Santa Margarita River Conjunctive Use Project

Pre-Feasibility Plan Formulation Study

San Diego County, California

U.S. Department of the Interior
Bureau of Reclamation
Southern California Area Office
Temecula, California

U.S. Department of Defense
Department of the Navy
Marine Corps Base
Camp Pendleton, California

Fallbrook Public Utility District
Fallbrook, California

May 2005

Santa Margarita River Conjunctive Use

Pre-Feasibility Plan Formulation Study

San Diego County, California

Prepared by

U.S. Department of the Interior
Bureau of Reclamation

and

Stetson Engineers Inc.
San Rafael, California

Acknowledgments

This study largely relied on work conducted by Stetson Engineers Inc. and presented in the following reports:

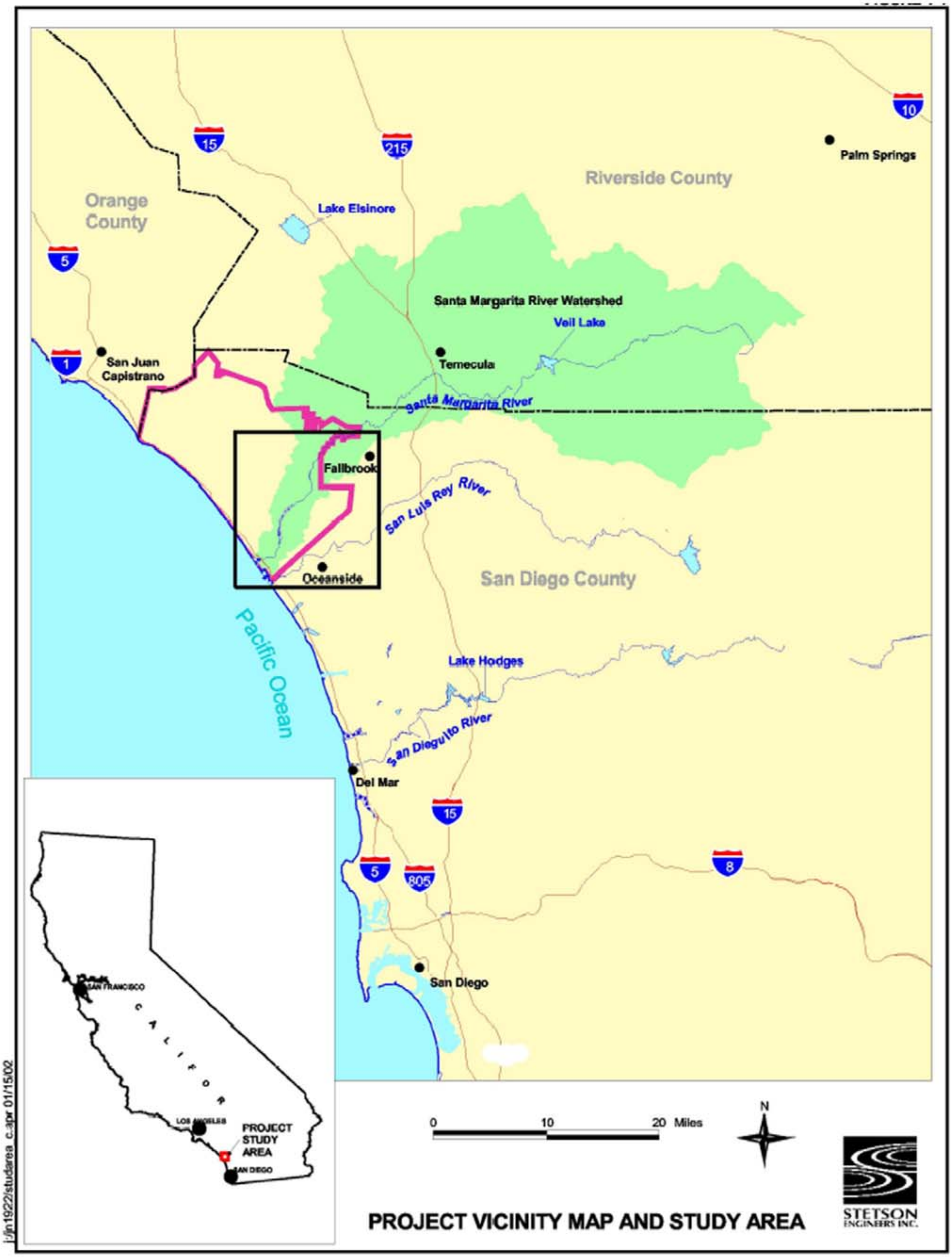
Santa Margarita River Recharge and Recovery Enhancement Program: Permit 15000 Feasibility Study for Marine Corps Base Camp Pendleton, March 23, 2001.

Conjunctive Use Project for the Lower Santa Margarita River Basin, Supplemental Study to the Santa Margarita River Recharge and Recovery Enhancement Program: Permit 15000 Feasibility Study for Marine Corps Base Camp Pendleton, February 2002.

Technical Engineering Report, Constructed Treatment Wetland Feasibility Study, Marine Corps Base Camp Pendleton, California, March 2003.

Draft: Three Dimensional Groundwater Flow Model of the San Mateo and San Onofre Basins, USMC Base Camp Pendleton, September 2004.

Stetson Engineers Inc., was instrumental in the completion of this study by providing assistance in the development of the alternatives and project yields. Stetson also provided valuable support in answering questions and providing technical details to the Bureau of Reclamation engineering team. Their dedication and professionalism is greatly appreciated.



PROJECT VICINITY MAP AND STUDY AREA

Contents

Tables

Figures

Executive Summary

This pre-feasibility plan formulation report compares, at appraisal level, conceptual alternatives to provide additional and/or replacement water supplies to Fallbrook Public Utility District (FPUD) and the Marine Corps Base Camp, Pendleton (Camp Pendleton) in San Diego County, California. This study investigates alternatives that could be constructed to put to beneficial use both naturally occurring streamflow, ground water, and tertiary treated wastewater. The purpose of this report is to provide information needed to select alternatives and/or project elements to be studied at a feasibility level. The information provided herein is to be used for screening purposes only.

The training requirements of Camp Pendleton have not been reviewed in relationship to the identified alternatives in this report. Before the final selection of an alternative during the feasibility process, all military training needs of Camp Pendleton will be reviewed to avoid any conflicts.

Introduction

Authority

In 2003, the Congress directed the Bureau of Reclamation (Reclamation), through Public Law (P.L.) 108-7, "to perform the studies needed to address current and future municipal, domestic, military, environmental, and other water uses from the Santa Margarita River, California." In 2004, the Congress appropriated funds to initiate the study (P.L. 108-137). The purpose of the pre-feasibility study is to evaluate a wide range of alternatives at an appraisal level of analysis to recommend the most attractive alternatives for further study during feasibility. Following completion of the pre-feasibility analysis and report, the feasibility study, public scoping, National Environmental Policy Act (NEPA), California Environmental Quality Act (CEQA), and other compliance will be initiated.

Purpose and Need for Project

The purposes of the project are to help meet water demands of Fallbrook Public Utility District and Marine Corps Base Camp Pendleton, to reduce dependence on imported water while maintaining watershed resources, and to improve water supply reliability by managing the yield of the lower Santa Margarita River basin and perfecting the water rights permits that were assigned to the Bureau of Reclamation in 1974.

Study Area

The study area is located in northern San Diego County and includes the geographic boundaries of the FPUD service area and the United States Naval Enclave, consisting of the Marine Corps Base and Marine Corps Air Station, Camp Pendleton, the Naval Hospital, Camp Pendleton, and Naval Weapons Station Seal Beach, Fallbrook Annex (NWS). Project alternatives address the construction and use of facilities within the boundaries of the Santa Margarita River, the San Mateo Creek, and San Onofre Creek basins.

The Santa Margarita River forms at the confluence of Temecula and Murrieta Creeks and flows southwest through FPUD, NWS, and the Base before it terminates at the Pacific Ocean. The Santa Margarita River basin consists of 744 square miles of drainage area in both San Diego and Riverside Counties. The Santa Margarita River basin may be separated into the "Upper Basin" and the "Lower Basin." The Upper Basin is located in Riverside County and is controlled by the drainage of Temecula and Murrieta Creeks. The Lower Basin is controlled by the 27-mile long Santa Margarita River and contains major tributaries such as De Luz, Sandia, and Fallbrook Creeks. Ground water is found in the alluvial basin located downstream from the confluence of the Santa Margarita River and De Luz Creek and, to a lesser extent, in the shallow alluvium upstream of that confluence.

Legal History and Framework

In the late 1880's, developers of land in the Fallbrook area of North San Diego County formed Fallbrook Water and Power Company, seeking to construct a dam on the lower Santa Margarita River as the source of both water and power for their development. Rancho Santa Margarita, Camp Pendleton's predecessor, filed suit to stop the dam construction, giving rise to more than 100 years of water rights litigation on the river. However, lack of finances and litigation over water rights led to the failure of both the plan and the company.

Many attempts were made over the years to develop a water supply to promote agricultural development in the Fallbrook area. Following years of decisions and appeals, in 1989, FPUD and Camp Pendleton entered into the "Four-Party Agreement" with two upper basin water districts. Finally, on September 13, 2004, Reclamation, Camp Pendleton, and FPUD signed an MOU describing the roles and responsibilities of each party in the completion of the feasibility study of the Santa Margarita Conjunctive Use Project, environmental impact statement (EIS), and environmental impact report (EIR). Reclamation is responsible for completing the feasibility study; Reclamation and Camp Pendleton are joint lead agencies for completing the EIS; and FPUD is lead agency for completion of the EIR.

On November 1, 2004, a Notice of Intent to prepare an EIS was published in the Federal Register. On December 14, 2004, a Notice of Preparation was sent to the California State Clearinghouse.

The project will operate within a legal and institutional framework that includes water rights, water quality standards, protection of Native American trust assets, and, as appropriate, biological and cultural resources protection standards, air quality standards, and California's public trust doctrine.

Water Resources

Alluvium is the principal source of ground water in the lower Santa Margarita River basin. The unconsolidated alluvial deposits are made up of three distinct geologic units: the Upper Alluvium, Lower Alluvium, and Terrace deposits. The Upper and Lower Alluvium are difficult to differentiate; however, the Lower Alluvium is generally more coarse-grained except in the Upper Ysidora sub-basin, where the entire section consists of coarse sand and gravel. These two units are the main ground-water bearing formations. The overlying Terrace deposits consist of older, decomposing partially indurated channel sediments. The total thickness of the alluvium increases downstream from about 120 feet at the De Luz Creek confluence to about 200 feet at the coast.

Downstream from the confluence of Murrieta Creek and Temecula Creek, the Santa Margarita River flows through a narrow, precipitous canyon, downstream to a point below its confluence with De Luz Creek. It then flows onto the coastal floodplain until it eventually drains into the Pacific Ocean. The entire lower basin has a drainage area of approximately 154 square miles, where De Luz Creek is the primary tributary to the Santa Margarita River. De Luz Creek drains a relatively undeveloped 47.5-square-mile watershed, and precipitation runoff comprises virtually all flow in the creek (FPUD, 1994).

Water Requirements

Camp Pendleton provided an assessment of present and future demands that they would apply against water service from the Conjunctive Use Project. The maximum future base-wide demand that Camp Pendleton could place on the pre-feasibility alternatives would be about 18,000 acre-feet per year (af/yr). It should be noted that these quantities do not include the use of recycled water to reduce demand for potable water.

FPUD provided an assessment of present and future demands that it would apply against water developed by the Conjunctive Use Project. The numbers represent maximum potential reductions in imported water that could be realized by FPUD, if the water were available from the conjunctive use project. These demands were based upon actual water use from years 1999 to 2004. Water use within the Fallbrook area is not expected to increase in the future. The maximum future demand that FPUD could put on the pre-feasibility alternatives through corresponding reduction in imports would be about 11,000 acre-feet per year.

Plan Formulation

Numerous studies have been conducted and reports written regarding use of the Santa Margarita River.

In June 2004, Reclamation, FPUD, Camp Pendleton, NWS, Stetson Engineers Inc., and North State Resources conducted a pre-feasibility alternatives development workshop to:

- Refine the purpose and need for the project
- Develop conceptual alternatives for meeting the purpose and need
- Develop criteria for ranking each alternative's capability to meet project objectives.

The purpose and need was developed at that 2-day workshop, and it has been refined during the ensuing months. After the workshop, the alternatives were refined into a summary document by Stetson Engineers Inc. This document was distributed for review to each of the workshop participants and comments were collected. The resulting revised alternatives are those that have been evaluated and presented in this report.

Alternatives eliminated from further consideration include:

- Fallbrook Dam
- De Luz Dam
- On-stream storage on Santa Margarita River
- Seawater desalination
- Exchange alternatives with Oceanside
- Brackish ground-water desalination
- Recovery and recharge of storm water in Murrieta-Temecula ground water basin
- Enlargement of Lake O'Neill

Three major alternative concepts, including 22 sub-set alternatives were evaluated for meeting the project purpose and need. The three major alternative concepts are as follows:

Concept 1—Conjunctive use in the lower Santa Margarita River basin using diversions to existing and new recharge ponds. Concept 1 project facilities include the following:

- Installing an Obermeyer spillway gate diversion structure (replaces existing sheet pile diversion structure)
- Increasing the capacity of O'Neill Ditch from 60 to 200 cfs

- Increasing the headgate capacity at the diversion structure from 60 to 200 cfs
- Rehabilitating five recharge ponds (pond Nos. 1-5)
- Modifying two unused recharge ponds (pond Nos. 6 and 7)
- Constructing new ground-water production wells in the Upper Ysidora and Chappo sub-basins
- Installing a collection system for recovered ground water
- Constructing an advanced water treatment plant
- Constructing new brine disposal line
- Constructing transmission bi-directional pipeline to Fallbrook
- Constructing two pumping plants
- Rehabilitating Lake O'Neill (dredging of sediment)

Modifying recharge pond Nos. 6 and 7 would provide increased infiltration capacity and surface storage. The maximum rate of diversion would be approximately 200 cfs. Improving these facilities would allow for the proper management of flows to Lake O'Neill and the recharge ponds. Increasing winter ground-water pumping rates would create ground-water storage capacity in the aquifer and allow for stream diversions to infiltrate to the aquifer.

Concept 2—Conjunctive use in the lower Santa Margarita River basin using diversions to recharge ponds, diversions, and direct pumping from a sump located near Fallbrook. Concept 2 project facilities include the following:

- Installing an Obermeyer spillway gate diversion structure (replaces existing sheet pile diversion structure)
- Increasing the capacity of O'Neill Ditch from 60 to 200 cfs
- Increasing the headgate capacity at the diversion structure from 60 to 200 cfs
- Rehabilitating five recharge ponds (pond Nos. 1-5)
- Modifying two unused recharge ponds (pond Nos. 6 and 7)
- Constructing new ground-water production wells in the Upper Ysidora and Chappo sub-basins
- Installing a collection system for recovered ground water
- Rehabilitating Lake O'Neill (dredging of sediment)
- Constructing two advanced water treatment plants
    - Haybarn Canyon
    - Red Mountain Reservoir
- Constructing new brine disposal line to the Pacific Ocean
- Constructing an Obermeyer spillway diversion structure at the Fallbrook sump
- Constructing a pumping plant for water from Fallbrook sump
- Constructing a raw water pipeline to deliver water to the Red Mountain advanced water treatment plant

- Constructing a pipeline from Morro Hill to Camp Pendleton (for emergency water supply)

Concept 3—Conjunctive use in the lower Santa Margarita River basin using diversions to recharge ponds in combination with instream check structures constructed in the Chappo basin along the Santa Margarita River. Concept 3 project facilities include the following:

- Constructing four in-stream check structures (in lieu of modifying two unused recharge ponds)
- Increasing the capacity of O'Neill Ditch from 60 to 100 cfs
- Increasing the headgate capacity at the diversion structure from 60 to 100 cfs
- Rehabilitating five recharge ponds (pond Nos. 1-5)
- Constructing new ground-water production wells in the Upper Ysidora and Chappo sub-basins
- Installing a collection system for recovered ground water
- Constructing an advanced water treatment plant
- Constructing new brine disposal line to the Pacific Ocean
- Constructing transmission bi-directional pipeline to Fallbrook
- Constructing two pumping plants
- Rehabilitating Lake O'Neill (dredging of sediment)

The components of the alternatives include improvements to existing facilities and potential new project facilities. A summary of these project features are displayed in table S-1.

Alternative Project Yields

Each pre-feasibility alternative produces a different water yield. For this pre-feasibility study, there are two yield definitions of interest: (1) the amount of water delivered on an average annual basis and (2) the amount of water delivered on a median year basis. Median year yields are important because they indicate that in half of the years, the yield will be greater than the indicated yield and that in half the years, the yield will be less than the indicated yield. Concept 1 develops the largest yield of the three major concepts, with a median year yield of 14,100 acre-feet of water per year. Concept 3 develops the lowest median yield of 12,000 acre-feet per year. Concept 2 develops 12,600 acre-feet per year.

Each of the pre-feasibility alternatives incorporates advanced water treatment. The treatment process will result in an overall process recovery of 85 percent. The objective of advanced treatment would be to produce finished water with total dissolved solids (TDS) of 425 mg/L. The 85 percent process recovery implies that there will be a 15 percent loss in the form of a concentrate that would need to be discharged into the brine line described in the main report. As a result,

Table S-1. Summary table of the alternative features

Description of items	Concept 1									Concept 2				Concept 3								
	1a	1b	1c	1d	1e	1f	1g	1h	1i	2a	2b	2c	2d	3a	3b	3c	3d	3e	3f	3g	3h	3i
Obermeyer spillway gate diversion structure	260 feet	xx	xx	xx	xx	xx	xx	xx	xx	260 ft	xx	xx	xx	—								
Road crossing culvert	200 cfs	xx	xx	xx	xx	xx	xx	xx	xx	200 cfs	xx	xx	xx	100 cfs	xx	xx	xx	xx	xx	xx	xx	xx
Increase O'Neill Ditch from 60 cfs	200 cfs	xx	xx	xx	xx	xx	xx	xx	xx	200 cfs	xx	xx	xx	100 cfs	xx	xx	xx	xx	xx	xx	xx	xx
Consider fish passage	XX	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx									
Increase headgate from 60 cfs	200 cfs	xx	xx	xx	xx	xx	xx	xx	xx	200 cfs	xx	xx	xx	100 cfs	xx	xx	xx	xx	xx	xx	xx	xx
Rehabilitate recharge ponds (nos. 1-5)	49 ac 312 af	xx	xx	xx	xx	xx	xx	xx	xx	49 ac 312 af	xx	xx	xx	49 ac, 312 af	xx	xx	xx	xx	xx	xx	xx	xx
Modify unused recharge ponds (nos. 6-7)	46 ac 242 af	xx	xx	xx	xx	xx	xx	xx	xx	46 ac 242 af	xx	xx	xx									
Flow control between ponds	200 cfs	xx	xx	xx	xx	xx	xx	xx	xx	200 cfs	xx	xx	xx	100 cfs	xx	xx	xx	xx				
Construct production wells, SMR	6 wells	6 wells	6 wells	6 wells	8 wells	7 wells	7 wells	6 wells	4 wells	4 wells	6 wells	7 wells	7 wells	4 wells	4 wells	4 wells	4 wells	6 wells	5 wells	5 wells	4 wells	2 wells
Install collection system for recovered GW	P-068	xx	xx	xx	xx	xx	xx	xx	xx	P-068	xx	xx	xx	P-068	xx	xx	xx	xx				
Construct Haybarn Canyon WTP	29 cfs	29 cfs	29 cfs	29 cfs	33 cfs	30 cfs	30 cfs	30 cfs	29 cfs	21 cfs	22 cfs	23 cfs	23 cfs	25 cfs	25 cfs	25 cfs	25 cfs	29 cfs	27 cfs	27 cfs	27 cfs	25 cfs
May include new brine pipeline for disposal	4 cfs	4 cfs	4 cfs	4 cfs	5 cfs	5 cfs	5 cfs	5 cfs	4 cfs	3 cfs	3 cfs	3 cfs	3 cfs	4 cfs	xx	xx	xx	xx	xx	xx	xx	xx
Construct transmission/ distribution facilities	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx
including bi-directional pipeline to Fallbrook and booster pumping plant	19 cfs	19 cfs	19 cfs	—	23 cfs	21 cfs	21 cfs	21 cfs	19 cfs	—	—	—	—	67,000 16 cfs	16 cfs	16 cfs	—	20 cfs	18 cfs	18 cfs	18 cfs	16 cfs
Install pumping plant (treated water) WTP to reservoir ridge	24 cfs	24 cfs	24 cfs	24 cfs	28 cfs	26 cfs	26 cfs	26 cfs	24 cfs	18 cfs	19 cfs	20 cfs	20 cfs	21 cfs	21 cfs	21 cfs	21 cfs	25 cfs	23 cfs	23 cfs	23 cfs	21 cfs
Construct treated water storage-tanks/clear wells	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx
Rehabilitate Lake O'Neill and diversion	125 ac 20 cfs	xx	xx	xx	xx	xx	xx	xx	xx	125 ac 20 cfs	xx	xx	xx	125 ac 20 cfs	xx	xx	xx	xx	xx	xx	xx	xx
San Mateo Cr / San Onofre Cr production wells		2 wells 7 cfs	2 wells 7 cfs	3 wells 8 cfs							3 wells 8 cfs				2 wells 7 cfs	2 wells 7 cfs	3 wells 8 cfs					
w/ wellhead treatment		7 cfs	7 cfs	8 cfs							8 cfs				7 cfs	7 cfs	8 cfs					
Pipeline/pump station to Orange County MWD water exchange		23,000 ft 7 cfs		23,000 ft 8 cfs							23,000 ft 8 cfs				23,000 ft 7 cfs		23,000 ft 8 cfs					
Cross-base pipeline, 104,000 feet (raw water from x to x)			SMC-SMR 7 cfs	SMR-SMC 40 cfs							SMR-SMC bi-directional 40 cfs					SMC-SMR 7 cfs	SMR-SMC 40 cfs					
SMC recharge pond				10-20 ac							10-20 ac						10-20 ac					
Treatment wetlands and reservoir (49 acres 1,600 af volume) on NWS					18 ac, 36 ac-ft													18 ac 36 af				
Land outfall turnout and pipeline					9,000 ft 4 cfs 12-in dia	18,400 ft 6 cfs 16-in dia	7,300 ft 6 cfs 16-in dia					18,400 ft 6 cfs 16-in dia	7,300 ft 6 cfs 16-in dia					9,000 ft 4 cfs 12-in dia	18,400 ft 6 cfs 16-in dia	7,300 ft 6 cfs 16-in dia		
Denitrified pipeline to Santa Margarita River					5,800 ft 9 cfs 20-inch dia													5,800 ft 9 cfs 20-inch dia				
Spreading basin at Santa Margarita River					acres TBD													acres TBD				
Camp Pendleton "X" Canyon treatment wetlands						Pueblitos Cy 33 ac, 90 af	Newton Cy 35 ac, 97 af					Pueblitos Cy 33 ac, 90 af	Newton Cy 35 ac, 97 af						Pueblitos Cy 33 ac, 90 af	Newton Cy 35 ac, 97 af		
Expansion area						12 ac, 33 af	11 ac, 32 af					12 ac, 33 af	11 ac, 32 af						12 ac, 33 af	11 ac, 32 af		
Denitrified pipeline from wetlands to lower Ysidora sub-basin						5,700 ft 6 cfs 16-in dia	20,600 ft 6 cfs 16-in dia					5,700 ft 6 cfs 16-in dia	20,600 ft 6 cfs 16-in dia						5,700 ft 6 cfs 16-in dia	20,600 ft 6 cfs 16-in dia		
Spreading pipelines for ground-water recharge to prevent seawater intrusion (acres TBD)						9,400 ft 6.3 cfs 16-in dia	9,400 ft 6 cfs 16-in dia					9,400 ft 6.3 cfs 16-in dia	9,400 ft 6 cfs 16-in dia						9,400 ft 6.3 cfs 16-in dia	9,400 ft 6 cfs 16-in dia		
Off-stream reservoir storage (2 dams/ 3 dikes)								55 ac 4,800 af													55 ac 4,800 af	
Bi-directional raw water pipeline from reservoir to pond no. 7								12,000 ft 40 cfs 36-in dia													12,000 ft 40 cfs 36-in dia	
Enhanced production pipeline									7,500 ft 4 cfs													7,500 ft 4 cfs
FPUD sump intake and pump structure										xx	xx	xx	xx									
Obermeyer spillway diversion structure at FPUD sump										357 ft, 5 cfs 10 ft high	xx	xx	xx									
Pumping plant and pipeline from FPUD sump to Red Mountain										29,000 ft 5 cfs	xx	xx	xx									
Knoll Park or Red Mountain primary WTP										5 cfs	xx	xx	xx									
Oceanside pipeline from Morrow Hill to Base (emergency supply)										28,000 ft 20 cfs	—	xx	xx									
Existing Oceanside pipeline from Morro Hill to Base (12-inch)											xx											
Instream check structure (no recharge ponds)														260 ft	xx	xx	xx	xx	xx	xx	xx	xx

The xx indicates the item in 1a, 2a, or 3a is included in the features for that alternative.

the net yield for service delivery of each of the alternatives would be less than the yields presented above.

Water Treatment

Three treatment processes were considered in cost analysis of the pre-feasibility alternatives:

- Advanced water treatment
- Minimal water treatment
- Chloramination

Advanced and minimal water treatments were considered separately in all alternatives. Chloramination was applied to alternatives involving deliveries to Orange County for water exchange purposes. In these exchange alternatives, the chloramination process was assumed to be incorporated as well head treatment on water produced and delivered from the San Mateo Creek basin.

Reclamation developed a cost model for desalination and other water treatment processes in the 1990s. The objective of this program is to estimate the cost of water treatment technologies based only on the water analysis and desired capacity. Inputs define the specific equipment used, but reasonable defaults are provided for use in the planning phase. WTCost© was applied to estimate the advanced water treatment and minimal treatment process costs of the 22 pre-feasibility sub-alternatives.

Pre-Feasibility Total Cost Analysis

Percentages of the construction costs were added to estimate total costs. Mobilization/ demobilization costs were estimated as 5 percent of the construction costs and unlisted items were estimated as 15 percent, to obtain a contract cost. A contingency of 25 percent of the contract cost was added to obtain a field cost. To obtain the total project cost, the estimated cost of the open space management zone and non-contract costs amounting to 33 percent of the field costs were added. Non-contract costs would include permitting, engineering, construction management, owner's administration, legal, and other costs.

