in the Initial Study/Environmental Assessment. The cultural resources study and Draft Jurisdictional Wetlands Determination would be included as appendices. Many of the impacts are anticipated to be the same or similar to Alternative Alignment B, and for the purposes of estimating costs it is assumed that no new significant impacts would be identified. The Initial Study/Environmental Assessment would serve as the basis for a supplemental environmental document.

Mitigation Monitoring Program

A mitigation monitoring program would be modified as appropriate for the revised alignment. Any additional mitigation measures identified in the supplemental environmental document would be incorporated.

ESTIMATED COSTS

Table 9-1 provides estimated costs for the work described above.

Table 9-1

Estimated Costs for Supplemental Environmental Documentation of Scenarios Using
Alternative Alignment A - Cross-Country Route

Task	Cost Range	
Site Access	\$10,000	\$40,000
Biological Surveys	20,000	40,000
Cultural Resource Studies	15,000	30,000
Mitigated Negative Declaration/FONSI	25,000	60,000
Mitigation Monitoring Program	2,000	5,000
TOTAL	\$72,000	\$175,000

CONCLUSIONS

No further environmental documentation is required to select a scenario using Alternative Alignment B (Pine Flat Road), because the only difference between these scenarios and the EIR/EIS Alternative is smaller pipeline sizes with slightly less environmental effects.

Supplemental environmental documentation for scenarios using Alternative Alignment A would require site access, biological field surveys, and cultural resources studies. The cost of supplemental environmental review could range from \$72,000 to \$175,000.

It is likely that environmental impacts encountered along the alternative pipeline alignment could be avoided by moving the alignment or mitigated to a level below significance. The environmental document is expected to be reasonably straightforward.

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