A net present value (NPV) for the pre-feasibility alternatives was developed by assuming annual maintenance costs as described over an assumed 50-year project life. The "plan formulation and evaluation" interest rate for fiscal year 2005 of 5.375 percent was applied in the present value calculations. Total costs for water for each of the pre-feasibility alternatives were developed by dividing the NPV of each alternative by the net yield and again dividing by 50 years.

Table S-2 presents the cost per acre-foot for each alternative, assuming advanced water treatment and minimal water treatment, respectively. The cost of water with advanced water treatment ranges by alternative from $560 to $850 per acre-foot. The cost of water with minimal water treatment ranges by alternative from $190 to $300 per acre-foot.

Table S-2. Cost of water per acre-foot with advanced or minimal water treatment

Alternative	Cost of water per acre-foot with advanced water treatment		Cost of water per acre-foot with minimal water treatment	
	Net Project Yield (af)	Cost per acre-foot ($/af)	Net Project Yield (af)	Cost per acre-foot ($/af)
1A	11,985	$ 699	14,100	$ 224
1B	14,785	$ 592	16,900	$ 210
1C	14,365	$ 635	16,900	$ 231
1D	14,875	$ 623	17,500	$ 231
1E	13,770	$ 687	16,200	$ 227
1F	12,835	$ 682	15,100	$ 225
1G	12,835	$ 686	15,100	$ 229
1H	12,580	$ 769	14,800	$ 292
1I	11,985	$ 698	14,100	$ 224
2A	10,710	$ 627	12,600	$ 215
2B	14,020	$ 581	16,000	$ 250
2C	11,560	$ 600	13,600	$ 203
2D	11,560	$ 605	13,600	$ 207
3A	10,200	$ 763	12,000	$ 225
3B	13,000	$ 628	14,800	$ 209
3C	12,580	$ 678	14,800	$ 233
3D	13,090	$ 672	15,400	$ 241
3E	11,985	$ 741	14,100	$ 228
3F	11,050	$ 746	13,000	$ 230
3G	11,050	$ 751	13,000	$ 234
3H	10,795	$ 848	12,700	$ 307
3I	10,200	$ 762	12,000	$ 224
	Average	**$ 685**	**Average**	**$ 232**
	Minimum	**$ 581**	**Minimum**	**$ 203**
	Maximum	**$ 848**	**Maximum**	**$ 307**

Screening of Alternatives

Each pre-feasibility alternative was screened and scored against a set of criteria developed during the pre-feasibility alternatives workshop. These criteria were placed into a matrix for each major concept. Separate matrices were prepared assuming that advanced water treatment and minimal water treatment are incorporated into the alternatives. The screening matrices are tools that can be used in selection of the most suitable alternatives for further evaluation during the feasibility study.

Each factor in the matrices contains weights that were assigned by workshop participants. During the scoring process, each alternative was assigned a rating for each factor. These ratings ranged from 1 to 5; 1 represents the lowest rating; 5 represents the highest. The ratings were then multiplied by the weights to develop a score for each factor. At the bottom of each alternative is a total score representing a sum of the scores of all factors.

Figures S-1 and S-2 present screening scores with advanced water treatment and minimal water treatment for each of the alternatives, respectively. Information from the screening matrices will be used to help develop a decision memorandum. This decision memorandum will identify the alternatives for feasibility study, document the reasons for their selection, and propose a feasibility plan of study.

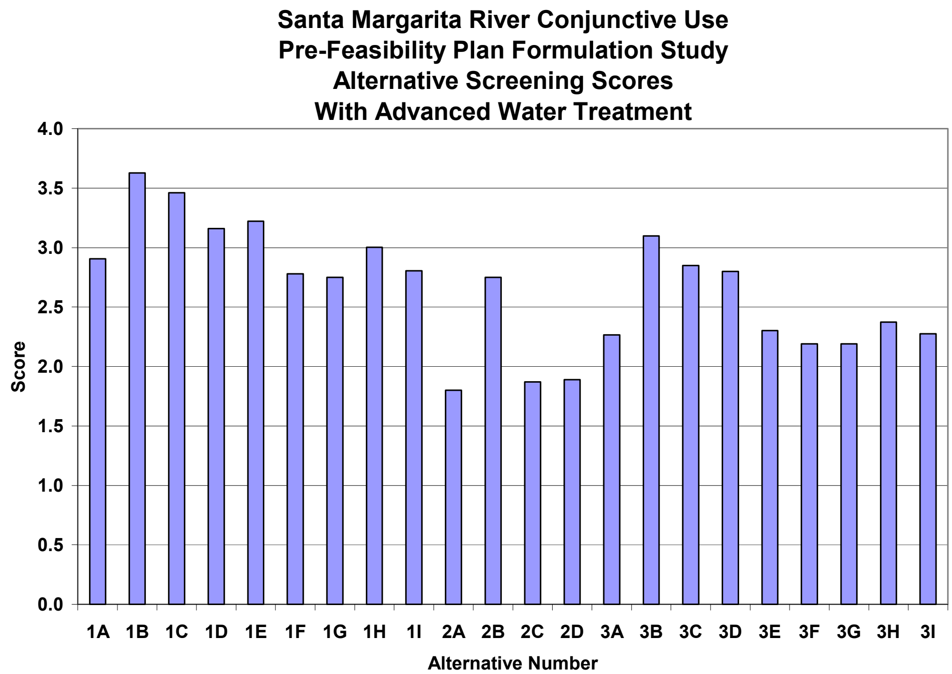


Figure S-1. Alternative screening scores assuming advanced water treatment.

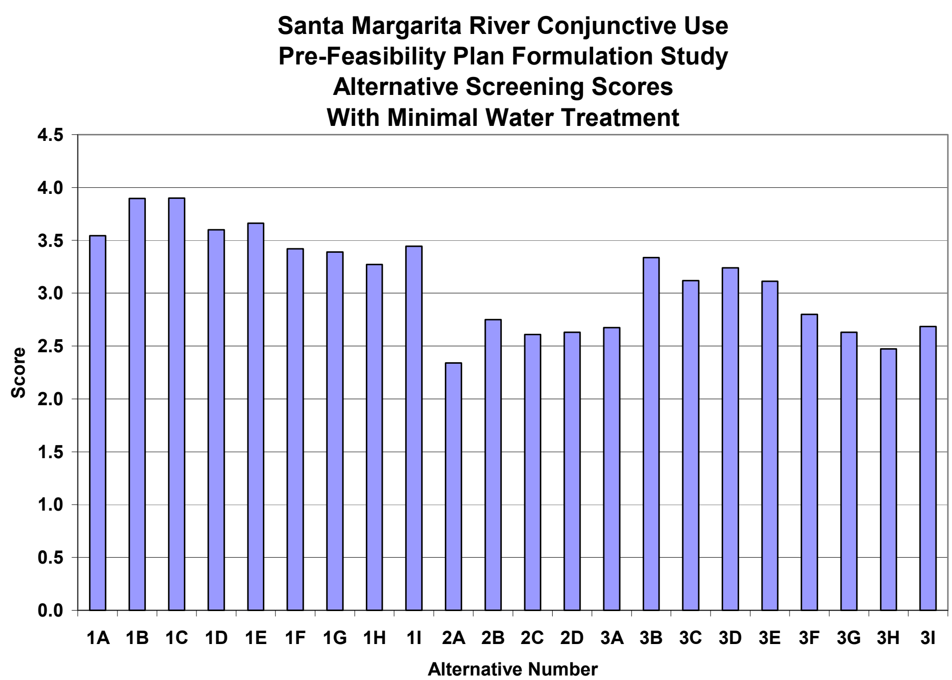


Figure S-2. Alternative screening scores assuming minimal water treatment.

1.0 Introduction

This pre-feasibility plan formulation report compares, at appraisal level, conceptual alternatives to provide additional and/or replacement water supplies to Fallbrook Public Utility District (FPUD) and the Marine Corps Base Camp Pendleton (Camp Pendleton) in San Diego County, California. This study investigates alternatives that could be constructed to put to beneficial use both naturally occurring streamflow, ground water, and tertiary treated wastewater. The purpose of this report is to provide information needed to select alternatives and/or project elements to be studied at a feasibility level. The cost estimates and assessments of alternatives are based on application of appraisal level estimating procedures. The level of detail is consistent with making comparisons of the alternatives for screening purposes.

The magnitudes of the project yields, construction costs, and net present values cannot be viewed as accurately depicting what would be required to fund, design, construct, and operate specific alternatives. Therefore, the information contained in this report cannot be used in pursuit of project authorizations and appropriations. The information provided herein is to be used for screening purposes only.

The training requirements of Camp Pendleton have not been reviewed in relationship to the identified alternatives in this report. Before the final selection of an alternative during the feasibility process, all military training needs of Camp Pendleton will be reviewed to avoid any conflicts.

1.1 Authority

In 2003, the Congress directed the Bureau of Reclamation (Reclamation), through Public Law (P.L.) 108-7, "to perform the studies needed to address current and future municipal, domestic, military, environmental, and other water uses from the Santa Margarita River, California." In 2004, the Congress appropriated funds to initiate the study (P.L. 108-137). The study has been divided into two parts: pre-feasibility and feasibility. The purpose of the pre-feasibility study is to evaluate a wide range of alternatives at an appraisal level of analysis to recommend the most attractive alternatives for further study during feasibility. This is a standard Reclamation plan formulation process. Following completion of the pre-feasibility analysis and report, the feasibility study, public scoping, National Environmental Policy Act (NEPA), California Environmental Quality Act (CEQA), and other compliance will be initiated.

1.2 Purpose of and Need for Project

The purposes of the project are to help meet water demands of Fallbrook Public Utility District and Marine Corps Base Camp Pendleton, to reduce dependence on imported water while maintaining watershed resources, and to improve water supply reliability by managing the yield of the lower Santa Margarita River basin and perfecting the water rights permits that were assigned to the Bureau of Reclamation in 1974.

1.3 Background

Location of Study Area

The study area is located in northern San Diego County and includes the geographic boundaries of the FPUD service area and the United States Naval Enclave, consisting of the Marine Corps Base and Marine Corps Air Station Camp Pendleton, the Naval Hospital, Camp Pendleton (collectively the Base), and Naval Weapons Station Seal Beach, Fallbrook Annex (NWS). Project alternatives address the construction and use of facilities within the boundaries of the Santa Margarita River, the San Mateo Creek, and San Onofre Creek basins.

The Santa Margarita River forms at the confluence of Temecula and Murrieta Creeks and flows southwest through FPUD, NWS, and the Base before it terminates at the Pacific Ocean. The Santa Margarita River basin consists of 744 square miles of drainage area in both San Diego and Riverside Counties. The Santa Margarita River basin may be separated into the “Upper Basin” and the “Lower Basin.” The Upper Basin is located in Riverside County and is controlled by the drainage of Temecula and Murrieta Creeks. The Lower Basin is controlled by the 27-mile long Santa Margarita River and contains major tributaries such as De Luz, Sandia, and Fallbrook Creeks. Ground water is found in the alluvial basin located downstream from the confluence of the Santa Margarita River and De Luz Creek and, to a lesser extent, in the shallow alluvium upstream of that confluence.

The alluvial basin located downstream from the confluence of the Santa Margarita River and De Luz Creek is further divided into three separate sub-basins: the Upper Ysidora, Chappo, and Lower Ysidora sub-basins. The Upper Ysidora sub-basin is the farthest upstream of the three basins and is characterized by coarse sediments, consisting mostly of sands and gravels. The Chappo sub-basin, located adjacent to the Upper Ysidora sub-basin, consists of sands, gravels, and clays, and is the largest of the three sub-basins. The farthest downstream sub-basin, the Lower Ysidora, consists mostly of sands and clays, and is the least ground-water productive of the three sub-basins. The three sub-basins range from less than ½ mile wide (Upper and Lower Ysidora sub-basins) to more than 2 miles wide (Chappo sub-basin).

Ground water from the Upper Ysidora and Chappo sub-basins provides more than 90 percent of the supply of potable water for the southern portion of Camp Pendleton. (Ground water outside the Santa Margarita basin serves the northern portion of Camp Pendleton.) Camp Pendleton also uses ground water from the Lower Ysidora sub-basin, primarily to irrigate agricultural lands leased to contracting agricultural businesses. An off-channel surface water spreading system, in operation since 1960, replenishes water pumped from the ground-water basins. This existing system, located west of the Naval Hospital, consists of a steel sheet pile diversion weir constructed across the Santa Margarita River and an earthen channel to convey river diversions to a series of five interconnected ground-water recharge ponds and to Lake O'Neill.

Lake O'Neill is a 1,680 acre-foot reservoir located on Fallbrook Creek, a minor tributary to the Santa Margarita River. Most of the water stored in the lake is diverted from the nearby Santa Margarita River. The Lake O'Neill dam and the diversion ditch from the Santa Margarita River were constructed in 1883 as part of the farm irrigation system. Since acquisition by the Federal Government for Camp Pendleton, Lake O'Neill has been used for ground-water recharge, military training, and recreation (Leedshill and Herkenhoff, 1988).

FPUD is located approximately 5 miles northeast of the Upper Ysidora sub-basin and does not contain large alluvial basins that may be used to produce ground water. Currently, FPUD's access to local ground-water supplies is limited to the shallow alluvial fill beneath the Santa Margarita River upstream of the Base boundary. The alluvial materials found along the Santa Margarita River, within the boundaries of FPUD, are no more than 200 yards wide and approximately 30 to 50 feet deep. Although limited supplies of ground water historically have been produced from shallow ground-water wells, FPUD does not currently extract surface or ground water from the Santa Margarita River. The domestic, agricultural, and commercial water demands within FPUD are exclusively met by imported water supplies purchased from the San Diego County Water Authority (CWA). Based on records published by the Santa Margarita River Watermaster's office, about 17,000 acre-feet of water was purchased from the CWA during water year 2004.

Description of Existing Camp Pendleton Facilities

Existing facilities include the diversion weir, ditch, and ground-water recharge facilities (figure 1.1).

A sheet pile weir in the Santa Margarita River channel allows water to be collected and diverted into O'Neill Ditch through an existing headgate and diversion structure located on the eastern bank of the river. O'Neill Ditch conveys water to five active ground-water recharge ponds or Lake O'Neill, depending on the time of year, available supply, and required demand. During the diversion season, a series of control structures and measuring devices allows Base personnel to manage, control, and measure the diversion to each of the different facilities. The operation of each of these facilities is discussed in the following

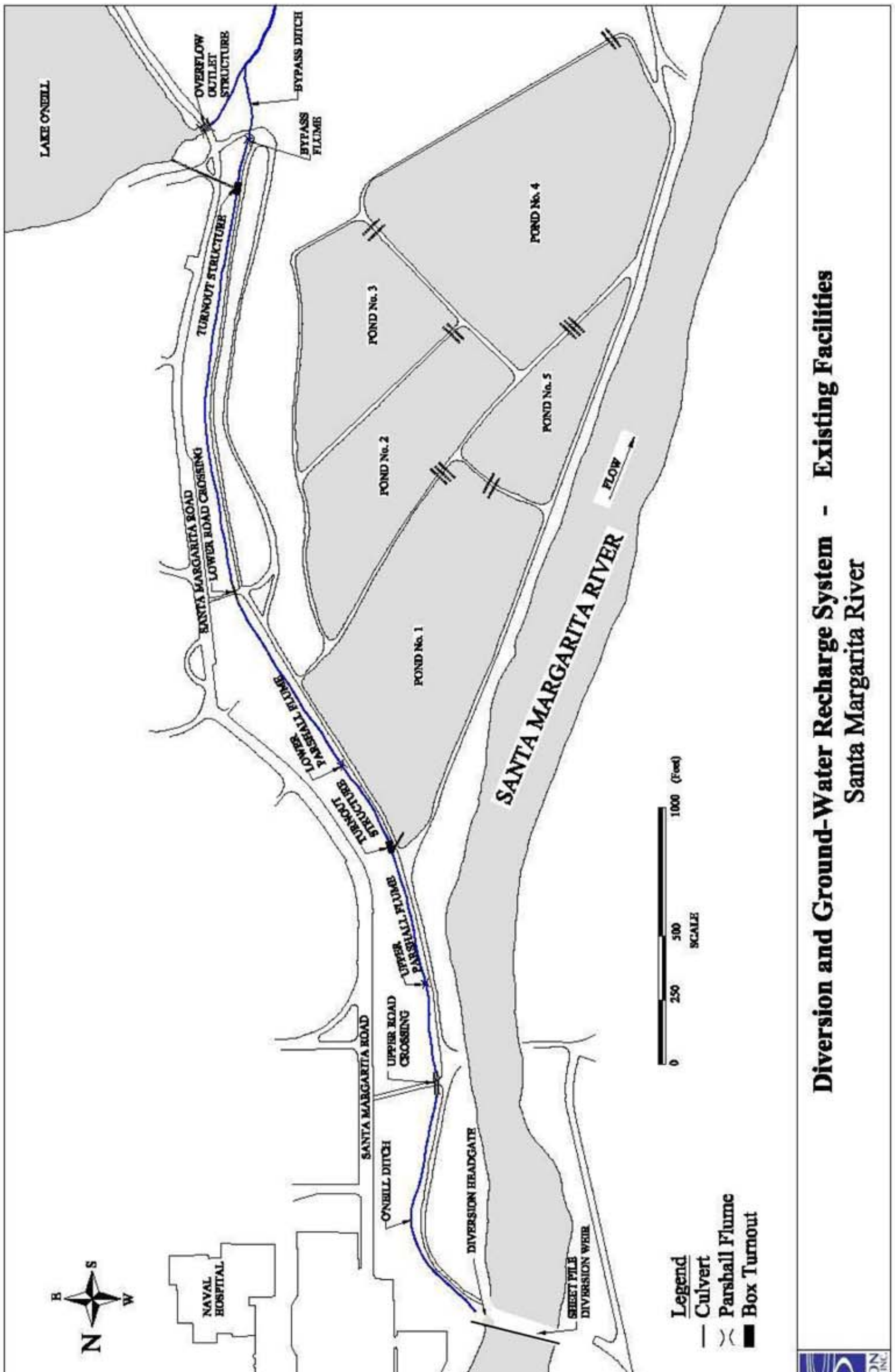


Figure 1.1. Existing active facilities.

sections of this report. Table 1.1 summarizes the existing diversion facilities on Camp Pendleton used to divert water from the Santa Margarita River.

Table 1.1. Summary of existing facilities used to divert water from the Santa Margarita River

Facility	Description	Current capacity
Conveyance facility		
River diversion dam, steel	Sheet pile weir, 283 feet long	----
River diversion inlet	60-inch × 48-inch slide gate mounted on concrete headwall 65-inch × 40-inch × 45-feet arch corrugated metal pipe	75 cubic feet per second (cfs)
O'Neill Ditch		
Earthen channel	Unlined earth ditch approximately 5,100 feet long	73-174 cfs
Road crossing (double culvert)	36-inch corrugated metal pipe and 36-inch reinforced concrete pipe	60 cfs
Upper flume	5-foot Parshall flume; concrete block and concrete lined	105 cfs
Recharge pond turnout structure	Concrete turnout structure with two 48-inch slide gates	82 cfs
Lower flume	3-foot Parshall flume; concrete block and concrete lined	62 cfs
Road crossing (single culvert)	42-inch corrugated metal pipe	39 cfs
Lake O'Neill turnout structure	Concrete turnout structure with 24-inch slide gate	20 cfs
Storage facilities		
Ground-water recharge ponds	5 active ground-water recharge ponds totaling 49 acres	260 acre-feet
Lake O'Neill	Lake formed by earthen levee	1,200 acre-feet

Note: Capacity of conveyance facilities calculated based on river water levels equal to crest height of the sheet pile weir.

Santa Margarita River Diversion Structure

The existing Santa Margarita River diversion structure was constructed in 1982 and consists of a steel sheet pile weir approximately 280 feet long. The sheet pile weir was constructed as a more permanent structure to replace previous rock weir designs that washed out during large flood events. According to the 1982 construction drawings, the sheet piles are 30 feet long and were driven to a depth that fixed the weir crest elevation at 115.5 feet.

Water impounded behind the sheet pile weir may be diverted through a 60-inch by 48-inch (span by rise) slide gate mounted on a concrete headwall on the eastern bank of the river. The existing slide gate was constructed as a result of Camp Pendleton's Department of Public Works 1970 plans to repair the flood damaged diversion system. The slide gate is manually operated to pass river diversions through a 45-foot long section of arch corrugated metal pipe (CMP) with dimensions of 65 inches by 40 inches. The invert elevation of the arch CMP at the entrance of the diversion is 112.1 feet, according to the 1982 construction drawings. The capacity of the arch CMP diversion pipe is estimated to be 75 cubic feet per second (cfs) with a water surface elevation 3.4 feet (115.5 feet-112.1 feet) above the pipe inlet.

Current operations require sediment removal behind the sheet pile weir and in front of the headwall and headgate.

Lake O'Neill

Lake O'Neill is a manmade reservoir formed by an earthen levee located on Fallbrook Creek, a tributary to the Santa Margarita River. The lake is filled primarily from Santa Margarita River diversions conveyed to the lake through O'Neill Ditch. The levee that impounds water in Lake O'Neill and the diversion canal from the river to the lake were constructed in 1883 as part of a farm system (Leedshill-Herkenhoff, 1988). The water rights associated with Lake O'Neill carry a priority date of 1883 and stipulate a maximum diversion rate to the lake of 20 cfs, not to exceed 1,500 acre-feet (including evaporation losses) annually.

Diversions from O'Neill Ditch to the lake are made through a concrete turnout structure and a 24-inch reinforced concrete pipe located at the lower end of O'Neill Ditch. Adjacent to the 24-inch pipe that fills the lake is a concrete overflow outlet structure with four 60-inch reinforced concrete pipes (RCP). The overflow outlet structure returns reservoir spills to a ditch that eventually drains back to the river. Lake water can also be returned to the river through an outlet pipe located in the southern corner of the lake.

Ground-Water Recharge Ponds

The Santa Margarita River diversion system conveys water to either Lake O'Neill or to five interconnected ground-water recharge ponds. The ground-water recharge pond system was constructed between 1955 and 1962, and Santa Margarita River diversions to the recharge ponds were first recorded in October 1960. The total surface area of the five-pond system currently in use is approximately 49 acres, and the capacity of the ponds is estimated to be approximately 260 acre-feet. Table 1.2 summarizes capacity of the five existing ground-water recharge ponds.

Under the current recharge pond operations, water is diverted from O'Neill Ditch into the recharge pond system through a single 79-inch by 49-inch CMP pipe at the head of pond No. 1. When the water level in pond No. 1 rises to the pond's outlet pipe invert elevations, flow passes ("spills") from pond No. 1 into either pond Nos. 2 or 5. The pipe invert elevations from pond No. 1 to pond No. 2 are slightly lower (12-15 inches) than the pipe invert elevations from pond No. 1 to pond No. 5; therefore, water first spills from pond No. 1 into pond No. 2 before spilling into pond No. 5.

Water filling above the invert elevation of the outlet pipes from pond No. 2 spills into pond No. 3, and water filling above the outlet pipes from pond No. 3 spills into pond No. 4. Similarly, water filling above the invert elevation of the outlet

Table 1.2. Capacity of existing ground-water recharge ponds

Pond No.	Surface area (acres)	Average water depth (feet)	Volume (acre-feet)
1	13.9	3.2	44.5
2	7.0	6.1	42.7
3	7.0	8.4	58.8
4	16.5	5.4	89.1
5	4.7	5.1	24.0
Total	49.1		259.1

Note: Approximate average depth of existing ponds based on 1962 survey map.

pipes from pond No. 5 spills into pond No. 4. At the lower end of pond No. 4 (the last pond currently being used in the system), two 30-inch CMP pipes return spills from pond No. 4 to the floodplain. Pond No. 4 only spilled in March of 1983 and has only filled twice since that time (Malloy, 2000). Pond No. 6 and 7 are not currently being used and would require some modification for them to become functional.

1.4 Legal History

In the late 1880's, developers of land in the Fallbrook area of North San Diego County formed Fallbrook Water and Power Company, seeking to construct a dam on the lower Santa Margarita River as the source of both water and power for their development. Rancho Santa Margarita, Camp Pendleton's predecessor, filed suit to stop the dam construction, giving rise to more than 100 years of water rights litigation on the river. However, lack of finances and litigation over water rights led to the failure of both the plan and the company.

In 1891, attempts were made to form an entity known as Fallbrook Irrigation District to develop a water supply to promote agricultural development in the Fallbrook area. However, the Supreme Court ruled that the statute under which the irrigation district had been formed, the Wright Act, was unconstitutional, halting those water development plans. In 1922, the Fallbrook Public Utility District was formed to provide water to the 500-acre Fallbrook township. Then, in 1925, Fallbrook Irrigation District was reinstituted, and wanted to dam the Santa Margarita River. In the meantime, Rancho Santa Margarita (the original owner of Camp Pendleton and Naval Annex lands) had started its long running battle with Vail Ranch, the main upstream water user, over rights to the waters of the river.

In 1928, Fallbrook Irrigation District filed suit to condemn unused riparian rights on the river, notwithstanding that Rancho Santa Margarita and Vail Ranch were battling each other for the river's relatively meager flows. In 1930, the year of the initial judgment in the Vail litigation, Fallbrook Irrigation District was issued a permit to appropriate 35,000 acre-feet for Santa Margarita River storage and 15,000 acre-feet for annual use. However, because of financial problems, Fallbrook Irrigation District could not build its dam; and, in 1937, the irrigation district was taken over by FPUD.

In 1940, Rancho Santa Margarita and Vail Ranch settled their lawsuit by way of a Stipulated Judgment, followed not long afterwards by the Navy's condemnation of part of Rancho Santa Margarita as the site for Camp Pendleton. Under the 1940 settlement, one-third of the river flow was allocated to Vail Ranch, the main upstream water user, and two-thirds to Rancho Santa Margarita. FPUD was not a party to the suit.

In 1946, FPUD applied for several diversion and storage permits on the river, and in 1948, the Navy filed for a permit to build DeLuz dam at Camp Pendleton. Then in 1949, the two parties agreed to build a multi-purpose dam at the DeLuz site to serve them both.

In 1951, the United States (on behalf of Camp Pendleton) brought suit against FPUD and about 3,600 other upstream users to enforce Camp Pendleton's right to the flow of the Santa Margarita River. Following years of decisions and appeals, the U.S. District Court issued a Modified Final Judgment and Decree in 1966. However, this decree did not apportion flow between Camp Pendleton and FPUD. Also, the court did not act on the United States' request to revoke water appropriation permits issued to FPUD by the State Water Resources Control Board (SWRCB).

To obtain a physical solution to their respective water rights claims, in 1968, FPUD and the United States (Camp Pendleton) entered into a Memorandum of Understanding (MOU). The MOU set forth a two-dam project on the river to provide both FPUD and Camp Pendleton with water. However, because of environmental and funding concerns, as well as other factors, the two-dam project ended in 1987 when the Navy was advised by its congressionally-directed technical investigator that no dam could be feasibly built, so an alternative "physical solution" needed to be found.

In 1989, FPUD and Camp Pendleton entered into the "Four-Party Agreement" with two upper basin water districts. Because of rapid inland growth and development, two upper basin water districts were having trouble disposing of the increasing flows of wastewater. As part of their consideration, the water districts would discharge sufficient highly treated wastewater effluent into the Santa Margarita River watershed for both FPUD and Camp Pendleton. FPUD and Camp Pendleton entered into a collateral agreement for splitting up the resulting effluent flows and storing them underground in the Base's aquifer. The agreement was entitled the Conjunctive Use Agreement.

During the following decade, much was done, but little was accomplished toward implementing a permanent "physical solution." Studies were made and demonstration projects run, but in October 2002, the water districts ceased their efforts to get the effluent discharge permitted.

Notwithstanding the potential promise of the Four-Party Agreement, Camp Pendleton and FPUD renewed their efforts in 1999 to find an alternative "physical solution." These efforts were assisted by the Cooperative Water Resources Management Agreement signed in 2002 providing for imported water augmentation of Santa Margarita River flows by an upstream water district in recognition of Camp Pendleton's rights under the 1940 Stipulated Judgment. In fiscal year 2004, an appropriation was made to Reclamation to study the feasibility of the Santa Margarita Conjunctive Use Project.

On September 13, 2004, Reclamation, Camp Pendleton, and FPUD signed an MOU describing the roles and responsibilities of each party in the completion of the feasibility study, environmental impact statement (EIS), and environmental impact report (EIR). Reclamation is responsible for completing the feasibility study; Reclamation and Camp Pendleton are joint lead agencies for completing the EIS; and FPUD is lead agency for completion of the EIR.

On November 1, 2004, a Notice of Intent to prepare an EIS was published in the Federal Register. On December 14, 2004, a Notice of Preparation was sent to the California State Clearinghouse.

1.5 Legal and Institutional Framework

The project will operate within a legal and institutional framework that includes water rights, water quality standards, protection of Native American trust assets, and, as appropriate, biological and cultural resources protection standards, air quality standards, and California's public trust doctrine.

Camp Pendleton has riparian and appropriative water rights to the use of Santa Margarita River flow dating back to the 1800s. These include the rights to use the ground water in the Upper Ysidora, Chappo, and Lower Ysidora sub-basins. The riparian rights allow the water to be used within the Santa Margarita River watershed. The appropriative rights allow the water to be used throughout the entire Base, or elsewhere.

As discussed under "Legal History," beginning in the 1920s, FPUD began investigations to create a dependable source of water to meet its growing domestic and agricultural demands. After years of studies, FPUD pursued investigations to construct a dam in the Lower Basin near the confluence of the Santa Margarita

River and Sandia Creek. Following further investigations with Reclamation and Camp Pendleton, FPUD applied for water rights permits to divert and store water from the Santa Margarita River. In 1946 and 1947, FPUD was granted three 10,000-acre-foot permits (table 1.3) for the diversion and storage of water from the Santa Margarita River at the proposed Fallbrook Reservoir site.
In 1963, the State issued a 165,000 acre-foot permit to the United States to divert and store water from the Santa Margarita River. The water was to be used in a two-dam project for FPUD and Camp Pendleton, termed the Santa Margarita Project.

These permits were assigned to Reclamation by FPUD and the U.S. Department of the Navy under SWRCB Order WR 73-50 on December 6, 1973.

Table 1.3. Selected appropriative water rights, Santa Margarita River basin: Permits and licenses

Permit No.	Current status	Owner	Date filed	Storage site	Annual amount (acre-feet)	Diversion period
8511	Permit	Reclamation	10/11/46	Fallbrook Reservoir	10,000	01/01 – 12/31
11356	Permit	FPUD	11/28/47	Fallbrook Reservoir	10,000	11/01 – 06/01
11357	Permit	Reclamation	11/28/47	Fallbrook Reservoir	10,000	11/01 – 06/01
15000	License	U.S. Navy	09/23/63	Underground	4,000	10/01 – 06/30
15000	Permit	Reclamation	09/23/63	De Luz Reservoir	165,000	01/01 – 12/31

However, by the 1980s, it was determined that the Santa Margarita Project was not feasible and other means should be used to secure additional water supplies and implement flood control measures using other methods. Since that time, Reclamation assigned Permit 11356 back to FPUD, which FPUD has worked to perfect by transferring the point of diversion to Lake Skinner. The three remaining water rights permits held by Reclamation provide the legal basis for appropriating water for a joint conjunctive use project. The use of these permits in a joint project also would provide the means for the two parties to reach a physical solution to their water rights dispute as agreed to in the 1968 MOU. In addition to the settlement of the existing litigation, the goal of a conjunctive use project is to provide a dependable supply of local water for FPUD, and an emergency delivery system for import water to Camp Pendleton, while allowing Camp Pendleton to meet its domestic, agricultural, and military water needs.

The project will require petitions for changes in point of diversion (storage). California's State Water Resources Control Board requires the following for changes of point of diversion, place of use, or purpose of use of water rights:

- Permission
- Petition
- Notification of California Department of Fish and Game of the petition for change
- Identification of affected fish and wildlife
- Compliance with Fish and Game Code and Endangered Species Act of 1973, as amended
- Identification of mitigation for fish and wildlife impacts
- Demonstration of no injury to other legal users

The project may require water transfers if it includes exchanges. Water transfers require the same petition process as for a change in point of diversion, place of use, or purpose of use. Only water that would have been consumptively used can be transferred.

Licensing will be required upon completion of construction and application of the water to beneficial use in the assigned use areas.

2.0 Water Resources

This section describes ground and surface water resources in the study area.

2.1 Ground Water

Alluvium is the principal source of ground water in the lower Santa Margarita River basin. The unconsolidated alluvial deposits are made up of three distinct geologic units: the Upper Alluvium, Lower Alluvium, and Terrace deposits. The Upper and Lower Alluvium are difficult to differentiate; however, the Lower Alluvium is generally more coarse-grained except in the Upper Ysidora sub-basin, where the entire section consists of coarse sand and gravel. These two units are the main ground-water bearing formations. The overlying Terrace deposits consist of older, decomposing partially indurated channel sediments. The total thickness of the alluvium increases downstream from about 120 feet at the De Luz Creek confluence to about 200 feet at the coast.

The lower Santa Margarita River basin on Camp Pendleton is composed of three hydrogeologic sub-basins: the Upper Ysidora, the Chappo, and the Lower Ysidora (figure 2.1). Ground water in the Upper Ysidora and Chappo sub-basins is essentially unconfined, while in the Lower Ysidora sub-basin it is semi-confined because of lenses of fine sediments. The Basement Complex in the Upper Ysidora sub-basin forms the sides and bottom of the basin. Sandstone and shale of the La Jolla formation forms the sides and bottom of the basin in the Chappo sub-basin and part of the Lower Ysidora sub-basin. The Basement Complex transmits little or no water to the alluvium. The La Jolla formation transmits small quantities of water to the basin.

As the sea level rose approximately 200 feet during the Quaternary period, the Santa Margarita River deposited alluvial fill in the three basins, forming two distinct geologic layers, the upper alluvium (Qu) and the lower alluvium (Ql). In each sub-basin, the subsurface hydraulic properties vary within these two alluvial units based on the sorting of gravels, sands, and finer grained sediments as the river deposited them in response to the rising seawater levels.

In the Upper Ysidora sub-basin, the Ql and Qu units consist of very permeable, well sorted sands and gravels with cobbles resulting in high infiltration rates from river water, percolation basins, and rainfall. In the Chappo sub-basin, the Qu is mostly composed of less transmissive silt, sandy silt, and clay, except beneath the river, where there are sands and gravels, and in an apparent subsurface stream channel beneath the supply depot area. The Ql unit of the Chappo sub-basin consists of well sorted gravels and sands.

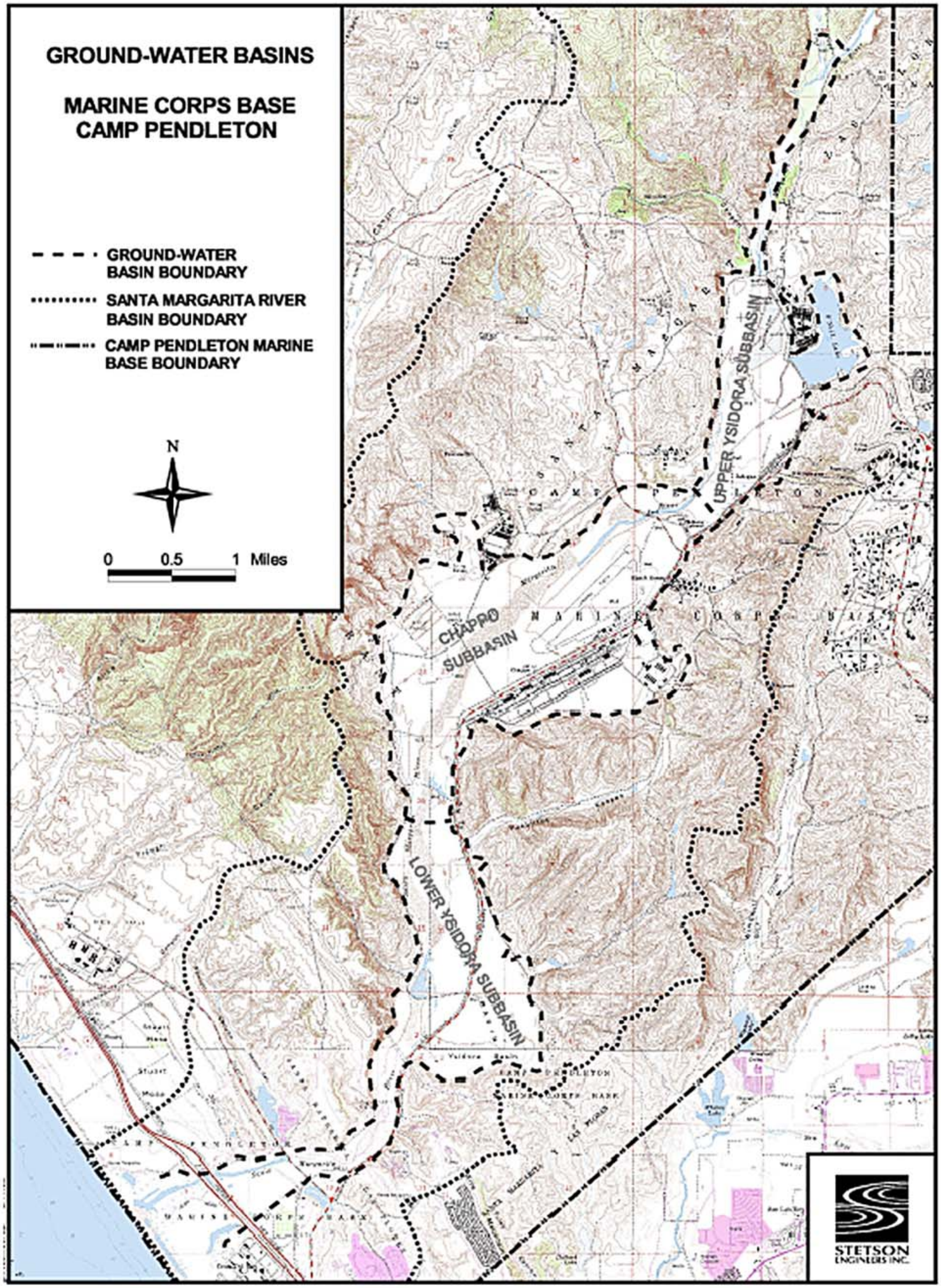


Figure 2.1. Ground water basins, Marine Corps Base Camp Pendleton.

The Lower Ysidora's Qu consists of less permeable silt and clay, intermixed with some sand. The Ql of the Lower Ysidora sub-basin contains mixed gravel, sand, silt, and clay. Some areas are very permeable, especially near the Lower Ysidora-Chappo narrows that define the boundary between the two sub-basins.

The Upper Ysidora sub-basin extends from the confluence of De Luz Creek and the Santa Margarita River to the Basilone Road narrows comprising a length of approximately 2 miles and a surface area of approximately 860 acres. Within this sub-basin, the primary recharge to the ground-water aquifer is seepage from the river and underflow from subsurface gravels in the Santa Margarita River stream channel alluvium. Other ground-water inflows include percolation from precipitation, range front recharge, percolation pond recharge, and infiltration from conveyance channels (from the diversion weir, spill and release from Lake O'Neill). The release channel receives flows from Lake O'Neill and, prior to September 12, 1999, from Sewage Treatment Plant (STP) Oxidation Pond 1. Primary outflows within this sub-basin include production well pumping, evapotranspiration (ET) from phreatophytes along the riparian corridor, and underflow through the narrows at Basilone Road. Water is diverted from the Santa Margarita River as it flows through the Upper Ysidora sub-basin, near the Naval Hospital, to five percolation recharge ponds and Lake O'Neill. The estimated ground-water storage capacity of the Qu is 7,500 acre-feet and of the Ql is 5,000 acre-feet (Troxall and Hofman, 1954).

The Chappo sub-basin extends for approximately 3.3 miles from the narrows at Basilone Road to the narrows at the northern end of the Lower Ysidora sub-basin. The surface area of the alluvium in the Chappo sub-basin is approximately 2,180 acres. Within this sub-basin, the primary recharge to the ground-water aquifer is seepage from the river and underflow from the upper sub-basin. There is minor return flow from irrigation of parade grounds and plants, but this is not considered a source of ground-water recharge as the grasses and trees use most of the applied water before it reaches the ground-water table. Primary outflows within this sub-basin include production well pumping, phreatophyte ET along the riparian corridor, and underflow through the narrows to the Lower Ysidora sub-basin. The estimated ground-water storage capacity of the Chappo sub-basin is 27,000 acre-feet (Troxall and Hofman, 1954).

The Lower Ysidora sub-basin extends for approximately 2.7 miles from the narrows south of the Chappo sub-basin to another narrows in the bedrock near the estuary and mouth of the Santa Margarita River. The surface area of the Lower Ysidora sub-basin is approximately 1,020 acres. Within this sub-basin, the primary recharge to the ground-water aquifer is seepage from the river, underflow from the Chappo sub-basin, and infiltration from the wetlands. Until 1993, another primary inflow was the percolation of secondary treated effluent from oxidation pond 13. Other ground-water inflows include percolation from precipitation and range front recharge. Primary outflows within this sub-basin include irrigation well pumping, ET by phreatophytes along the riparian corridor and wetland areas, and underflow through the narrows at the base of the Lower Ysidora sub-basin.

2.2 Surface Water

In the Upper Basin of the Santa Margarita River, Murrieta Creek and Temecula Creek combine to form the 27-mile long Santa Margarita River that flows to the Pacific Ocean. Immediately downstream from the confluence of these two creeks, U.S. Geological Survey (USGS) streamflow gage #11044000 marks the location of the station referred to as the “Gorge.” The 82-year period of record associated with this gage records the runoff from the 586-square-mile drainage area that dominates the Santa Margarita basin. Historic mean daily discharges at this gage have been measured between 0.2 and 20,000 cfs. The remaining 154-square-mile drainage area downstream from the Gorge is defined as the lower Santa Margarita River basin.

Downstream from the confluence of Murrieta Creek and Temecula Creek, the Santa Margarita River flows through a narrow, precipitous canyon, from the Gorge downstream to a point below its confluence with De Luz Creek. Beyond this point, it flows onto the coastal floodplain until it eventually drains into the Pacific Ocean. The entire lower basin has a drainage area of approximately 154 square miles, where De Luz Creek is the primary tributary to the Santa Margarita River. De Luz Creek drains a relatively undeveloped 47.5-square-mile watershed, and precipitation runoff comprises virtually all flow in the creek (FPUD, 1994).

Precipitation runoff comprises a significant majority of surface flow in the Santa Margarita River basin. Local runoff generated by precipitation events is dependent on soil characteristics, land slopes, existing soil moisture, storm intensity, and storm duration. Because of these factors, the runoff varies greatly from year to year, month to month, and location to location. Within the alluvial floodplain, runoff is generally minimal due to the flatness of topography, undeveloped characteristic of the area, and sandy soil. In the foothills and mountainous areas dominated by bedrock formations, runoff may be significant during large precipitation events.

The Santa Margarita River is often dry for several months of the year in parts of the Chappo and Lower Ysidora sub-basins. Table 2.1 presents monthly mean daily flows at the Ysidora USGS gauging station. The driest months are June through October; the wettest months are January through March. In extremely dry years, there has been no surface flow at all reaching the ocean. In extremely wet years, the mean daily flow has reached as high as 19,500 cfs and the peak instantaneous flow has exceeded 44,000 cfs.

Table 2.1 Monthly statistics of mean daily flow (in cfs) from Ysidora USGS gauging station (11046000)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
100	166	145	43	12	4	1	1	1	2	7	19

Source: http://nwis.waterdata.usgs.gov/ca/nwis/nwisman/?site_no=11046000&agency_cd=USGS.

3.0 Water Requirements

This section describes the water requirements of Camp Pendleton and FPUD that could be applied against water developed by the pre-feasibility Conjunctive Use Project alternatives.

3.1 Camp Pendleton

Camp Pendleton provided an assessment of present and future demands that they would apply against water service from the Conjunctive Use Project. Monthly demands were provided for years starting in year 2000 and ending in 2050. Table 3.1 presents the monthly basin-wide demands provided by Camp Pendleton. The maximum future base-wide demand that Camp Pendleton could place on the pre-feasibility alternatives would be about 18,000 acre-feet per year (af/yr). It should be noted that these quantities do not include the use of recycled water to reduce demand for potable water.

Table 3.1. Total present and future Camp Pendleton demands that could be met by the Conjunctive Use Project (acre-feet/month)

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
2000	901	812	743	624	446	624	802	891	901	1020	1129	1010	**9900**
2010	1037	935	855	718	513	718	923	1026	1037	1174	1300	1163	**11400**
2015	1198	1080	988	830	593	830	1067	1185	1198	1357	1501	1343	**13170**
2020	1344	1211	1108	931	665	931	1196	1329	1344	1521	1684	1507	**14770**
2030	1390	1252	1145	962	687	962	1237	1374	1390	1573	1741	1558	**15270**
2040	1435	1293	1183	994	710	994	1277	1419	1435	1624	1798	1609	**15770**
2050	1629	1468	1342	1128	805	1128	1450	1611	1629	1843	2040	1825	**17897**

3.2 Fallbrook Public Utility District

FPUD provided an assessment of present and future demands that it would apply against water developed by the Conjunctive Use Project. Total water demands were provided on a minimum, average, and maximum year basis. Table 3.2 summarizes these monthly demands. The numbers in this table represent maximum potential reductions in imported water that could be realized by FPUD, if the water were available from the conjunctive use project. These demands were based upon actual water use from years 1999 to 2004. Water use within the Fallbrook area is not expected to increase in the future. The maximum future demand that FPUD could put on the pre-feasibility alternatives through corresponding reduction in imports would be about 11,000 acre-feet per year. On a monthly basis, the demands, shown in table 3.2, do not always increase across the minimum, average, and maximum demand year categories. This is due to effects of climate variation or agricultural water demands. Increases are, however, reflected on the annual totals shown at the bottom of table 3.2.

Table 3.2. Present and future potential reductions in import water, that could be realized by FPUD, if the water were available from the conjunctive use project (acre-feet)

Month	Minimum demand year	Average demand year	Maximum demand year
July	1071.1	865.0	684.7
August	1158.7	1149.4	1164.7
September	1009.2	1015.1	1149.9
October	1071.5	1077.9	1170.0
November	763.7	914.9	1027.2
December	728.3	825.4	900.9
January	945.9	723.3	779.6
February	501.2	782.4	857.6
March	312.0	491.8	533.0
April	561.3	715.8	922.0
May	548.5	641.9	750.2
June	998.1	989.9	1073.4
TOTAL	**9669.5**	**10192.8**	**11013.2**

4.0 Development of Pre-Feasibility Alternatives

This section describes previous investigations, the pre-feasibility alternatives workshop, and alternatives eliminated from further consideration.

4.1 Previous Investigations

Numerous studies have been conducted and reports written regarding use of the Santa Margarita River. These include the following:

Santa Margarita Project, San Diego County, California, Draft Supplemental Environmental Statement, Reclamation, April 1984.

Conjunctive Use Study: Lower Santa Margarita River Basin, FPUD, June 1994.

Santa Margarita River Recharge and Recovery Enhancement Program: Permit 15000 Feasibility Study for Marine Corps Base Camp Pendleton, Stetson Engineers Inc., March 23, 2001.

Conjunctive Use Project for the Lower Santa Margarita River Basin, Supplemental Study to the Santa Margarita River Recharge and Recovery Enhancement Program: Permit 15000 Feasibility Study for Marine Corps Base Camp Pendleton, Stetson Engineers Inc., February 2002.

Technical Engineering Report, Constructed Treatment Wetland Feasibility Study, Marine Corps Base Camp Pendleton California, Stetson Engineers Inc., March 2003.

Environmental Impact Statement for the Tertiary Treatment Plant and Associated Facilities, Marine Corps Base Camp Pendleton, The Environmental Company, April 2004.

Draft: Three Dimensional Groundwater Flow Model of the San Mateo and San Onofre Basins, USMC Base Camp Pendleton, Stetson Engineers Inc., September 2004.

4.2 Pre-Feasibility Alternatives Workshop

On June 29 and 30, 2004, Reclamation, FPUD, Camp Pendleton, NWS, Stetson Engineers Inc., and North State Resources conducted a pre-feasibility alternatives development workshop. The purpose of the workshop was to (1) refine the purpose and need for the project, (2) develop conceptual alternatives for meeting the purpose and need, and (3) develop criteria for ranking each alternative's capability to meet project objectives. A facilitator directed the workshop over the course of the two days and assisted in documenting the decisions and conclusions that were jointly agreed upon. The purpose and need presented in section 1.2 was developed at that workshop and has been refined during the ensuing months. After the workshop, the alternatives were refined into a summary document by Stetson Engineers Inc. This document was distributed for review to each of the workshop participants and comments were collected. Stetson made revisions to the summary document according to these comments. The resulting revised alternatives are those that have been evaluated and presented in this report.

4.3 Alternatives Eliminated from Further Consideration

The following project concepts were eliminated from further consideration as described in the following sections.

- Fallbrook Dam
- De Luz Dam
- On-stream storage on Santa Margarita River
- Seawater desalination
- Exchange alternatives with Oceanside
- Brackish ground-water desalination
- Recovery and recharge of storm water in Murrieta-Temecula ground water basin
- Enlargement of Lake O'Neill

Fallbrook and De Luz Dam

These dams were studied in detail, as documented in the *Santa Margarita Project, San Diego County, California,* Draft Supplemental Environmental Statement*,* April 1984. The Santa Margarita Project consisted of the 36,500-acre-foot Fallbrook Dam and Reservoir; the 142,950 acre-foot De Luz Dam and Reservoir; the Fallbrook pumping plants and conveyance line; the cross-base aqueduct and pumping plants; recreation and fishing facilities; and wildlife conservation and enhancement management areas. Although the project would have recreational benefits, recreation is not part of the project purpose and need. The average project yield ranged from 10,400 acre-feet under initial conditions to 11,500 acre-feet under year 2020 conditions. This project is considered not feasible because of potential environmental impacts and very high construction costs. The original Fallbrook Dam project received a jeopardy opinion from the U.S. Fish and Wildlife Service.

Other On-Stream Storage

The study of any other storage reservoirs on the Santa Margarita would result in less feasible results than those studied in the April 1984 *Santa Margarita Project, San Diego County, California,* Draft Supplemental Environmental Statement. No further study of on-stream reservoir sites is required.

Seawater Desalination

Use of desalted ocean water would not meet the purpose and need of the project because it would not provide for the perfection of Reclamation's Santa Margarita River permits nor increase the yield of the lower Santa Margarita River basin.

Water Exchange With Oceanside

An exchange of water with the city of Oceanside was considered but eliminated from further consideration because (1) there are insufficient demands in Oceanside at the lower elevations that would make this alternative feasible and (2) Oceanside has made commitments to an ocean desalination project in Carlsbad. By letter dated July 21, 2004, Reclamation requested confirmation that the city of Oceanside was not interested in water exchange concepts involving the Santa Margarita River Conjunctive Use Project. By e-mail dated July 27, 2004, Mr. Barry Martin, Water Utilities Director, provided confirmation.

Brackish Water Desalination

The only local source of brackish water is in the Lower Ysidora sub-basin, which extends to a narrows in the bedrock near the estuary and mouth of the Santa Margarita River. Significant pumping from this area would likely result in sea-water intrusion. Construction and sustained operation of a desalting plant designed to accommodate brackish waters would not be feasible.

Recovery and Recharge of Storm Water in Murrieta-Temecula Ground-Water Basin

Development of a project to recharge and recover water within the Murrieta-Temecula ground-water basin would not make water available for use in Camp Pendleton and/or Fallbrook. This basin is currently overdrafted, and the amounts of water that could be recharged would not likely reverse this situation.

Enlargement of Lake O'Neill

It would not be physically possible to raise the dam on Lake O'Neill without inundating valuable facilities nor economically feasible to deepen the reservoir. However, dredging of the lake to return it to its original capacity is considered in this study.

5.0 Pre-Feasibility Alternative Concepts

This section provides an overview and detailed description of the alternative concepts.

5.1 Overview of Alternative Concepts

Three major concepts, including 22 sub-set alternatives were evaluated for meeting the project purpose and need. The three major concepts are as follows:

Concept 1—Conjunctive use in the lower Santa Margarita River basin using diversions to existing and new recharge ponds. Concept 1 project facilities include the following:

- Installing an Obermeyer spillway gate diversion structure (replaces existing sheet pile diversion structure)
- Increasing the capacity of O'Neill Ditch from 60 to 200 cfs
- Increasing the headgate capacity at the diversion structure from 60 to 200 cfs
- Rehabilitating five recharge ponds (pond Nos. 1-5)
- Modifying two unused recharge ponds (pond Nos. 6 and 7)
- Constructing new ground-water production wells in the Upper Ysidora and Chappo sub-basins
- Installing a collection system for recovered ground water
- Constructing an advanced water treatment plant
- Constructing new brine disposal line
- Constructing transmission bi-directional pipeline to Fallbrook
- Constructing two pumping plants
- Rehabilitating Lake O'Neill (dredging of sediment)

Modifying recharge pond Nos. 6 and 7 would provide increased infiltration capacity and surface storage. The maximum rate of diversion would be approximately 200 cfs. Improving these facilities would allow for the proper management of flows to Lake O'Neill and the recharge ponds. Increasing winter ground-water pumping rates would create ground-water storage capacity in the aquifer and allow for stream diversions to infiltrate to the aquifer.

Concept 2—Conjunctive use in the lower Santa Margarita River basin using diversions to recharge ponds, diversions, and direct pumping from a sump located near Fallbrook. Concept 2 project facilities include the following:

- Installing an Obermeyer spillway gate diversion structure (replaces existing sheet pile diversion structure)

- Increasing the capacity of O'Neill Ditch from 60 to 200 cfs
- Increasing the headgate capacity at the diversion structure from 60 to 200 cfs
- Rehabilitating five recharge ponds (pond Nos. 1-5)
- Modifying two unused recharge ponds (pond Nos. 6 and 7)
- Constructing new ground-water production wells in the Upper Ysidora and Chappo sub-basins
- Installing a collection system for recovered ground water
- Rehabilitating Lake O'Neill (dredging of sediment)
- Constructing two advanced water treatment plants
  - Haybarn Canyon
  - Red Mountain Reservoir
- Constructing new brine disposal line to the Pacific Ocean
- Constructing an Obermeyer spillway diversion structure at the Fallbrook sump
- Constructing a pumping plant for water from Fallbrook sump
- Constructing a raw water pipeline to deliver water to the Red Mountain advanced water treatment plant
- Constructing a pipeline from Morro Hill to Camp Pendleton (for emergency water supply)

Concept 3—Conjunctive use in the lower Santa Margarita River basin using diversions to recharge ponds in combination with in-stream check structures constructed in the Chappo basin along the Santa Margarita River. Concept 3 project facilities include the following:

- Constructing four instream check structures (in lieu of modifying two unused recharge ponds)
- Increasing the capacity of O'Neill Ditch from 60 to 100 cfs
- Increasing the headgate capacity at the diversion structure from 60 to 100 cfs
- Rehabilitating five recharge ponds (pond Nos. 1-5)
- Constructing new ground-water production wells in the Upper Ysidora and Chappo sub-basins
- Installing a collection system for recovered ground water
- Constructing an advanced water treatment plant
- Constructing new brine disposal line to the Pacific Ocean
- Constructing transmission bi-directional pipeline to Fallbrook
- Constructing two pumping plants
- Rehabilitating Lake O'Neill (dredging of sediment)

Improvements to Existing Facilities

Some of the project elements that are part of the three major alternative concepts include improvements and/or replacement of existing structures. Following is a description of the sheet pile diversion replacement with an Obermeyer diversion structure, ditch and headgate improvements, and existing recharge pond improvements.

Obermeyer Diversion Structure

An Obermeyer diversion structure would allow for an increased amount of water to be diverted into O'Neill Ditch, while simultaneously restoring a more natural sediment transport regime, reducing the operation and maintenance costs of removing sediment accumulated behind the weir and in front of the headwall and headgate.

The Obermeyer spillway gate system consists of a row of steel gate panels supported on their downstream side by inflatable air bladders. The air bladders consist of a three-ply, nylon reinforced fabric with a special 5-millimeter-thick EPDM (ethylene propylene diene monomer) outer cover to protect the dam against ultraviolet rays and ozone. Total fabric thickness is 0.50 inch, and the expected life is more than 30 years. The bladder is inflated with air to a design pressure of 16 to 20 pounds per square inch (psi) in about 30 minutes using an air compressor. The control system automatically maintains internal pressure and can be operated remotely from an office computer workstation with the addition of a modem and a phone line.

The Obermeyer spillway gate system would be lowered/deflated during the first 12 to 24 hours of a 10-year or greater flood flow, allowing sediment and debris to pass down the river channel. After a flood flow has passed, the Obermeyer spillway gate system would be raised/inflated to re-allow full diversion capacity to be restored.

The capacity of the Concept 1 and Concept 2 headgate for the ditch would be increased from 60 cfs to 200 cfs.

Ditch and Headgate Improvements

The ditch capacity that is appropriate for diverting the required amount of Santa Margarita River water during critical dry periods was determined (dependent on the alternative being considered) to be either 100 cfs (Concept 3) or 200 cfs (Concepts 1 and 2). This amount is based on the hydrology of the river for a 75-year period of record (1925-99) and available off-stream storage in the ground-water recharge ponds and Lake O'Neill. A water depth in the existing ditch of 5 feet is required for a 200-cfs flow.

Recharge Pond Improvements (Pond Nos. 1-5 and 6-7)

Because of the increased capacity of the diversion dam and conveyance facilities, capacity improvements to the recharge ponds are required to control the flow of water between each of the ponds. Depending on the alternative, additional weirs would be required to increase the instantaneous flow between each of the five recharge ponds from 100 cfs to 200 cfs. New control structures would include motor-operated sliding weir gates mounted on cast-in-place concrete box structures to control pond water levels and to measure flow between ponds.

The sliding weir gate structures would control pond water levels such that flow from one pond would cascade to another without backwater effects between ponds that are in series. Eliminating the backwater effects between ponds would allow flow to be easily and accurately measured. The maximum allowable pond water levels would be fixed by the crest height of each sliding weir gate. Pond Nos. 6 and 7 are not currently being used and would require some modification for them to become functional.

Potential New Project Facilities

Within each major concept are defined sub-alternatives that include combinations of the following concepts and facilities:

- Advanced water treatment plants
- Bi-directional pipeline and pumping plants to Fallbrook from the Haybarn water treatment facility
- San Mateo Creek and San Onofre Creek (SMC/SOC) ground-water basins
- Sustained yield pumping in the SMC/SOC basins
    - Conjunctive use of Santa Margarita River water in the SMC/SOC basins
    - Water exchanges with Orange County and/or Metropolitan Water District of Southern California (MWD)
    - Raw water pipeline from the SMC/SOC basins to the Santa Margarita River
    - Bi-directional raw water pipeline from the SMC/SOC basins to the Santa Margarita River
- Reclaimed water and treatment wetlands
    - Treatment wetlands and reservoir on NWS
    - Treatment wetlands on Camp Pendleton in Pueblitos Canyon
    - Treatment wetlands on Camp Pendleton in Newton Canyon
    - Denitrified pipelines from the treatment wetlands to recharge areas along the lower Santa Margarita River
- Off-stream reservoir site on Camp Pendleton
- Direct diversion from recharge ponds
- Pipeline from Oceanside to Camp Pendleton for emergency water supply
- Brine line to the Pacific Ocean
- In-stream check structures

Following is a description of these potential new project concepts and facilities.

Advanced Water Treatment

All pre-feasibility alternatives include advanced water treatment as described in section 7 of this report. In section 8, the sensitivity of the cost of each of the alternatives is discussed relative to replacing advanced treatment with primary treatment processes.

Fallbrook Conveyance Pipeline

Some pre-feasibility alternatives include an option to construct a pipeline to convey treated potable water from Camp Pendleton to the town of Fallbrook. At a pre-feasibility level, it was assumed that water would be pumped from near Lake O'Neill to Red Mountain Reservoir. Two pump stations, one primary and one booster, would be used to lift the water 500 and 600 feet, respectively. The total length of the pipeline would be 67,000 feet.

San Mateo Creek and San Onofre Creek Ground-Water Basins

Stetson Engineers Inc. has completed a study of potential ground-water management scenarios in the San Mateo Creek and San Onofre Creek ground-water basins. Scenarios included sustained basin yield pumping and development of conjunctive use elements consistent with use of water from the Santa Margarita River basin. Stetson Engineers Inc. estimated the sustained pumping yield (above historic levels) of the San Mateo and San Onofre Creek basins to be 2,800 and 2,300 acre-feet per year, on median and average annual basis, respectively. Under sustained use, it is assumed that pumping is in equilibrium with local runoff and recharge from San Mateo and San Onofre Creeks (Stetson Engineers Inc., September 2004).

The additional median year yield that would be available as a result of conjunctive use of divertable flow from the Santa Margarita River is 600 acre-feet per year. Implementation of conjunctive use of San Margarita River water in the San Mateo Creek and San Onofre Creek basins would require the construction of a cross-base pipeline and recharge ponds in the San Mateo Creek basin. Included in the pre-feasibility alternatives are two options for such a pipeline:

- Raw water pipeline from the SMC/SOC basins to the Santa Margarita River.
- Bi-directional raw water pipeline from the SMC/SOC basins to the Santa Margarita River. Bi-directional pumping capabilities would, in concept, increase yield of the project by optimizing storage capacity and supply operations.

Ground water could be conjunctively managed to increase the amount of water that can be diverted from the Santa Margarita River and stored in the aquifers on the Base. The development of a ground-water conjunctive use program is intended to provide an increased amount of local ground-water supplies and to help Camp Pendleton avoid regulatory issues regarding habitat maintenance along the Santa Margarita River's riparian corridor. One of the most important aspects of the proposed conjunctive use pumping is that maximum ground-water withdrawals occur during the winter months when habitat maintenance requirements are at a minimum. During the dry summer months, ground-water withdrawal rates are reduced to support sensitive habitat.

Water Exchanges with Orange County

Construction of a 23,000-foot-long pipeline from ground-water wells in the San Mateo Creek basin to the South County/Pico Pipeline in Orange County would allow for an exchange of water at Fallbrook. Water would be lifted a total of 450 feet of static head. Water delivered to Orange County would be exchanged for water from the San Diego Aqueduct at Fallbrook, where it would be delivered through existing facilities into Red Mountain Reservoir.

Salinity of the waters in the San Mateo Creek and San Onofre Creek basins average about 560 milligrams per liter (mg/L) and, therefore, would not require advanced treatment. However, water pumped from the San Mateo Creek basin (and indirectly from San Onofre Creek basin) would undergo well head treatment involving the process of chloramination.

Chloramination is used in the treatment of drinking water with a chloramines disinfectant. Both chlorine and small amounts of ammonia are added to the water, which react together to form chloramines. Chloramines are a long-lasting disinfectant and, therefore, are sometimes used in large distribution systems.

Reclaimed Water and Treatment Wetlands

Another option is the construction of a treatment wetland and associated storage reservoir and other facilities on the Naval Weapons Station. The basic components are a land outfall pipeline from the existing ocean outfall pipeline to the treatment wetland, treatment wetland in one of two canyons, storage reservoir, and pipeline from storage reservoir to Santa Margarita River.

Land Outfall Pipeline

The water reuse cycle associated with treatment wetlands begins with the release of tertiary treated wastewater from the FPUD wastewater treatment plant. Currently, this water either is sold as reclaimed water or is carried down FPUD's existing 16-inch ocean outfall pipeline. The tertiary treated wastewater releases would flow through the ocean outfall pipeline to a new 9,000-foot land outfall pipeline (assumed to be high density polyethylene [HDPE]) and then to the treatment wetland. The land outfall pipeline is designed to operate entirely under gravity flow.

Treatment Wetland

The San Diego Regional Water Quality Control Board adopted a "Water Quality Control Plan," or "Basin Plan" in September 1994. The Basin Plan has objectives for the quality of both surface and ground water. The proposed treatment wetland is designed to reduce nitrate levels in the effluent from the wastewater treatment plant to meet the ground water quality objectives in the Basin Plan. A multi-cell treatment wetland will allow for operation and maintenance flexibility in the future. After treatment and temporary storage, the water would be released from the storage reservoir through a denitrified pipeline to the main natural channel of the Santa Margarita River. A spillway allows water to spill out of the wetland and into the natural channel during large precipitation events.

The goal is to use the recycled water to meet habitat demands and minimize the impact of reduced ground-water pumping during the summer months and dry years. The goal is also to increase the yield of the project through the use of FPUD's tertiary treated wastewater.

The primary role of the treatment wetland is to "polish" the tertiary treated effluent released from the FPUD wastewater treatment plant. The wetland would reduce nitrate concentrations in the effluent water to a level that is acceptable for discharge to the storage reservoir and, subsequently, to the Santa Margarita River.

Dam and Storage Reservoir
A 49-acre storage reservoir, with a volume of 1,600 acre-feet, would capture and store the releases from the treatment wetland following nitrate reduction of the tertiary treated wastewater. The storage reservoir is designed to store 7 months of wastewater releases and allow for controlled releases during the subsequent 5 months. Between July and November, controlled releases would be delivered to the Santa Margarita River through the 5,800-foot pipeline. The reservoir capacity is designed to capture the median natural inflow for controlled release to the natural drainage.

The zoned-earthfill embankment consists of an impervious core; a chimney sand filter and gravel drain, as well as a filter blanket and drain downstream of the core in contact with the foundation; pervious shell materials, and a toe drain. The 25-foot wide crest is at elevation 400 feet. This embankment would have 10 feet of freeboard protection above the normal water surface because of the lack of good contour data. In addition, the design includes extra freeboard because it is assumed that this structure would not have any emergency spillway or overflow section. An outlet works through the embankment would allow discharge to the system, as discussed in other sections of this report. The embankment slopes are 3:1 (horizontal to vertical) upstream and 2.5:1 downstream from the crest to its contact with the excavated foundation. The upstream slopes would be protected with a 3-foot-thick layer of riprap, and the downstream slopes would be seeded to provide erosion protection to the structure. A typical cross section and plan of the embankments is shown in **figure 5.1a**. Because of the high seismicity in this area, the dam would be founded entirely on bedrock, and it is assumed that the cutoff trench would extend under the complete width and length of the embankment. For the purposes of this pre-feasibility estimate and the lack of any

Figure 5.1a. Typical cross section and plan embankments, NWS storage reservoir

specific geologic data, the depth to bedrock could vary between 10 and 50 feet. A 10-foot excavation was assumed for the cost estimate.

Treatment Wetlands on Camp Pendleton in either of two canyons
Treatment wetlands are used to remove nutrients from wastewater treatment plant effluent through the process of nitrification/denitrification. Nitrification refers to the oxidation of ammonia with free oxygen and is accomplished by certain species of bacteria. Denitrification refers to the use of nitrate (NO_3^-) by bacteria as a replacement for free oxygen (O_2) when insufficient free oxygen is available for the oxidation of biodegradable carbon. In contrast to denitrification, nitrification requires aerobic conditions and, thus, is more likely to occur in zones of open water placed where significant atmospheric re-aeration occurs.

Two wetland sites on Camp Pendleton are incorporated into some of the pre-feasibility alternatives considered in this document. These sites are located in Pueblitos Canyon or Newton Canyon Ponds. Both wetland areas would receive treated effluent from a regional wastewater treatment plant via land outfall pipelines. Denitrified water from the wetlands would be delivered via dentrified pipeline for aquifer recharge.

Pueblitos Canyon
One possible location for a wastewater treatment wetland is in Pueblitos Canyon. This site is considered advantageous because of its flexibility to treat a wide range of flows due to the large amount of land available and its proximity to the Santa Margarita River discharge point. Stetson Engineers Inc., determined that much of the land in Pueblitos Canyon is already disturbed and is not of high habitat value. This site has higher capital, operations, and maintenance costs than the Newton Canyon site because of its distance from the treated effluent pipeline and high pumping lift associated with transporting the treated effluent to the site.

Newton Canyon Ponds
There exists the opportunity to construct a wastewater treatment wetland at the site of the Newton Canyon Ponds. This site is advantageous because of its proximity to the proposed regional wastewater treatment plant and land availability. Stetson Engineers Inc., determined that a treatment wetland constructed at this site would provide treatment capacity of 5,600 acre-feet per year. The construction of a wastewater treatment wetland at the location of the Newton Canyon Ponds would require new pipeline construction and pumping of denitrified water to a discharge point nearly 4 miles north in the Lower Ysidora sub-basin.

It is assumed for the purposes of this pre-feasibility analysis that reclaimed water would be available from the proposed regional wastewater treatment plant in the southeast section of Camp Pendleton.

Denitrified Pipeline from Treatment Wetlands to Recharge Areas along the Lower Santa Margarita River

A buried pipeline would convey reservoir releases to the Santa Margarita River. The "denitrified" or reservoir discharge pipeline is designed to operate entirely under gravity flow from the reservoir to the river. The design pipeline is a 20-inch HDPE with invert elevations of 295 feet mean sea level (msl) at the connection to the 36-inch dam outlet pipeline and 130 feet msl at the Santa Margarita River. The total required length of the 20-inch pipeline is 5,800 feet.

Controlled releases from the storage reservoir would blend with the Santa Margarita River to provide water that supports the riparian habitat in the lower Santa Margarita River basin. The timing of these controlled releases would allow ground-water pumping to remain unimpeded during the dry summer months. The benefit of these releases to both the habitat and the two parties would be realized not only during the dry summer months, but also during the years of extended drought.

The reservoir and dam is designed to allow for the controlled and uncontrolled bypass of natural inflows formed during storm events. Both the controlled and uncontrolled bypass of natural runoff would serve to maintain natural conditions in the natural drainage channel between the reservoir and the Santa Margarita River. Direct releases from the reservoir to the Santa Margarita River would reduce operation and maintenance of the natural drainage and prevent changes to the natural habitat in this area.

Off-Stream Reservoir Site on Camp Pendleton

Incorporated into some pre-feasibility alternatives is reservoir site 6 from the March 23, 2001, *Santa Margarita River Recharge and Recovery Enhancement Program: Permit 15000 Feasibility Study for Marine Corps Base Camp Pendleton*. This impoundment would require a series of earth embankments located in the upper Pilgrim Creek watershed. This site would provide a water volume of approximately 4,600 acre-feet, assuming a normal water surface elevation of 460 feet, and would cover approximately 156 acres. The normal water surface elevation of 460 feet was stated in the 2001 study; however, there is conflicting data that indicates that this normal water surface elevation (460 feet) would provide about 252 acres (7,300 acre-feet) as indicated in appendix G: Potential Off-Stream Storage Sites, or 55 acres (4,800 acre-feet) as reported in Chapter 7: Alternative Evaluation.

The proposed reservoir would be contained by five embankment structures, including two larger dams and three smaller dikes. All these structures are assumed to be zoned earthfill embankments consisting of an impervious core; a chimney sand filter and gravel drain, as well as a filter blanket and drain downstream of the core in contact with the foundation; pervious shell materials, and a toe drain. The crest of the structures is 25 feet wide at elevation 465 feet, allowing for 5 feet of freeboard. This should be sufficient for an off-stream reservoir, and one of the smaller dikes would be constructed with a fuse plug or emergency spillway. The embankments slopes are 3:1 (horizontal to vertical) upstream and 2.5:1 downstream from the crest to its contact with the excavated foundation. The upstream slopes would be protected with a 3-foot-thick layer of riprap, and the downstream slopes would be seeded to provide erosion protection to the structure. A typical cross section and plan of the embankments is shown in **figure 5.1b**.

Because of the high seismicity in this area, the dams and dikes would be founded entirely on bedrock, and it is assumed that the cutoff trench would extend under the complete width and length of the embankment. For the purposes of this pre-feasibility estimate and the lack of any specific geologic data, the depth of to bedrock could vary between 10 and 50 feet. A 10-foot excavation was assumed for the cost estimate.

Water stored in the reservoir can be returned back into the system via an outlet works at one of the main embankments; however, since no data was available and these appurtenant structure designs were beyond the scope of this study, the costs for this structure, the emergency spillway, as well as the toe drain, is factored into the pre-feasibility estimate using unlisted items.

Dam No. 1 is the largest of all the dams at this site and has a crest length of 820 feet and an embankment height (to original ground) of 105 feet. Dam No. 2 has a crest length of 642 feet and a height of 55 feet. The three smaller dikes (dike Nos. 1, 2, and 3) total about 863 feet (443, 261, and 159 feet, respectively) and have embankment heights of 15, 8, and 5 feet, respectively.

Direct Diversion from Recharge Ponds

This concept was developed as an alternative to pumping ground water during wet periods on the river. The concept is to pump directly from pond No. 6 when the pond is full. An alternative to pumping surface water directly from the pond is to pump from wells in proximity to pond Nos. 6 and 7. Wells also could be placed in the ponds.

Brine Line to Pacific Ocean

All pre-feasibility alternatives involve advanced water treatment, as described in section 7.0. The treatment plant design assumes an 85-percent recovery and 15-percent reject concentrate stream. It is assumed, for the purposes of the pre-feasibility study, that all reject brine would be transported through an existing and abandoned 16- to 18-inch-diameter concrete pipeline. This pipeline begins at sewage plant No. 3 on Camp Pendleton and extends to a crossing upstream of the Stuart Mesa Road bridge over the Santa Margarita River. A pipeline would have to be constructed to convey the reject stream from the Haybarn water treatment plant to the beginning of the abandoned line at sewage plant No. 3. The abandoned pipeline was damaged by flood flows at the location where the pipeline crosses the Santa Margarita River. Therefore, before the abandoned line could be used, the damaged section would have to be repaired and/or replaced.

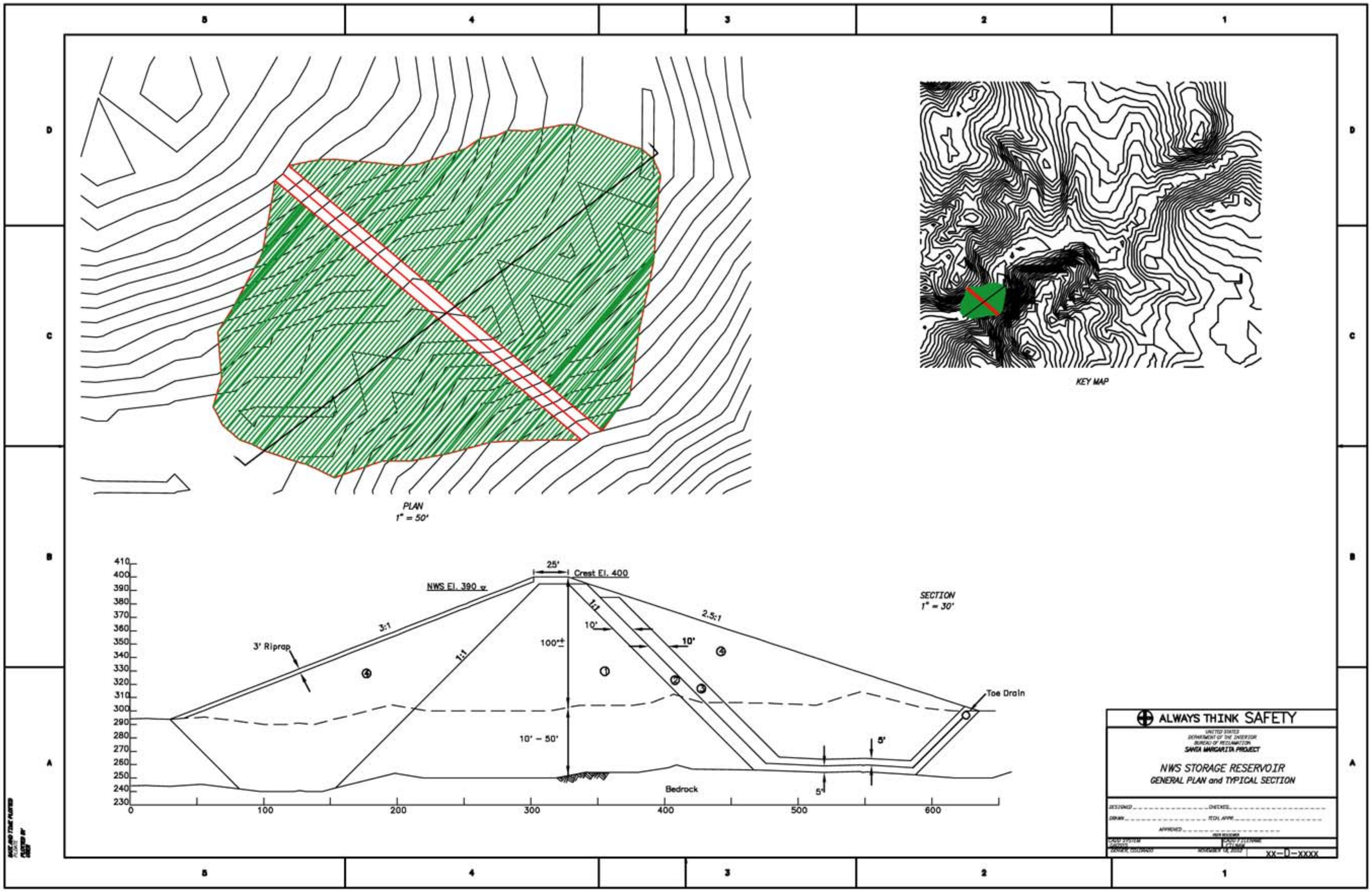


Figure 5.1b. Typical cross section and plan embankments, offstream storage reservoir.

An extension to the pipeline would need to be constructed to convey the concentrate to the Pacific Ocean. A permit from the Regional Water Quality Control Board would be necessary for off-shore discharge within 3 miles of the coast. If the off-shore discharge will occur beyond 3 miles from the coast, then a permit would be required from the U.S. Environmental Protection Agency.

Permits to construct the brine line would also be necessary from the State of California. For the purposes of making pre-feasibility comparisons, it was assumed that the outfall would extend 3,000 feet beyond the estuary into the Pacific Ocean. The expected TDS of the concentrated reject stream would be 2,800 mg/L.

In-stream Check Structures

Some of the pre-feasibility alternatives involve construction of in-stream check structures along the Santa Margarita River downstream from Basilone Road. The purpose of the check structures is to increase recharge to the Chappo sub-basin (figure 2.1). These structures would be constructed in lieu of constructing pond Nos. 6 and 7. Reclamation used a one-dimensional hydraulic surface model (HEC-RAS Version 3.1.1) provided by West Consultants for the Santa Margarita River to develop the location and size of four check structures. The location of these four check structures is shown in **figure 5.2.a**. **Figures 5.2b through 5.2e** depict the location of each check structure across the flood channel in the Chappo sub-basin. The structures do not span the entire flood channel but are confined to the present day active flow channel. The shortest structure would be about 200 feet long; the longest would be about 400 feet. Each would be about 3 feet with side slopes of 3:1. About 1000 cubic yards would be needed to construct the four structures.

The check structures would be designed to be temporary in nature and would be washed out every 3 to 5 years during high flow events. During low-flow periods, sediment would accumulate upstream of the structures. The temporary nature of the structures would allow flood flows to remove the barriers and transport fine materials down stream of the Chappo sub-basin. Fine materials, if allowed to accumulate for extended periods of time upstream of the structures, could seal the ponding areas and reduce recharge rates.

Stetson Engineers Inc. assessed the hydraulic modeling results to determine from historic flows how much additional recharge the four check structures could be expected to provide. The results of this yield evaluation are incorporated in the alternative yields discussed later in this report.

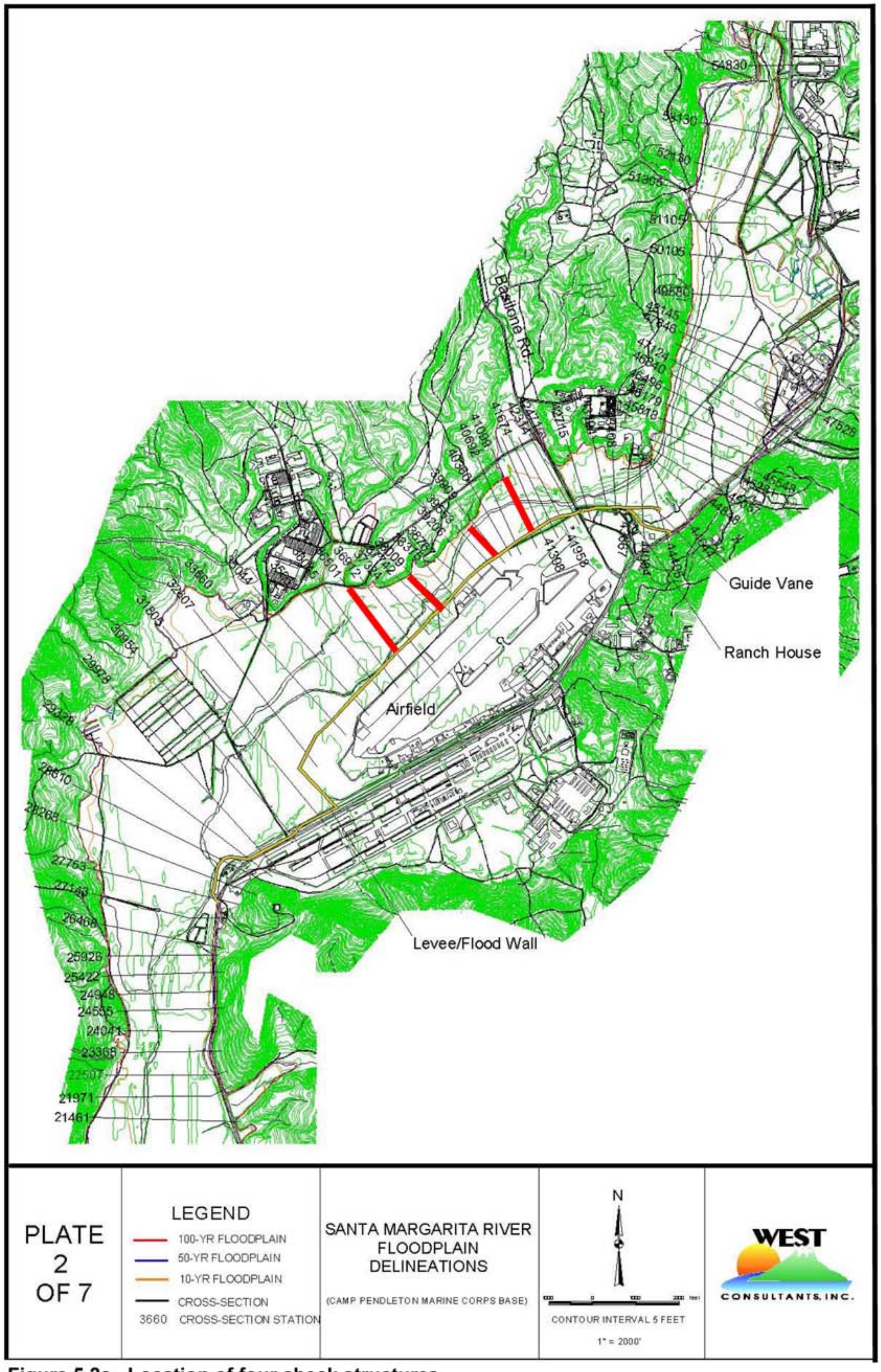
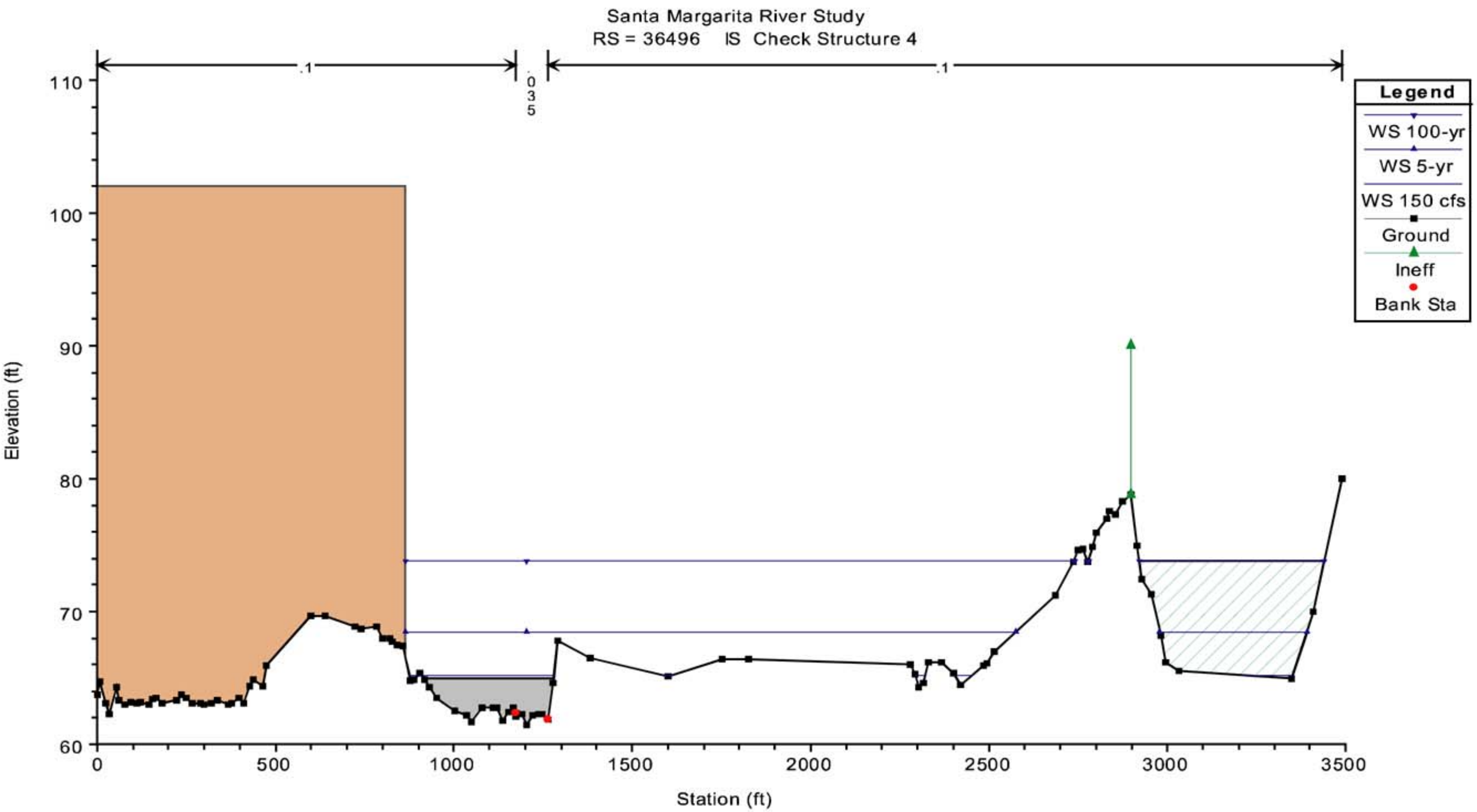


Figure 5.2a. Location of four check structures.

Figure 5.2b.


Santa Margarita River Study
RS = 36496 IS Check Structure 4
.1
.035
.1
Legend
WS 100-yr
WS 5-yr
WS 150 cfs
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
110
100
90
80
70
60
0
500
1000
1500
2000
2500
3000
3500

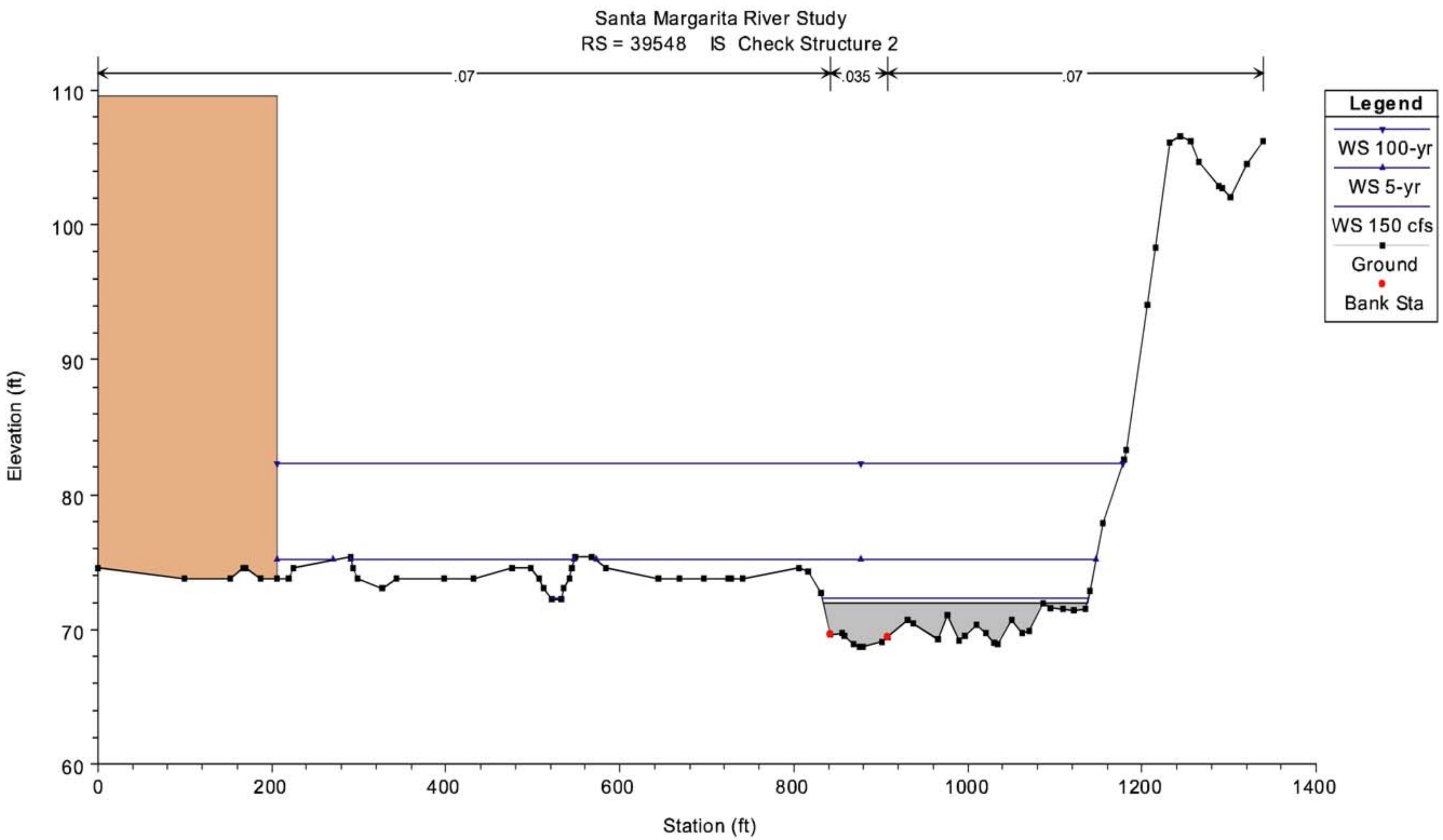
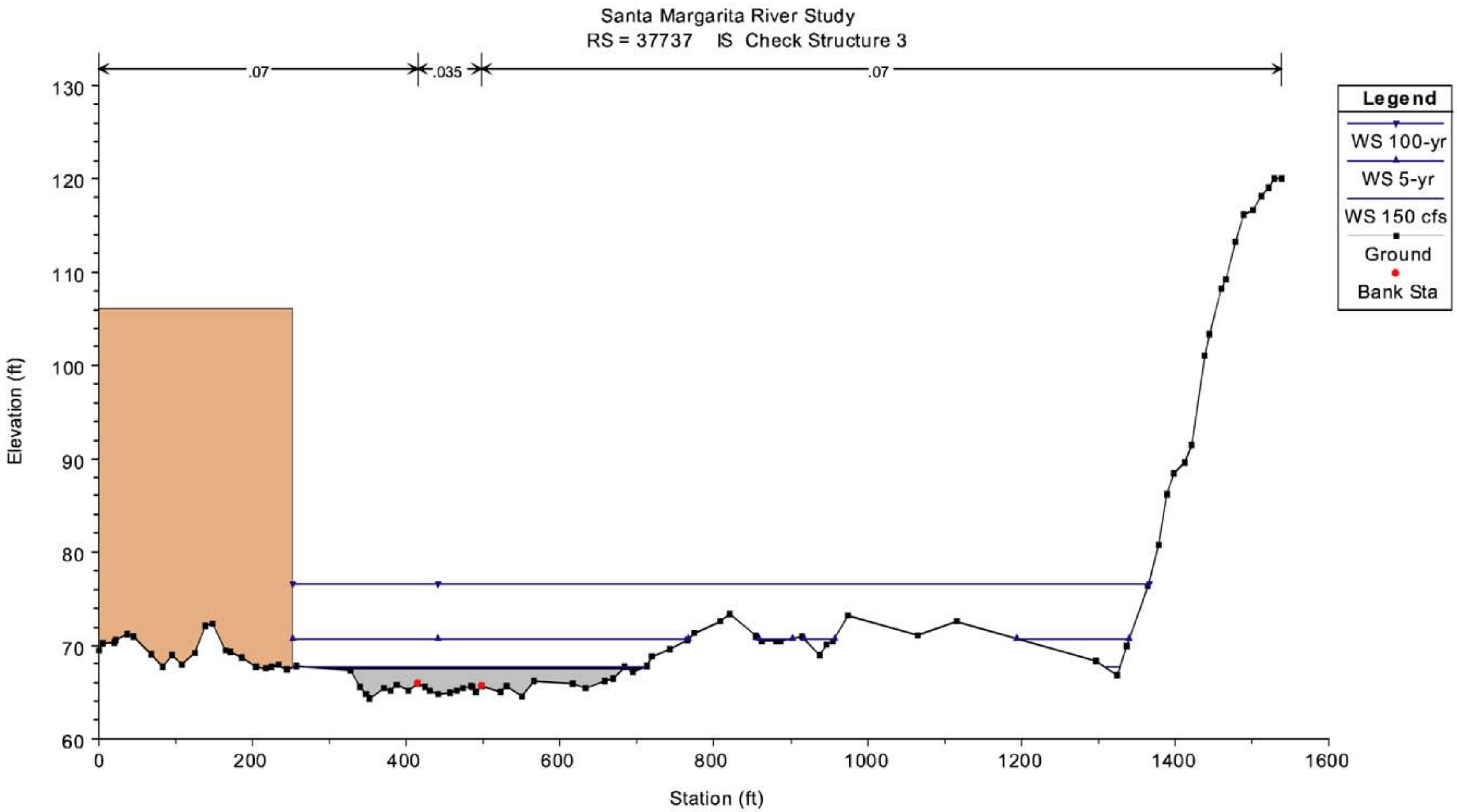
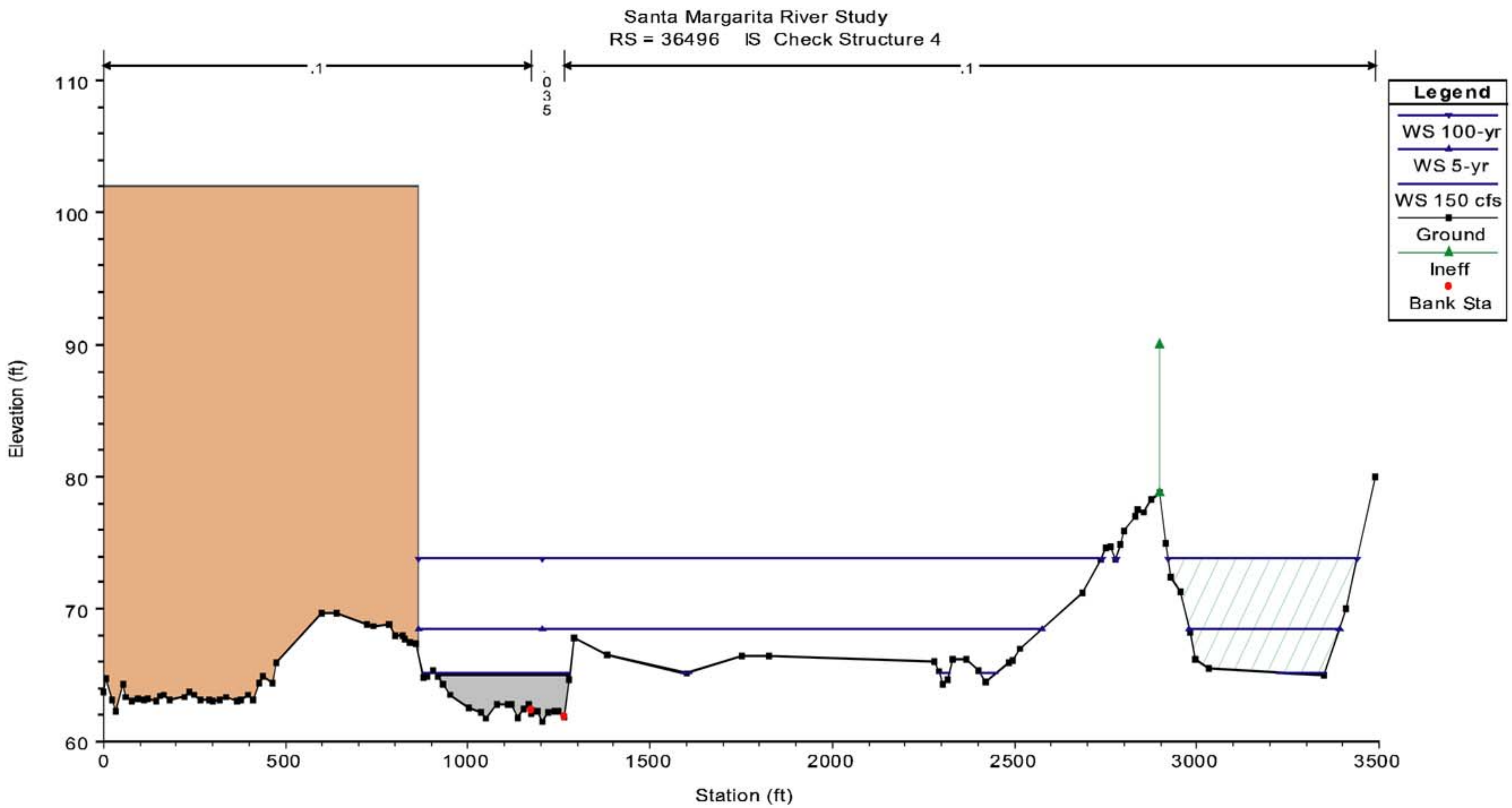

Santa Margarita River Study
RS = 39548 IS Check Structure 2
.07
.035
.07
Legend
WS 100-yr
WS 5-yr
WS 150 cfs
Ground
Bank Sta
Elevation (ft)
Station (ft)
110
100
90
80
70
60
0
200
400
600
800
1000
1200
1400

Figure 5.2c.



Santa Margarita River Study
RS = 37737 IS Check Structure 3
.07
.035
.07
Legend
WS 100-yr
WS 5-yr
WS 150 cfs
Ground
Bank Sta
Elevation (ft)
Station (ft)
130
120
110
100
90
80
70
60
0
200
400
600
800
1000
1200
1400
1600

Figure 5.2d.



Santa Margarita River Study
RS = 36496 IS Check Structure 4
.1
.035
.1
Legend
WS 100-yr
WS 5-yr
WS 150 cfs
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
110
100
90
80
70
60
0
500
1000
1500
2000
2500
3000
3500

Figure 5.2e.

5.2 Alternative 1A

Figure **5.3** is a generalized map showing pre-feasibility Alternative 1a in plan view. Following is a description of and details about the components of Alternative 1a. Details include preliminary facility capacities and/or sizing. References are also provided to previous Stetson Engineers Inc. reports that served as the source of information used to develop this alternative.

Description

- Replace existing sheet pile diversion weir with Obermeyer spillway gate diversion structure
- Consider fish passage capability
- Increase ditch capacity from 60 to 200 cfs
- Increase headgate capacity from 60 to 200 cfs at diversion structure
- Construct new production wells
- Rehabilitate recharge ponds (Pond Nos. 1-5)
- Modify two unused recharge ponds (Pond Nos. 6-7)
- Install collection system for pumped ground water
- Construct water treatment plant (may include new pipeline for discharge/disposal of brine or backwash)
- Construct transmission/distribution facilities, including bi-directional pipeline to Fallbrook
- Install a minimum of two pumping stations for treated water
- Construct new treated water storage (tanks and/or clear wells)
- Rehabilitate Lake O'Neill

Details

Obermeyer diversion structure	260 feet
Road-crossing culvert	200 cfs
O'Neill Ditch	200 cfs
Lake O'Neill	125 acres
	20 cfs diversion
Flow control between ponds	200 cfs
Recharge ponds 1-5	49 acres, 312 af volume
Recharge ponds 6 and 7	46 acres, 242 af volume
New Santa Margarita River (SMR) production wells	6 wells
Collection system	P-068
Haybarn Canyon water treatment plant (WTP)	29 cfs
Brine line	4 cfs
Pipeline from SMR to FPUD	19 cfs
Pump stations	
WTP to water tank	24 cfs

Sources

Santa Margarita River Recharge and Recovery Enhancement Program Permit 15000 Feasibility Study for Marine Corps Base Camp Pendleton, Stetson Engineers Inc., March 23, 2001.

Conjunctive Use Project for the Lower Santa Margarita River Basin, Supplemental Study to the Santa Margarita River Recharge and Recovery Enhancement Program: Permit 15000 Feasibility Study for Marine Corps Base Camp Pendleton, Stetson Engineers Inc., February 2002.

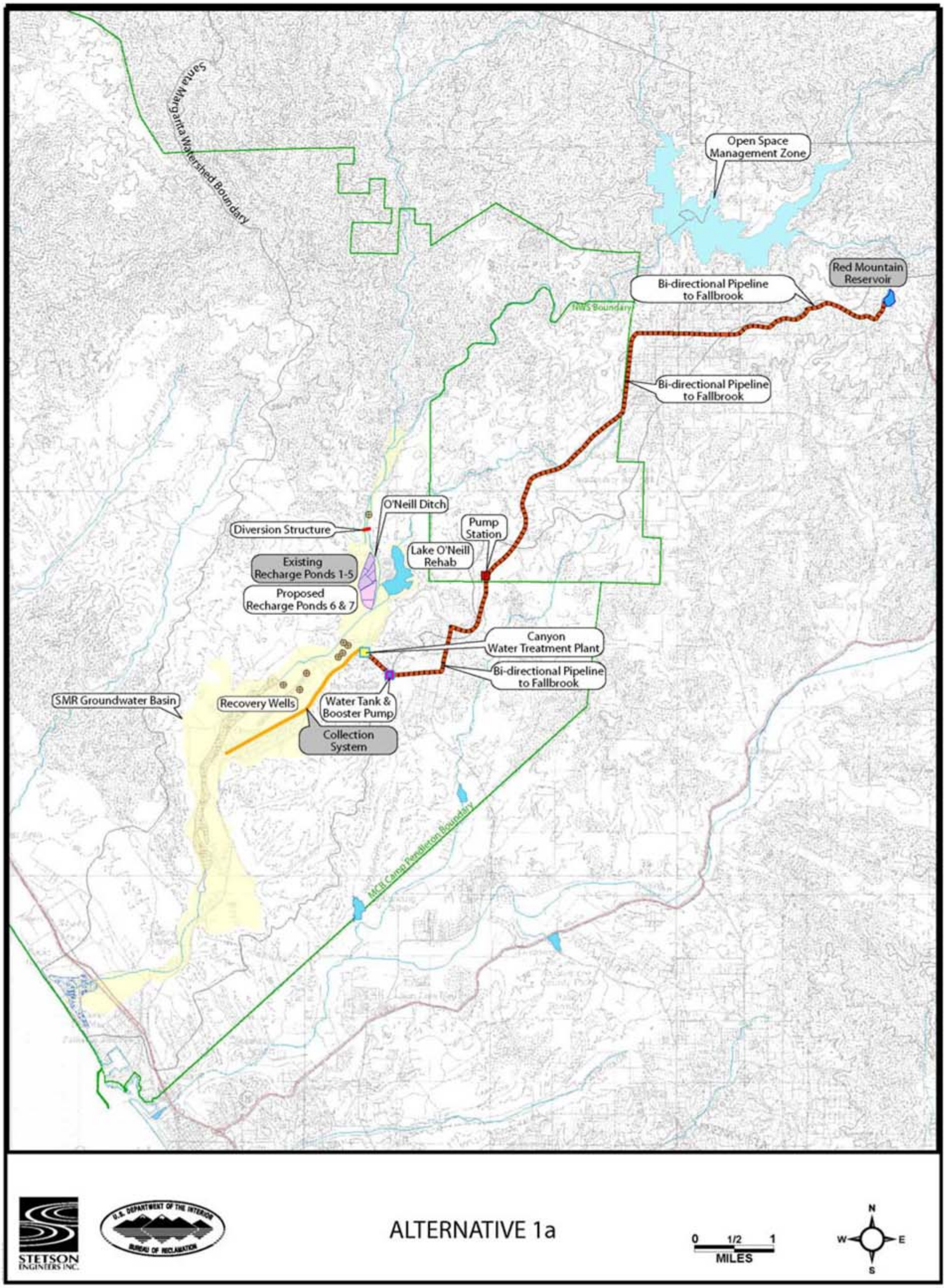


Figure 5.3. Alternative 1a.

5.3 Alternative 1B

Figure 5.4 is a generalized map showing pre-feasibility Alternative 1b in plan view. Following is a description of and details about the components of Alternative 1b. Details include preliminary facility capacities and/or sizing. References are also provided to previous Stetson Engineers Inc. reports that served as the source of information used in the development of this alternative.

Description

Alternative 1a components plus:

Alternative 1b specific components:

- San Mateo Creek basin sustained yield pumping
- New San Mateo Creek (SMC)/San Onofre Creek (SOC) basin extraction wells with wellhead treatment
- Pipeline/pump station to Orange County/MWD water exchange

Details

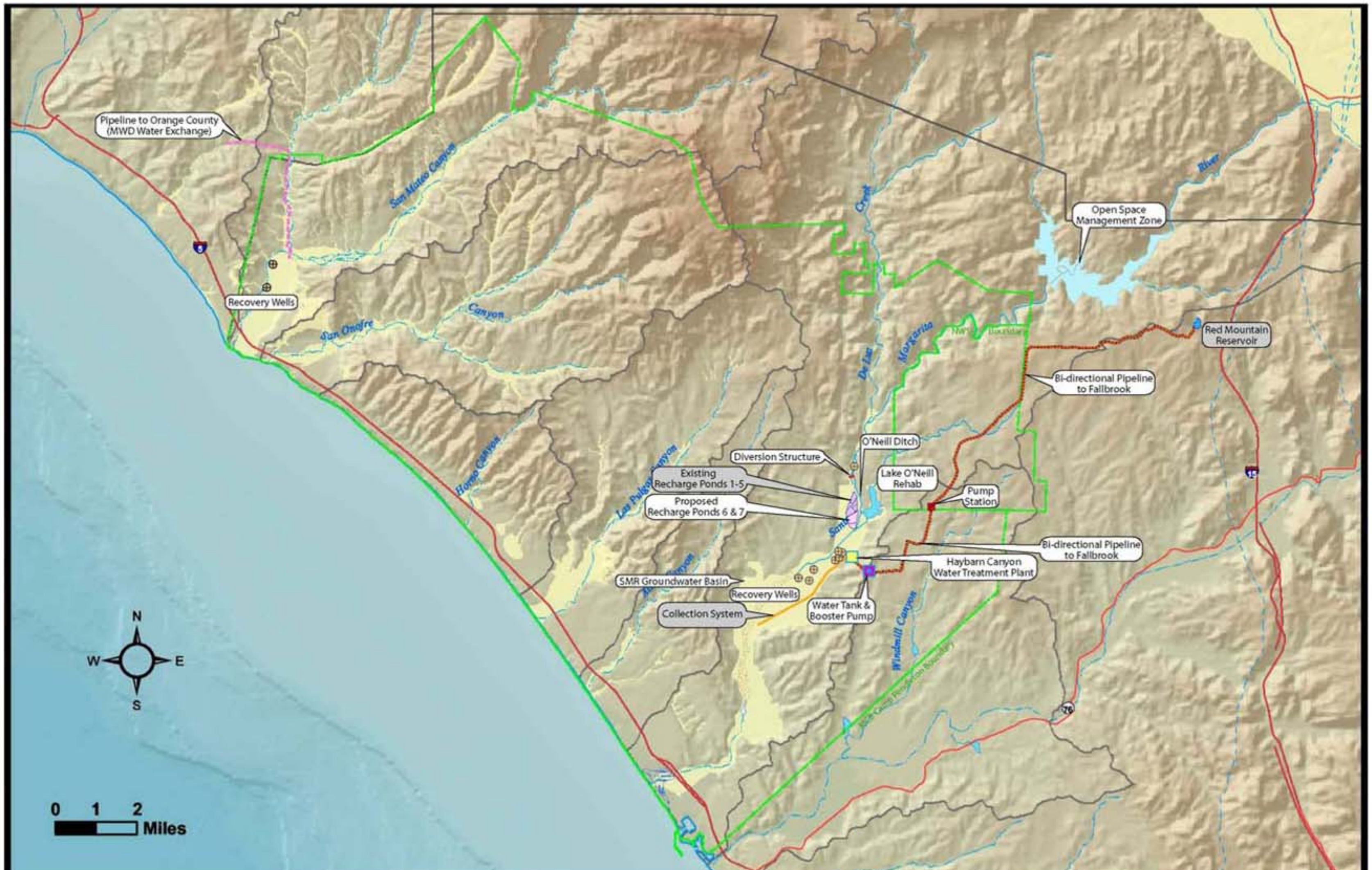
New SMC/SOC production wells	2 wells, 7cfs
SMC/SOC wellhead treatment	7 cfs
Pipeline to Orange County	23,000 feet, 7 cfs

Sources

Personal Communication

South Coast Water District: Mike Dunnbar (949) 499-4555 ext 112
Santa Margarita Water District: Clay Hutter (949) 459-6581

Tri-Cities MWD water supply system operations description



Alternative 1b

Figure 5.4. Alternative 1b.

5.4 Alternative 1C

Figure 5.5 is a generalized map showing pre-feasibility Alternative 1c in plan view. Following is a description of and details regarding the components of Alternative 1c. Details include preliminary facility capacities and/or sizing. References are also provided to previous Stetson Engineers Inc. reports that served as the source of information used in the development of this alternative.

Description

Alternative 1a components plus:

Alternative 1c specific components:

- San Mateo Creek basin sustained yield pumping
- New SMC/SOC basin production wells with wellhead treatment
- *Raw water* pipeline from SMC/SOC basin to SMR
- No water exchange

Details

New SMC/SOC production wells	2 wells, 7 cfs
SMC/SOC wellhead treatment	7 cfs
Cross-base pipeline (Raw water pipeline from SMC to SMR)	104,000 ft, 7 cfs

Sources

Santa Margarita River Recharge and Recovery Enhancement Program Permit 15000 Feasibility Study for Marine Corps Base Camp Pendleton, Stetson Engineers Inc., March 23, 2001.

Conjunctive Use Project for the Lower Santa Margarita River Basin, Supplemental Study to the Santa Margarita River Recharge and Recovery Enhancement Program: Permit 15000 Feasibility Study for Marine Corps Base Camp Pendleton, Stetson Engineers Inc., February 2002.

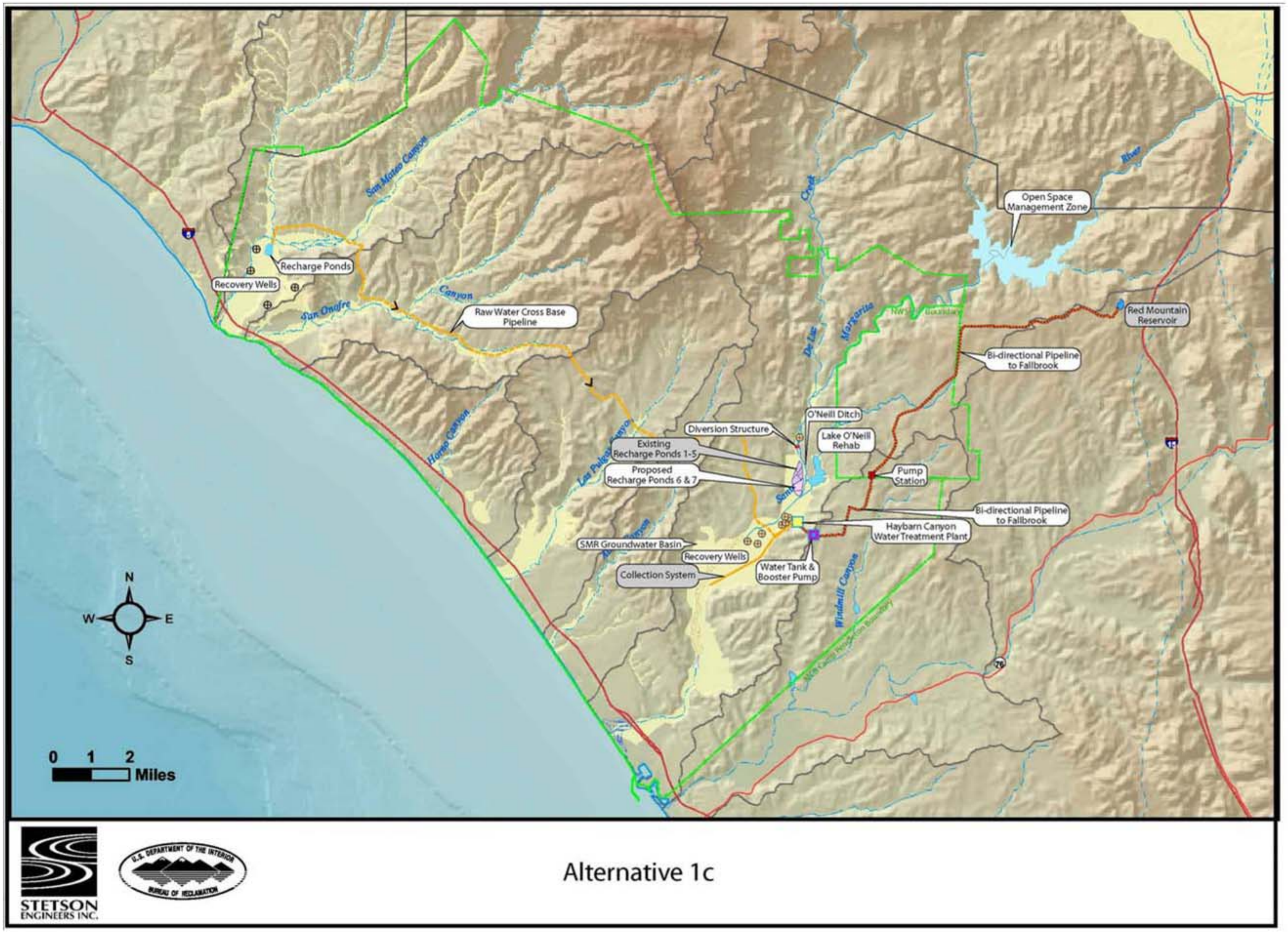


Figure 5.5. Alternative 1c

5.5 Alternative 1D

Figure 5.6 is a generalized map showing pre-feasibility Alternative 1d in plan view. Following is a description of and details regarding the components of Alternative 1d. Details include preliminary facility capacities and/or sizing. References are also provided to previous Stetson Engineers Inc. reports that served as the source of information used in the development of this alternative.

Description

Alternative 1a components without bi-directional pipeline to Fallbrook plus:

Alternative 1d specific components:

- San Mateo Creek basin conjunctive use
- Cross-base water pipeline
- Pipeline to Orange County/MWD water exchange

Details

New SMC/SOC production wells	3 wells
SMC/SOC wellhead treatment	8 cfs
Cross-base pipeline	104,000 feet, 40 cfs
(Raw water pipeline from SMR to SMC)	
SMC recharge pond	10 to 20 acres
Pipeline to Orange County	23,000 feet, 8 cfs

Sources

Santa Margarita River Recharge and Recovery Enhancement Program Permit 15000 Feasibility Study for Marine Corps Base Camp Pendleton, Stetson Engineers Inc., March 23, 2001.

Conjunctive Use Project for the Lower Santa Margarita River Basin, Supplemental Study to the Santa Margarita River Recharge and Recovery Enhancement Program: Permit 15000 Feasibility Study for Marine Corps Base Camp Pendleton, Stetson Engineers Inc., February 2002.

Draft: Three Dimensional Groundwater Flow Model of the San Mateo and San Onofre Basins, USMC Base Camp Pendleton, Stetson Engineers Inc., September 2004.

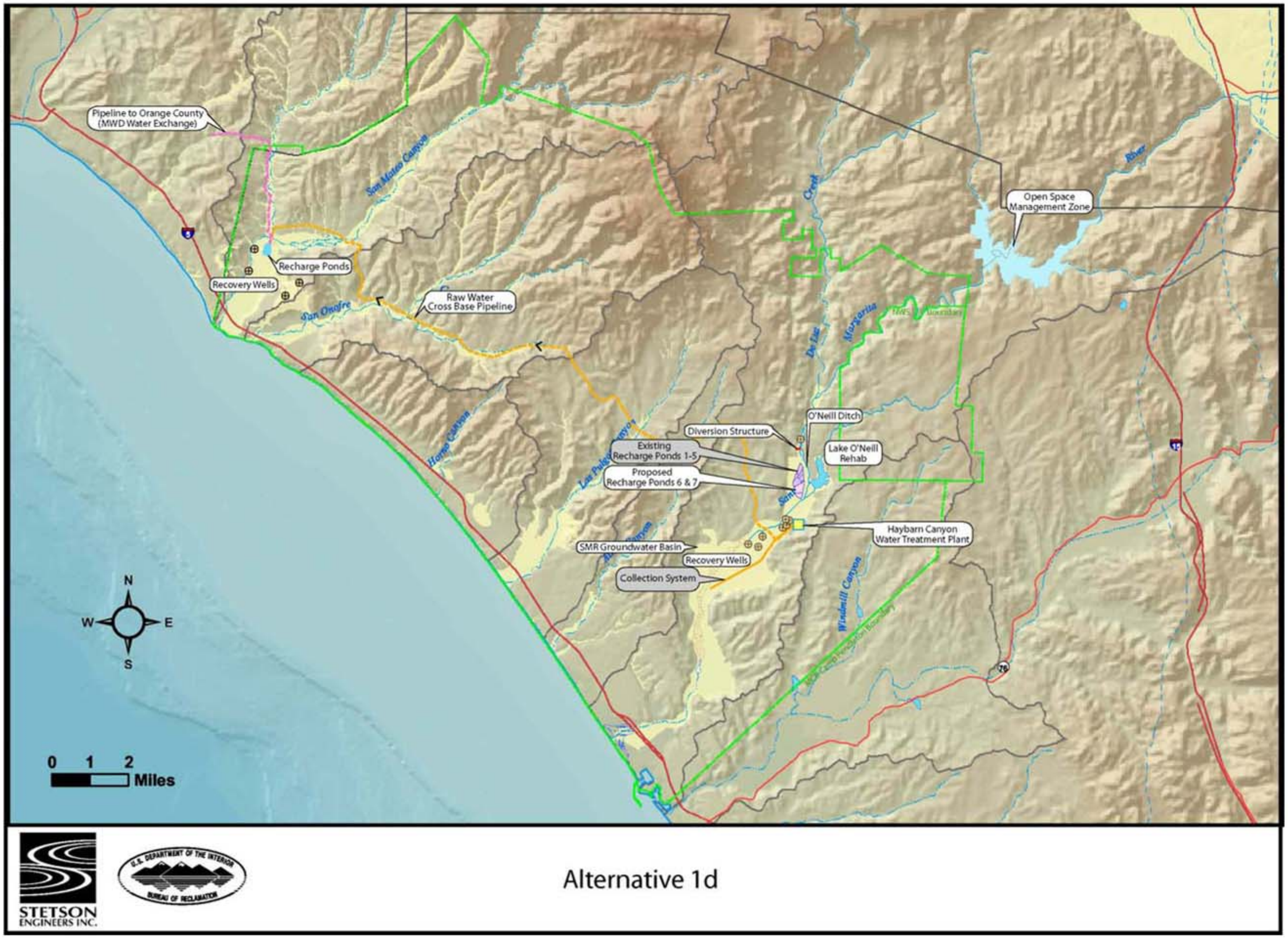


Figure 5.6. Alternative 1d

5.6 Alternative 1E

Figure 5.7 is a generalized map showing pre-feasibility Alternative 1e in plan view. Following is a description of and details regarding the components of Alternative 1e. Details include preliminary facility capacities and/or sizing. References are also provided to previous Stetson Engineers Inc. reports that served as the source of information used in the development of this alternative.

Description

Alternative 1a components plus:

Alternative 1e specific components:

- Treatment wetlands and reservoir on Naval Weapon Station (NWS)
- Land outfall turnout and pipeline
- Denitrified pipeline to Santa Margarita River
- Spreading basin at Santa Margarita River

Details

Haybarn Canyon WTP	33 cfs
Brine line	5 cfs
New SMR production wells	8 wells
Pump stations	
WTP to water tank	28 cfs
Pipeline from SMR to FPUD	23 cfs
Land outfall pipeline	9,000 feet, 12-inch diameter, 4 cfs
NWS treatment wetland	18 acres, 36 af volume
NWS storage reservoir	49 acres, 1,600 af volume
Denitrified pipeline	5,800 feet, 20-inch diameter, 9 cfs
Spreading basin	TBD acres

Sources

Santa Margarita River Recharge and Recovery Enhancement Program Permit 15000 Feasibility Study for Marine Corps Base Camp Pendleton, Stetson Engineers Inc., March 23, 2001.

Conjunctive Use Project for the Lower Santa Margarita River Basin, Supplemental Study to the Santa Margarita River Recharge and Recovery Enhancement Program: Permit 15000 Feasibility Study for Marine Corps Base Camp Pendleton, Stetson Engineers Inc., February 2002.

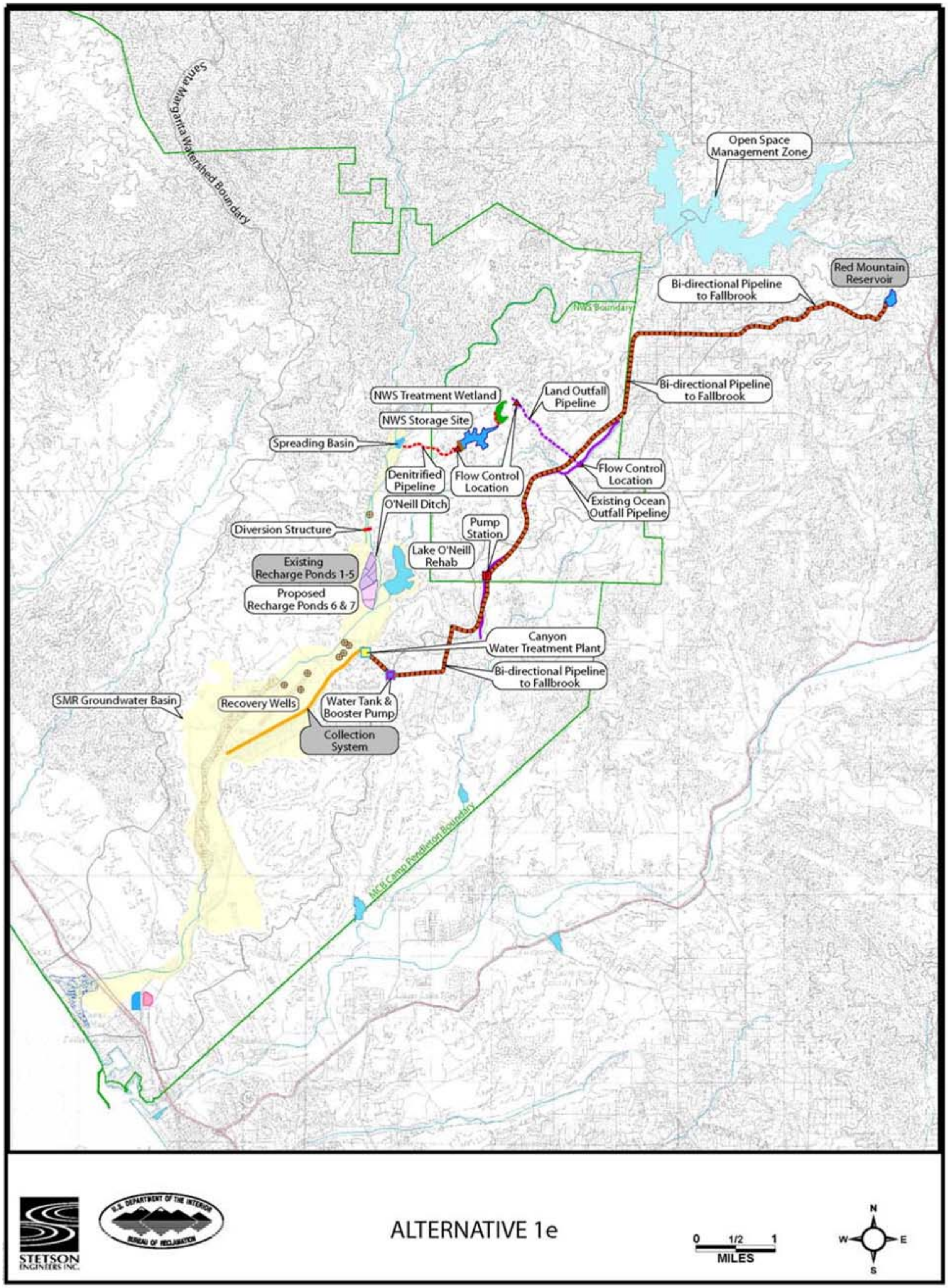


Figure 5.7. Alternative 1e.

5.7 Alternative 1F

Figure 5.8 is a generalized map showing pre-feasibility Alternative 1f in plan view. Following is a description of and details regarding the components of Alternative 1f. Details include preliminary facility capacities and/or sizing. References are also provided to previous Stetson Engineers Inc. reports that served as the source of information used in the development of this alternative.

Description

Alternative 1a components plus:

Alternative 1f specific components:

- Land outfall turnout and pipeline
- Camp Pendleton Pueblitos Canyon treatment wetlands
- Denitrified pipeline from wetlands to Lower Ysidora sub-basin
- Spreading pipelines for ground-water recharge to prevent seawater intrusion

Details

Haybarn Canyon WTP	30 cfs
Brine line	5 cfs
New SMR production wells	7 wells
Pump stations	
WTP to water tank	26 cfs
Pipeline from SMR to FPUD	21 cfs
Land outfall pipeline	18,400 feet, 16-inch diameter, 6 cfs
Pueblitos Canyon treatment wetland	33 acres, 90 acre-feet volume
Expansion area	12 acres, 33 acre-feet volume
Denitrified pipeline	5,700 feet, 16-inch diameter, 6 cfs
Ground-water recharge (spreading) pipeline	9,400 feet, 16-inch diameter, 6.3 cfs
Spreading basin	TBD acres

Sources

Santa Margarita River Recharge and Recovery Enhancement Program Permit 15000 Feasibility Study for Marine Corps Base Camp Pendleton, Stetson Engineers Inc., March 23, 2001.

Technical Engineering Report; Constructed Treatment Wetland Feasibility Study for Marine Corps Base Camp Pendleton, Stetson Engineers Inc., March 2003.

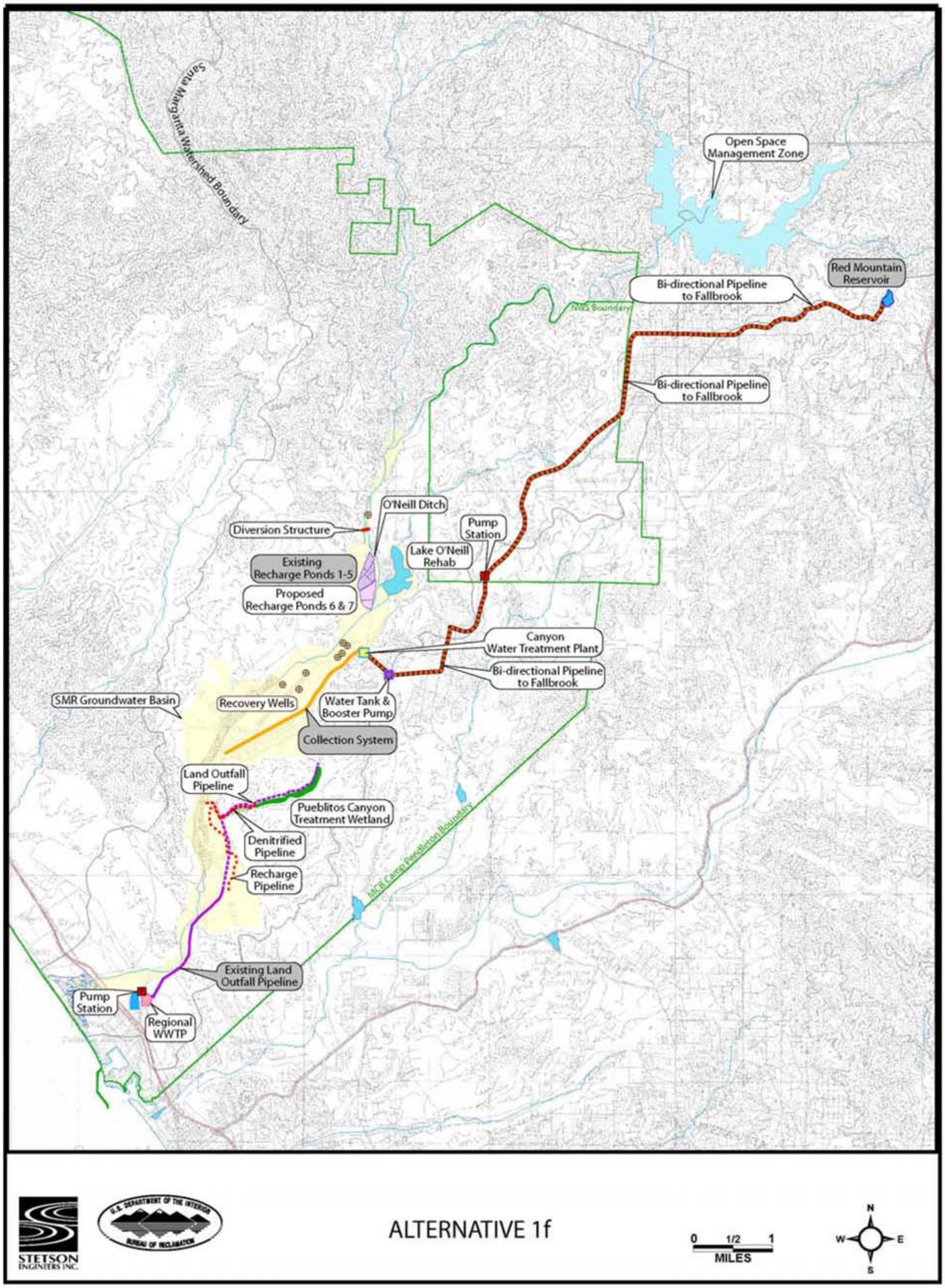


Figure 5.8. Alternative 1f.

5.8 Alternative 1G

Figure 5.9 is a generalized map showing pre-feasibility Alternative 1g in plan view. Following is a description of and details regarding the components of Alternative 1g. Details include preliminary facility capacities and/or sizing. References are also provided to previous Stetson Engineers Inc. reports that served as the source of information used in the development of this alternative.

Description

Alternative 1a components plus:

Alternative 1g specific components:

- Land outfall turnout and pipeline
- Camp Pendleton Newton Canyon treatment wetlands
- Denitrified pipeline from wetlands to Lower Ysidora sub-basin
- Spreading pipelines for ground-water recharge to prevent seawater intrusion

Details

Haybarn Canyon WTP	30 cfs
Brine line	5 cfs
New SMR production wells	7 wells
Pump stations	
WTP to water tank	26 cfs
Pipeline from SMR to FPUD	21 cfs
Land outfall pipeline	7,300 feet, 16-inch diameter, 6 cfs
Newton Canyon treatment wetland	35 acres, 97 af volume
Expansion area	11 acres, 32 af volume
Denitrified pipeline	20,600 feet, 16-inch diameter, 6 cfs
Ground-water recharge (spreading) pipeline	9,400 feet, 16-inch diameter, 6 cfs
Spreading basin	TBD acres

Sources

Santa Margarita River Recharge and Recovery Enhancement Program Permit 15000 Feasibility Study for Marine Corps Base Camp Pendleton, Stetson Engineers Inc., March 23, 2001.

Technical Engineering Report; Constructed Treatment Wetland Feasibility Study for Marine Corps Base Camp Pendleton, Stetson Engineers Inc., March 2003.

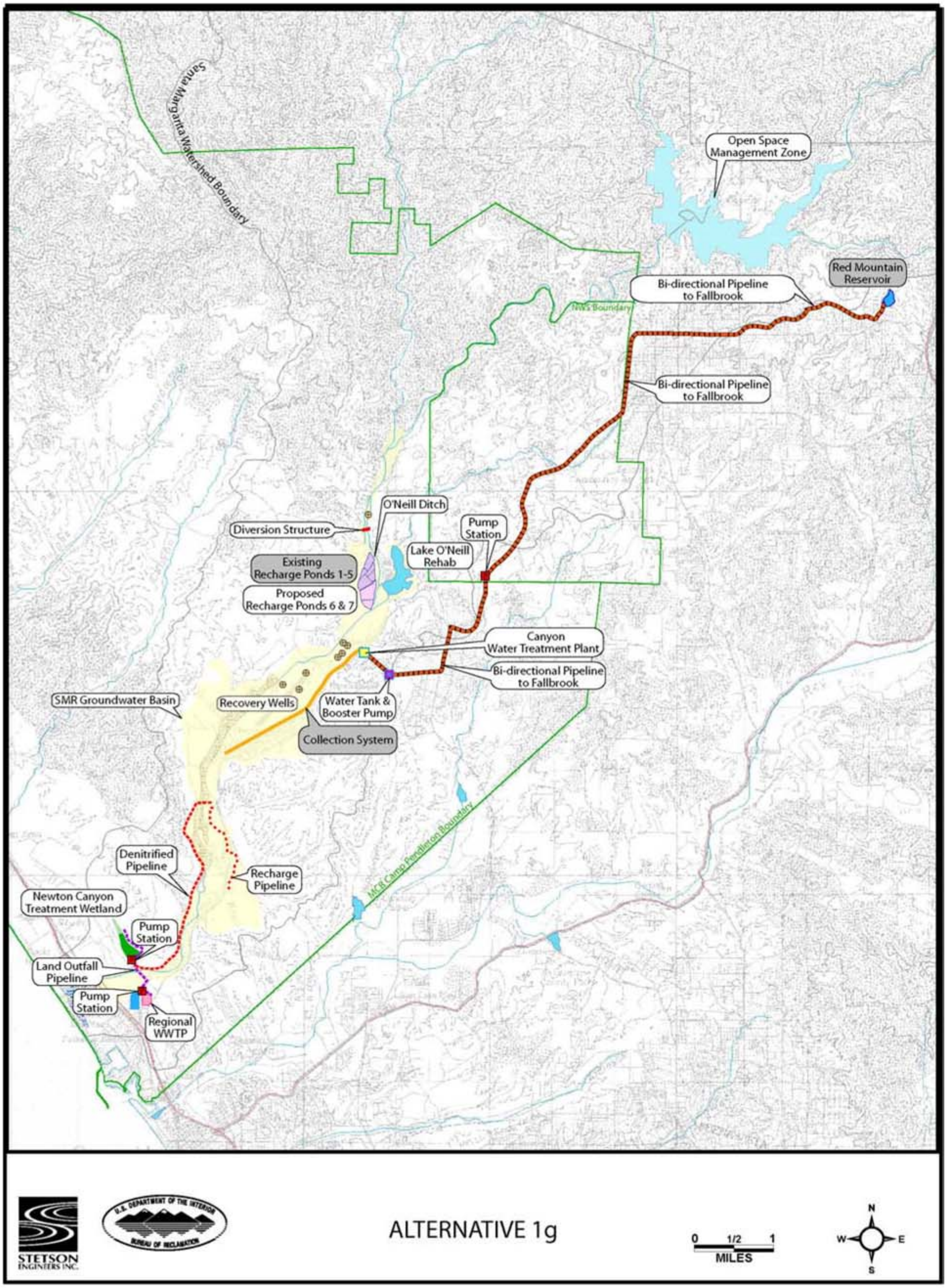


Figure 5.9. Alternative 1g.

5.9 Alternative 1H

Figure 5.10 is a generalized map showing pre-feasibility Alternative 1h in plan view. Following is a description of and details regarding the components of Alternative 1h. Details include preliminary facility capacities and/or sizing. References are also provided to previous Stetson Engineers Inc. reports that served as the source of information used in the development of this alternative.

Description

Alternative 1a components plus:

Alternative 1h specific components:

- Off-stream surface reservoir storage
- Bi-directional *raw water* pipeline between reservoir and pond No. 7

Details

Haybarn Canyon WTP	30 cfs
Brine line	5 cfs
New SMR production wells	6 wells
Pump stations	
WTP to water tank	26 cfs
Pipeline from SMR to FPUD	21 cfs
Off-stream storage	55 acres, 4,800 acre-foot volume
Pipeline between reservoir and pond No. 7 (Bi-directional *raw water*)	12,000 feet, 36-inch diameter, 40 cfs

Source

Santa Margarita River Recharge and Recovery Enhancement Program Permit 15000 Feasibility Study for Marine Corps Base Camp Pendleton, Stetson Engineers Inc., March 23, 2001.

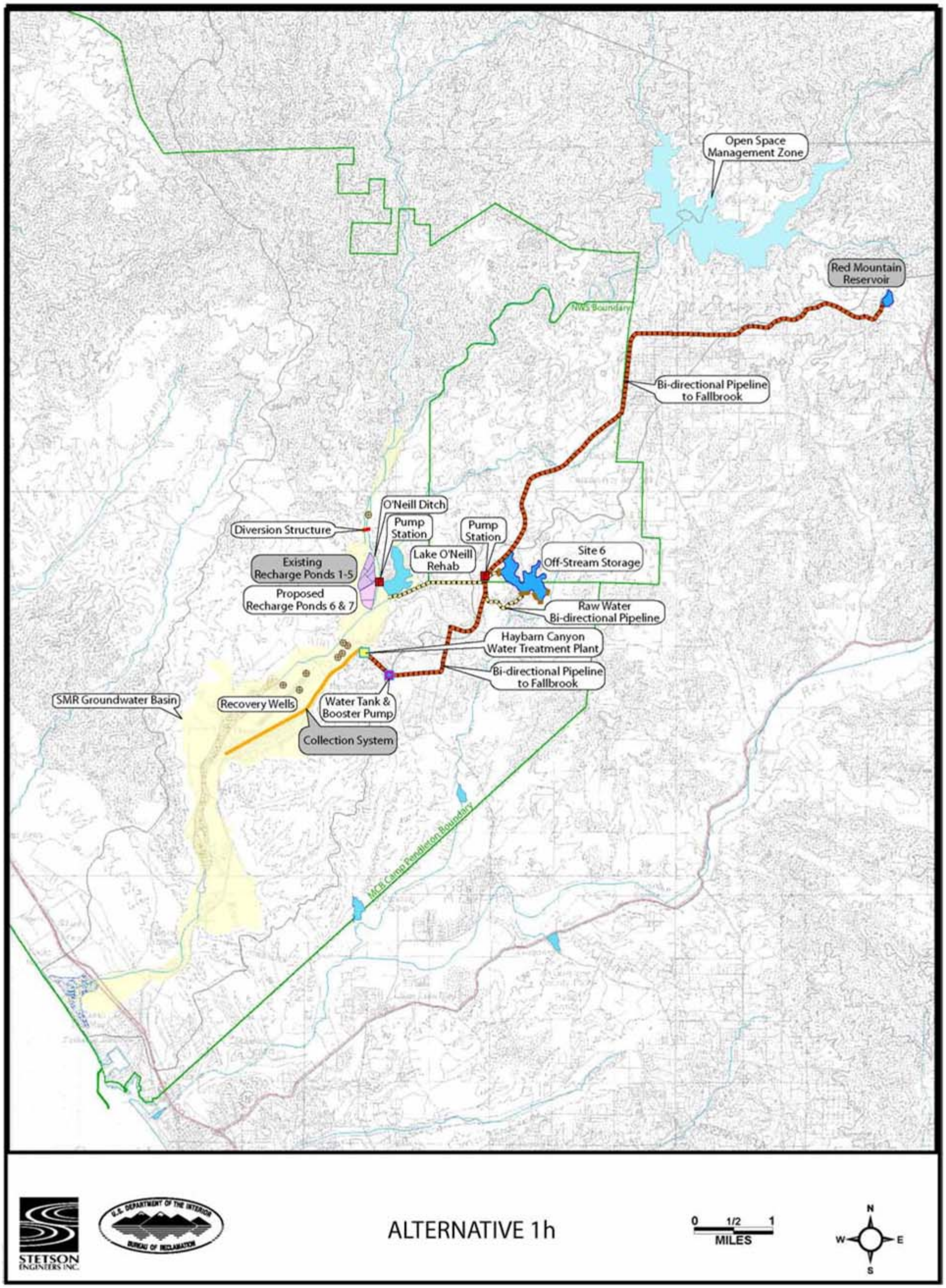


Figure 5.10. Alternative 1h.

5.10 Alternative 1I

Figure 5.11 is a generalized map showing pre-feasibility Alternative 1i in plan view. Following is a description of and details regarding the components of Alternative 1i. Details include preliminary facility capacities and/or sizing. References are also provided to previous Stetson Engineers Inc. reports that served as the source of information used in the development of this alternative.

Description

Alternative 1a components plus:

Alternative 1i specific components:

- Close production wells to provide enhanced extraction
- Pipeline and pump station to Haybarn Canyon WTP

Details

Alternative 1a details (previously shown, with following changes):

New SMR production wells	4 wells
Enhanced production pipeline	7,500 feet, 4 cfs

Source

Santa Margarita River Recharge and Recovery Enhancement Program Permit 15000 Feasibility Study for Marine Corps Base Camp Pendleton, Stetson Engineers Inc., March 23, 2001.

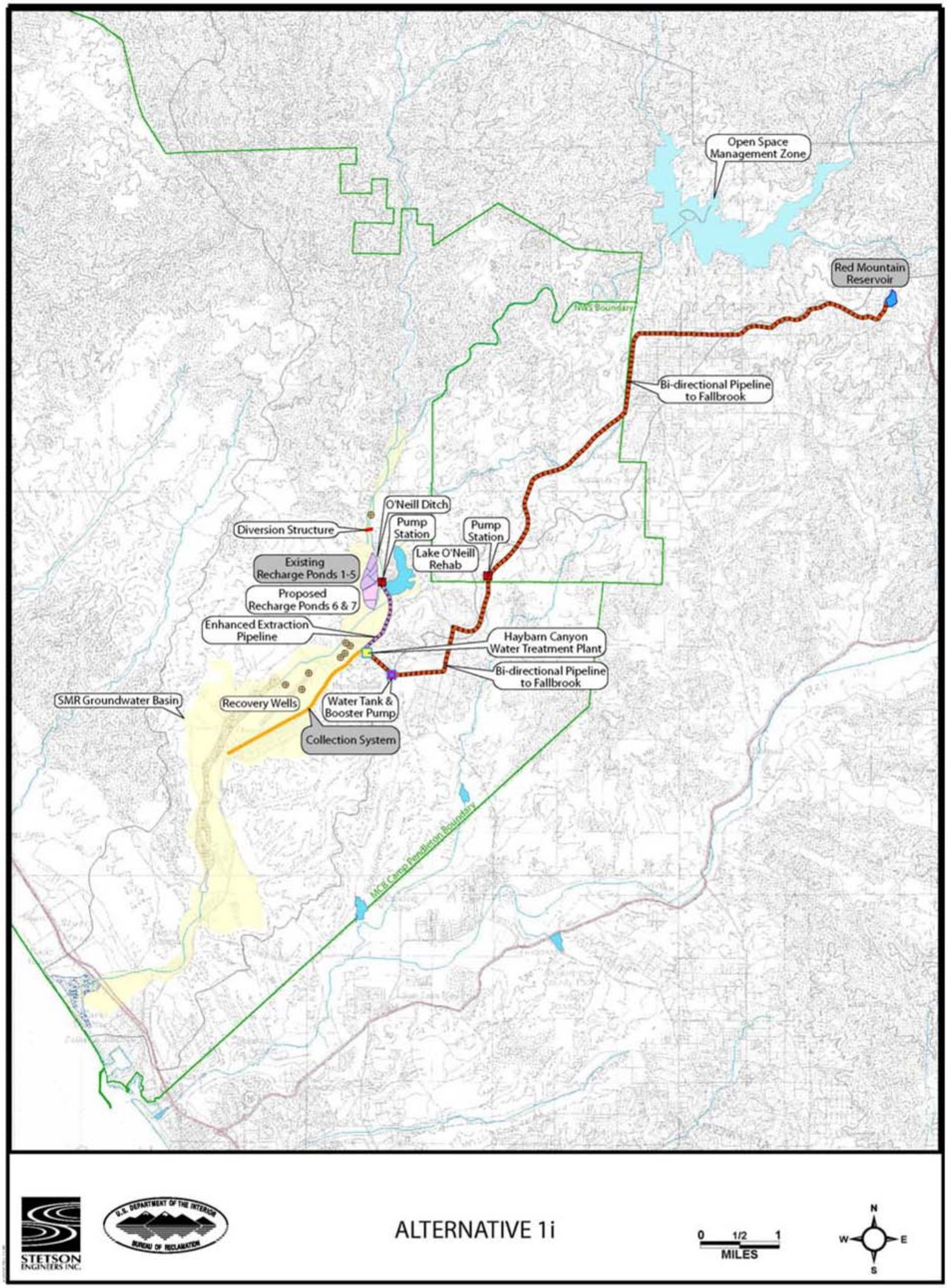


Figure 5.11. Alternative 1i.

5.11 Alternative 2A

Figure 5.12 is a generalized map showing pre-feasibility Alternative 2a in plan view. Following is a description of and details regarding the components of Alternative 2a. Details include preliminary facility capacities and/or sizing. References are also provided to previous Stetson Engineers Inc. reports that served as the source of information used in the development of this alternative.

Description

- Replace existing sheet pile diversion weir with Obermeyer spillway gate diversion structure
- Consider fish passage capability
- Increase ditch capacity from 60 to 200 cfs
- Increase headgate capacity from 60 to 200 cfs at diversion structure
- Construct new production wells
- Rehabilitate recharge ponds (Pond Nos. 1-5)
- Modify two unused recharge ponds (Pond Nos. 6-7)
- Install collection system for pumped ground water
- Construct water treatment plant at Haybarn Canyon (may include new pipeline for discharge/disposal of brine or backwash)
- Construct transmission/distribution facilities
- Install a minimum of two pumping stations for treated water without bi-directional pipeline to Fallbrook
- Construct new treated water storage (tanks and/or clear wells)
- Rehabilitate Lake O'Neill
- Construct diversion weir above FPUD sump
- Primary treatment plant at Knoll Park or Red Mountain
- Raw water pipeline to Red Mountain Reservoir
- New Oceanside pipeline from Morro Hill to Base (no direct Camp Pendleton aqueduct connection)

Details

Obermeyer diversion structure	260 feet
Road-crossing culvert	200 cfs
O'Neill Ditch	200 cfs
Lake O'Neill	125 acres
	20 cfs diversion
Flow control between ponds	200 cfs
Recharge pond Nos. 1-5	49 acres, 312 af volume
Recharge pond Nos. 6 and 7	46 acres, 242 af volume
New SMR production wells	4 wells
Collection system	P-068
Haybarn Canyon WTP	21 cfs

Pump stations	
Water treatment plant to water tank	18 cfs
Brine line	3 cfs
New FPUD sump intake and pump structure	
Obermeyer diversion structure at FPUD sump (*raw water)*	357 feet, 10 feet high, 5 cfs
Pipeline from FPUD sump to Red Mountain	29,000 feet, 5 cfs
Knoll Park or Red Mountain primary WTP	5 cfs
New Oceanside pipeline from Morro Hill (emergency supply)	28,000 feet, 20 cfs

Source

Santa Margarita River Recharge and Recovery Enhancement Program Permit 15000 Feasibility Study for Marine Corps Base Camp Pendleton, Stetson Engineers Inc., March 23, 2001.

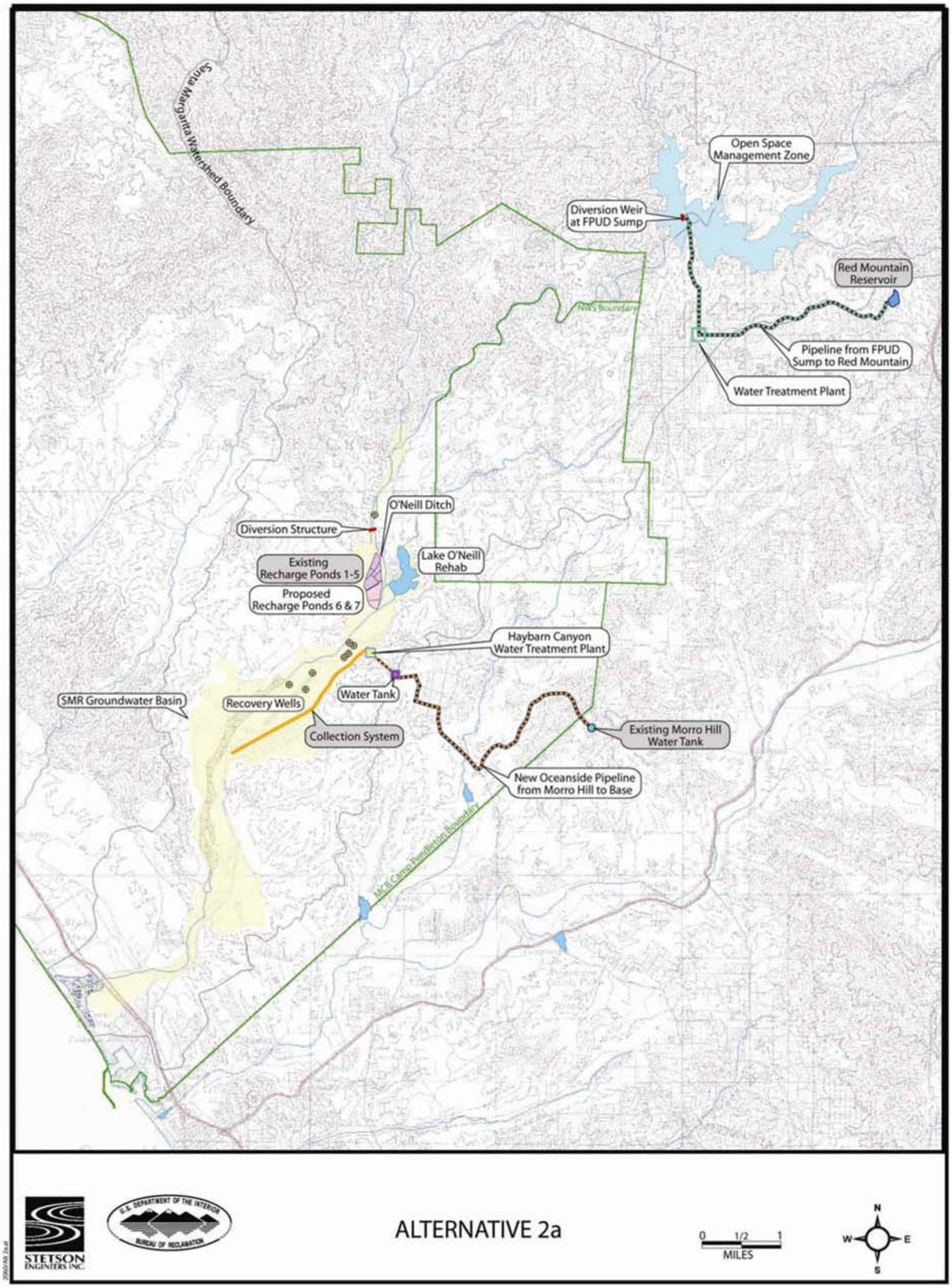


Figure 5.12. Alternative 2a.

5.12 Alternative 2B

Figure 5.13 is a generalized map showing pre-feasibility Alternative 2b in plan view. Following is a description of and details regarding the components of Alternative 2b. Details include preliminary facility capacities and/or sizing. References are also provided to previous Stetson Engineers Inc. reports that served as the source of information used in the development of this alternative.

Description

- Alternative 2a components without new Oceanside pipeline from Morro Hill to Base (Morro Hill emergency pipeline capacity available from cross-base pipeline) plus:

Alternative 2b specific components:

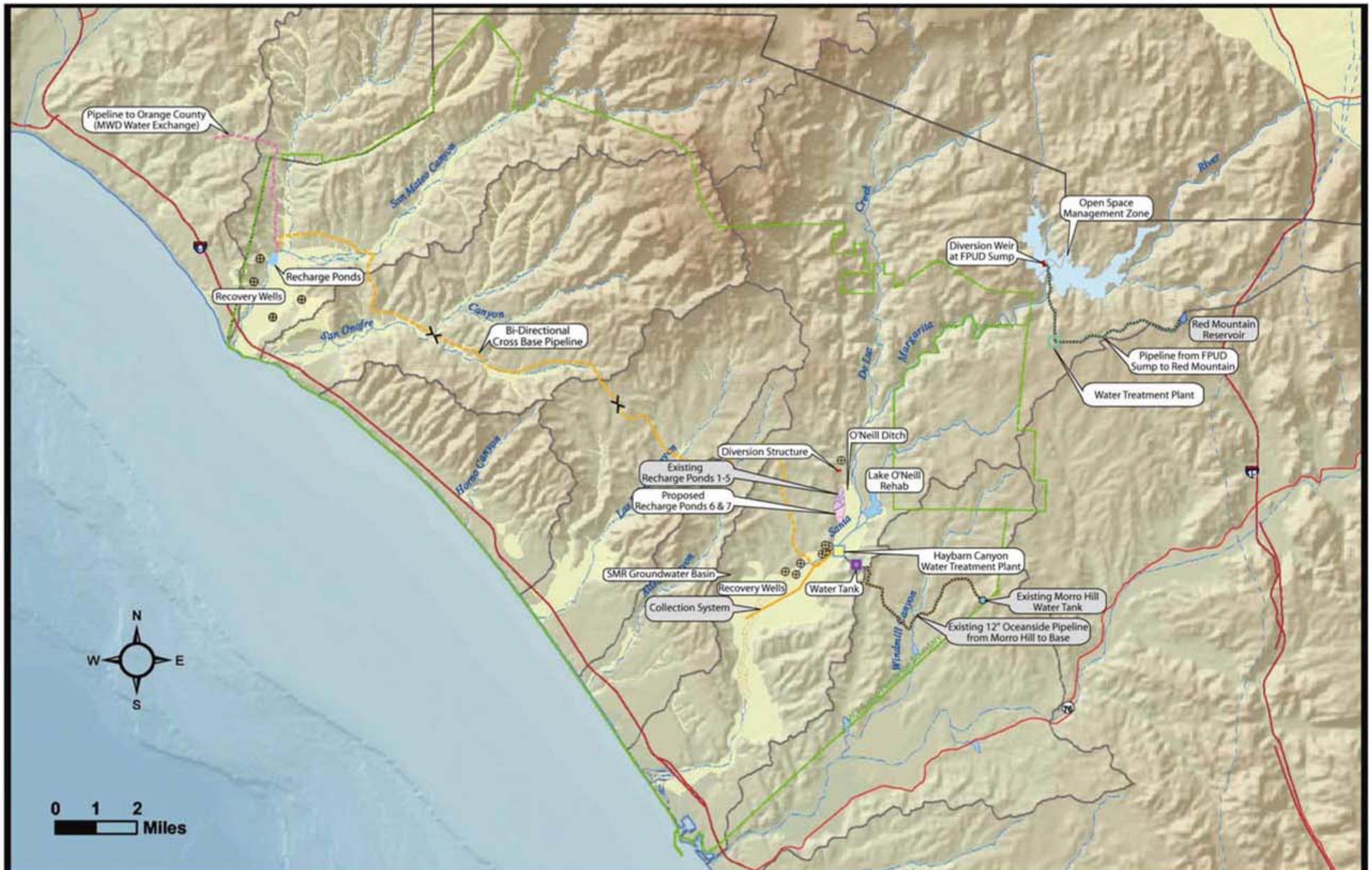
- San Mateo Creek basin conjunctive use
- New SMC/SOC basin production wells with wellhead treatment
- Pipeline to Orange County/MWD water exchange
- *Bi-directional* pipeline across Camp Pendleton to San Mateo Creek basin
- Use existing 12-inch Oceanside pipeline from Morro Hill to Base

Details

Haybarn Canyon WTP	22 cfs
Pump stations	
Water treatment plant to water tank	19 cfs
New SMC/SOC production wells	6 wells
Bi-directional cross-base pipeline (*Dual-purpose* pipeline from SMR to SMC)	104,000 feet, 40 cfs
New SMC/SOC production wells	3 wells
SMC/SOC wellhead treatment	8 cfs
Pipeline to Orange County	23,000 feet, 8 cfs
SMC recharge pond	10 to 20 acres

Source

Santa Margarita River Recharge and Recovery Enhancement Program Permit 15000 Feasibility Study for Marine Corps Base Camp Pendleton, Stetson Engineers Inc., March 23, 2001.



STETSON ENGINEERS INC.

U.S. DEPARTMENT OF THE INTERIOR BUREAU OF RECLAMATION

Alternative 2b

2060/Alt-2b.ai

Figure 5.13. Alternative 2b.

5.13 Alternative 2C

Figure 5.14 is a generalized map showing pre-feasibility Alternative 2c in plan view. Following is a description of and details regarding the components of Alternative 2c. Details include preliminary facility capacities and/or sizing. References are also provided to previous Stetson Engineers Inc. reports that served as the source of information used in the development of this alternative.

Description

Alternative 2a components plus:

Alternative 2c specific components:

- Land outfall turnout and pipeline
- Camp Pendleton Pueblitos Canyon treatment wetlands
- Denitrified pipeline from wetlands to Lower Ysidora sub-basin
- Spreading pipelines for ground-water recharge to prevent seawater intrusion

Details

Haybarn Canyon WTP	23 cfs
New SMR production wells	7 wells
Pump Stations	
WTP to water tank	20 cfs
Land outfall pipeline	18,400 feet,16-inch diameter,6 cfs
Pueblitos Canyon treatment wetland	33 acres, 90 af volume
Expansion area	12 acres, 33 af volume
Denitrified pipeline	5,700 feet, 16-inch diameter, 6 cfs
Ground-water recharge (spreading) pipeline	9,400 feet,16-inch diameter, 6.3 cfs
Spreading basin	

Sources

Santa Margarita River Recharge and Recovery Enhancement Program Permit 15000 Feasibility Study for Marine Corps Base Camp Pendleton, Stetson Engineers Inc., March 23, 2001.

Technical Engineering Report; Constructed Treatment Wetland Feasibility Study for Marine Corps Base Camp Pendleton, Stetson Engineers Inc., March 2003.

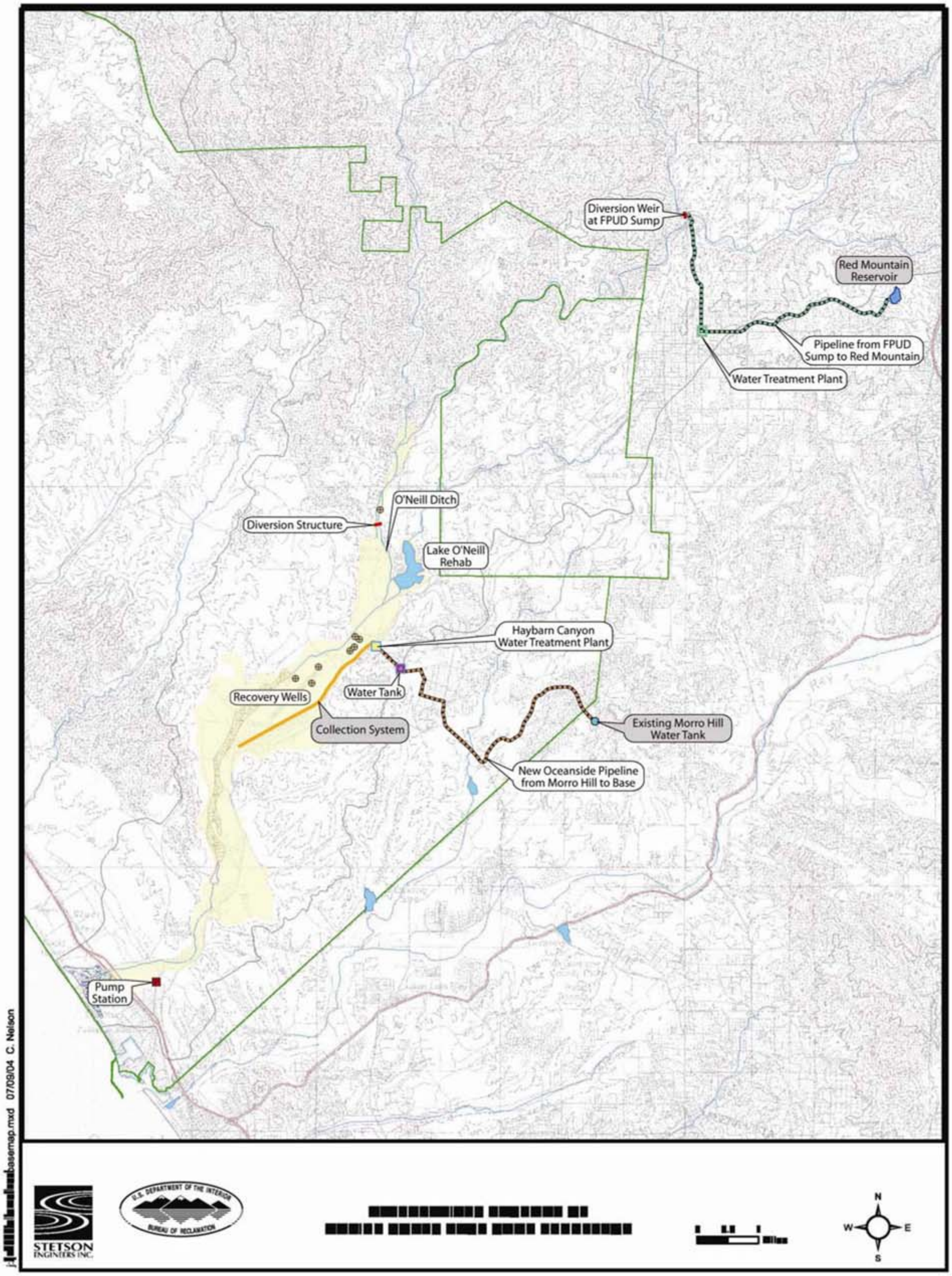


Figure 5.14. Alternative 2c.

5.14 Alternative 2D

Figure 5.15 is a generalized map showing pre-feasibility Alternative 2d in plan view. Following is a description of and details regarding the components of Alternative 2d. Details include preliminary facility capacities and/or sizing. References are also provided to previous Stetson Engineers Inc. reports that served as the source of information used in the development of this alternative.

Description

Alternative 2a components plus:

Alternative 2d specific components:

- Land outfall turnout and pipeline
- Camp Pendleton Newton Canyon treatment wetlands
- Denitrified pipeline from wetlands to Santa Margarita River vicinity
- Spreading pipelines for ground-water recharge to prevent seawater intrusion

Details

Haybarn Canyon WTP	23 cfs
New SMR production wells	7 wells
Pump stations	
WTP to water tank	20 cfs
Land outfall pipeline	7,300 feet, 16-inch diameter, 6 cfs
Newton Canyon treatment wetland	35 acres, 97 af volume
Expansion area	11 acres, 32 af volume
Denitrified pipeline	20,600 feet, 16-inch diameter, 6 cfs
Ground-water recharge (spreading) pipeline	9,400 ft, 16-inch diameter, 6 cfs
Spreading basin	TBD acres

Sources

Santa Margarita River Recharge and Recovery Enhancement Program Permit 15000 Feasibility Study for Marine Corps Base Camp Pendleton, Stetson Engineers Inc., March 23, 2001.

Technical Engineering Report; Constructed Treatment Wetland Feasibility Study for Marine Corps Base Camp Pendleton, Stetson Engineers Inc., March 2003.

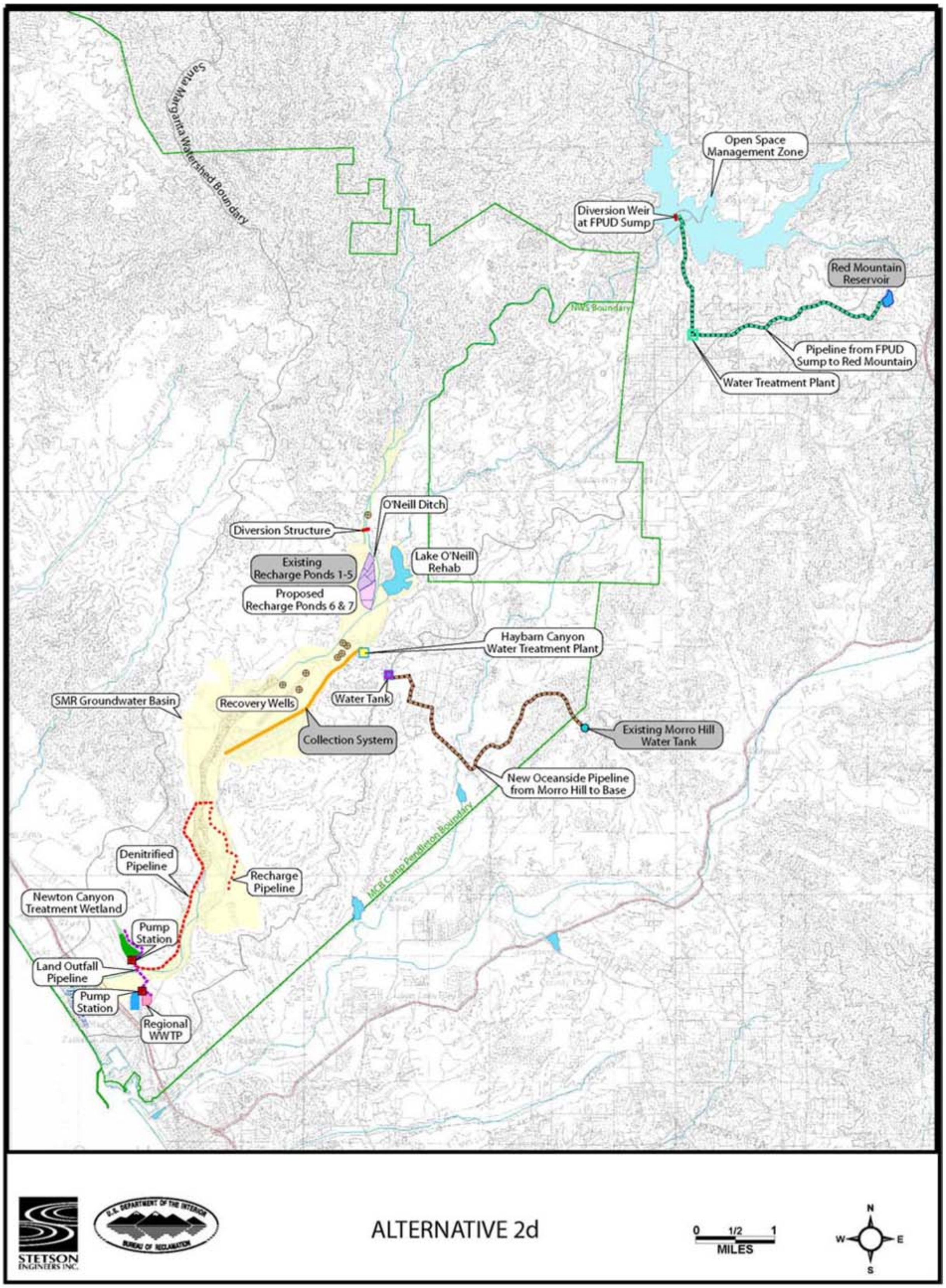


Figure 5.15. Alternative 2d.

5.15 Alternative 3A

Figure 5.16 is a generalized map showing pre-feasibility Alternative 3a in plan view. Following is a description of and details regarding the components of Alternative 3a. Details include preliminary facility capacities and/or sizing. References are also provided to previous Stetson Engineers Inc. reports that served as the source of information used in the development of this alternative.

Description

- In-stream check structures in lieu of recharge ponds
- Increase ditch from 60 to 100 cfs
- Rehabilitate recharge ponds (Pond Nos. 1-5)
- Construct new production wells
- Install collection system for pumped ground water
- Construct water treatment plant (may include new pipeline for discharge/disposal of brine or backwash)
- Construct transmission/distribution facilities, including bi-directional pipeline to Fallbrook
- Install a minimum of two pumping stations for treated water
- Construct new treated water storage (tanks and/or clear wells)
- Rehabilitate Lake O'Neill

Details

Sheet pile weir	260 ft
Road-crossing culvert	100 cfs
O'Neill Ditch	100 cfs
Lake O'Neill	125 acres
	20 cfs diversion
Flow control between ponds	100 cfs
Recharge pond Nos. 1-5	49 acres, 312 af volume
New SMR production wells	4 wells
Collection system	P-068
Water treatment plant	25
Brine line	4 cfs
Pipeline to FPUD	67,000 feet, 16 cfs
Pump stations	
WTP to water tank	21 cfs

Sources

Santa Margarita River Recharge and Recovery Enhancement Program Permit 15000 Feasibility Study for Marine Corps Base Camp Pendleton, Stetson Engineers Inc., March 23, 2001.

Conjunctive Use Project for the Lower Santa Margarita River Basin, Supplemental Study to the Santa Margarita River Recharge and Recovery Enhancement Program: Permit 15000 Feasibility Study for Marine Corps Base Camp Pendleton, Stetson Engineers Inc., February 2002.

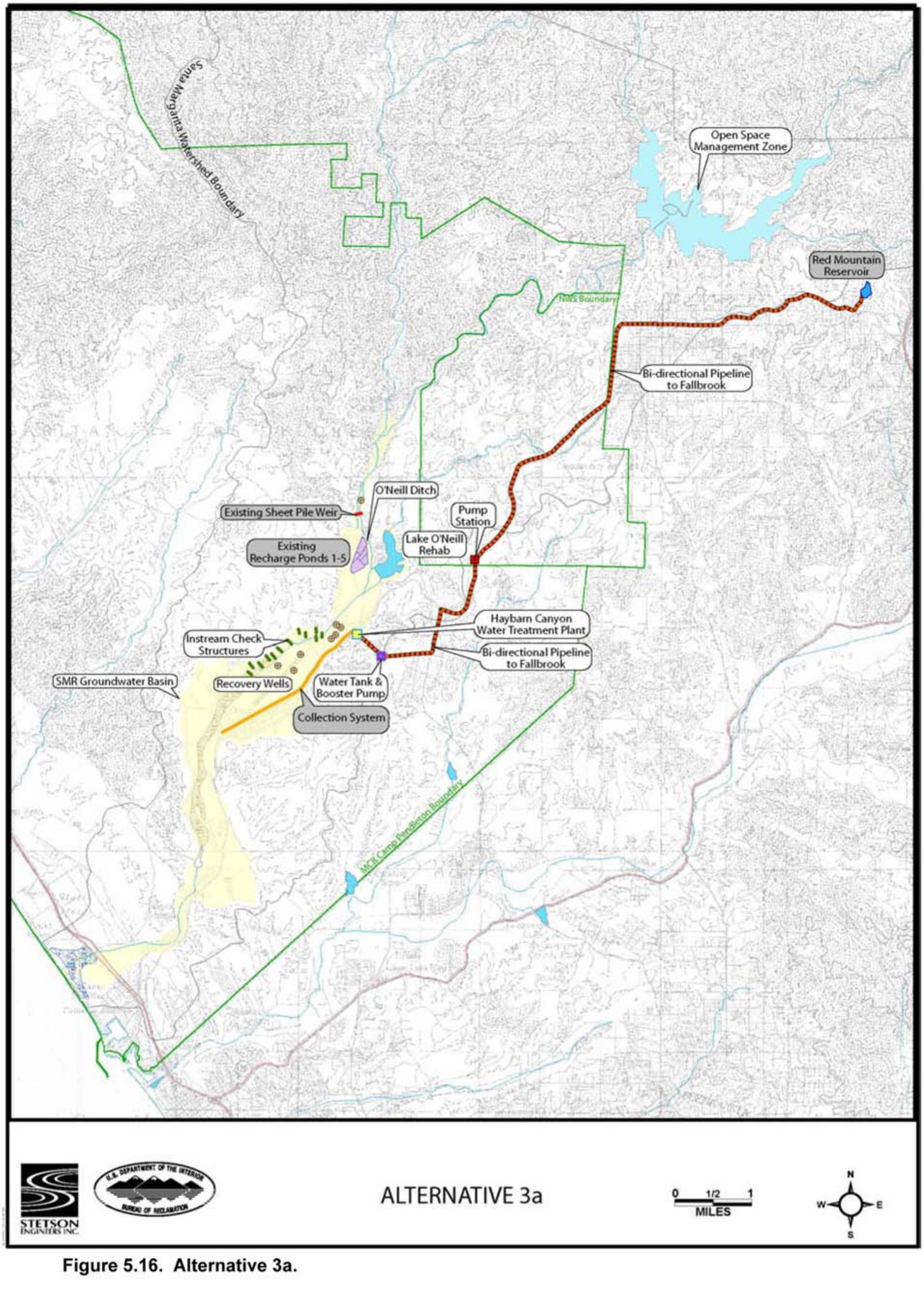


Figure 5.16. Alternative 3a.

5.16 Alternative 3B

Figure 5.17 is a generalized map showing pre-feasibility Alternative 3b in plan view. Following is a description of and details regarding the components of Alternative 3b. Details include preliminary facility capacities and/or sizing. References are also provided to previous Stetson Engineers Inc. reports that served as the source of information used in the development of this alternative.

Description

Alternative 3a components plus:

Alternative 3b specific components:

- San Mateo Creek basin sustained yield pumping
- New SMC/SOC basin production wells with wellhead treatment
- Pipeline/pump station to Orange County/MWD water exchange

Details

New SMC/SOC production wells	2 wells, 7cfs
SMC/SOC wellhead treatment	7 cfs
Pipeline to Orange County	23,000 feet, 7 cfs

Sources

Santa Margarita River Recharge and Recovery Enhancement Program Permit 15000 Feasibility Study for Marine Corps Base Camp Pendleton, Stetson Engineers Inc., March 23, 2001.

Conjunctive Use Project for the Lower Santa Margarita River Basin, Supplemental Study to the Santa Margarita River Recharge and Recovery Enhancement Program: Permit 15000 Feasibility Study for Marine Corps Base Camp Pendleton, Stetson Engineers Inc., February 2002

Personal Communication

South Coast Water District: Mike Dunnbar (949) 499-4555 ext 112
Santa Margarita Water District: Clay Hutter (949) 459-6581

Tri-Cities MWD water supply system operations description

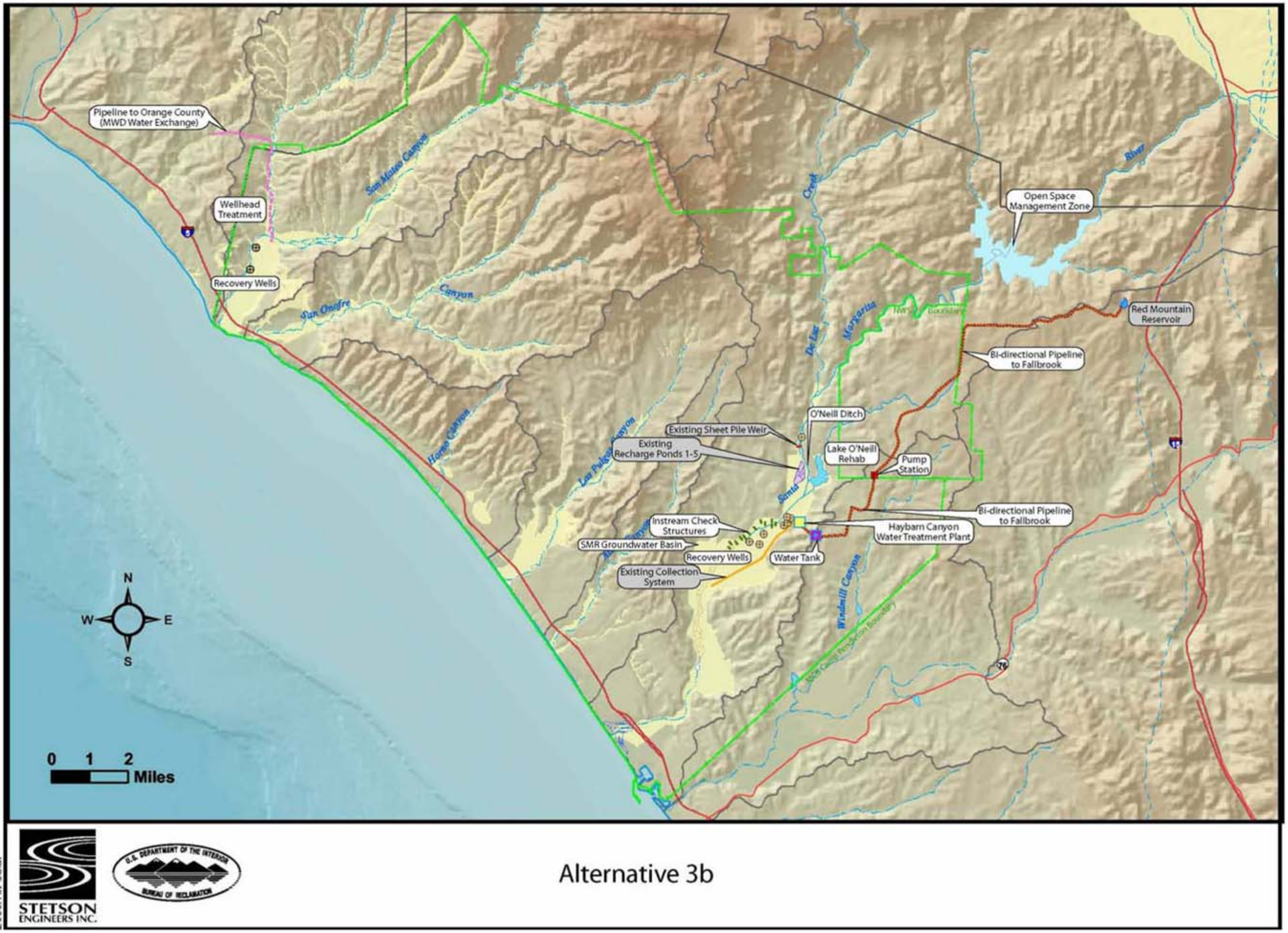


Figure 5.17. Alternative 3b

5.17 Alternative 3C

Figure 5.18 is a generalized map showing pre-feasibility Alternative 3c in plan view. Following is a description of and details regarding the components of Alternative 3c. Details include preliminary facility capacities and/or sizing. References are also provided to previous Stetson Engineers Inc. reports that served as the source of information used in the development of this alternative.

Description

Alternative 3a components plus:

Alternative 3c specific components:

- San Mateo Creek basin sustained yield pumping
- New SMC/SOC basin production wells with wellhead treatment
- *Raw water* pipeline from SMC/SOC basin to SMR
- No water exchange

Details

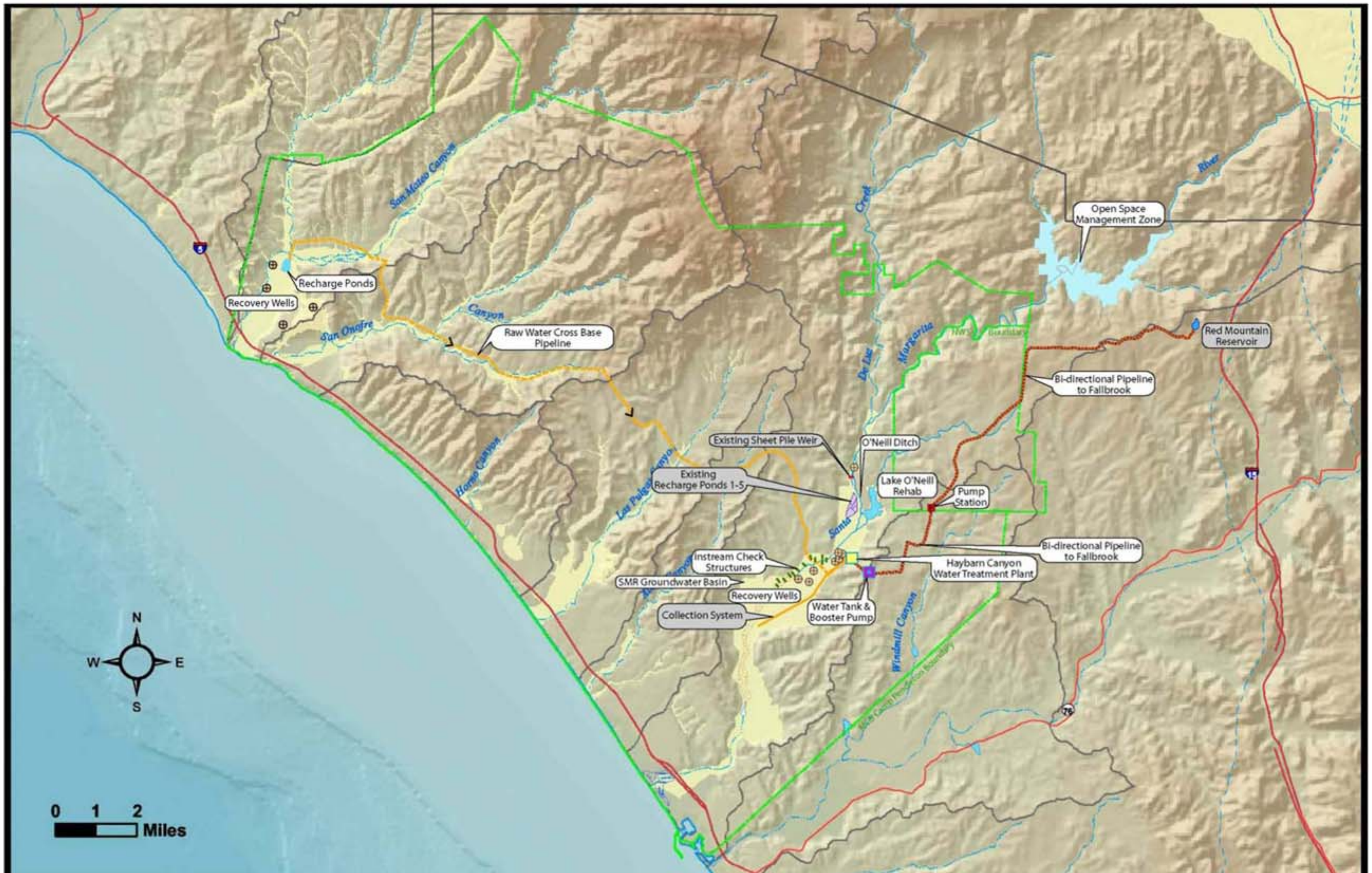
New SMC/SOC production wells	2 wells, 7 cfs
SMC/SOC wellhead treatment	7 cfs
Cross-base pipeline (Raw water pipeline from SMC to SMR)	104,000 feet, 7 cfs

Sources

Santa Margarita River Recharge and Recovery Enhancement Program Permit 15000 Feasibility Study for Marine Corps Base Camp Pendleton, Stetson Engineers Inc., March 23, 2001.

Conjunctive Use Project for the Lower Santa Margarita River Basin, Supplemental Study to the Santa Margarita River Recharge and Recovery Enhancement Program: Permit 15000 Feasibility Study for Marine Corps Base Camp Pendleton, Stetson Engineers Inc., February 2002.

Figure 5.18. Alternative 3c.



Alternative 3c

5.18 Alternative 3D

Figure 5.19 is a generalized map showing pre-feasibility Alternative 3d in plan view. Following is a description of and details regarding the components of Alternative 3d. Details include preliminary facility capacities and/or sizing. References are also provided to previous Stetson Engineers Inc. reports that served as the source of information used in the development of this alternative.

Description

Alternative 3a components without bi-directional pipeline to Fallbrook plus:

Alternative 3d specific components:

- San Mateo Creek basin conjunctive use
- Cross-base water pipeline
- Pipeline to Orange County/MWD water exchange

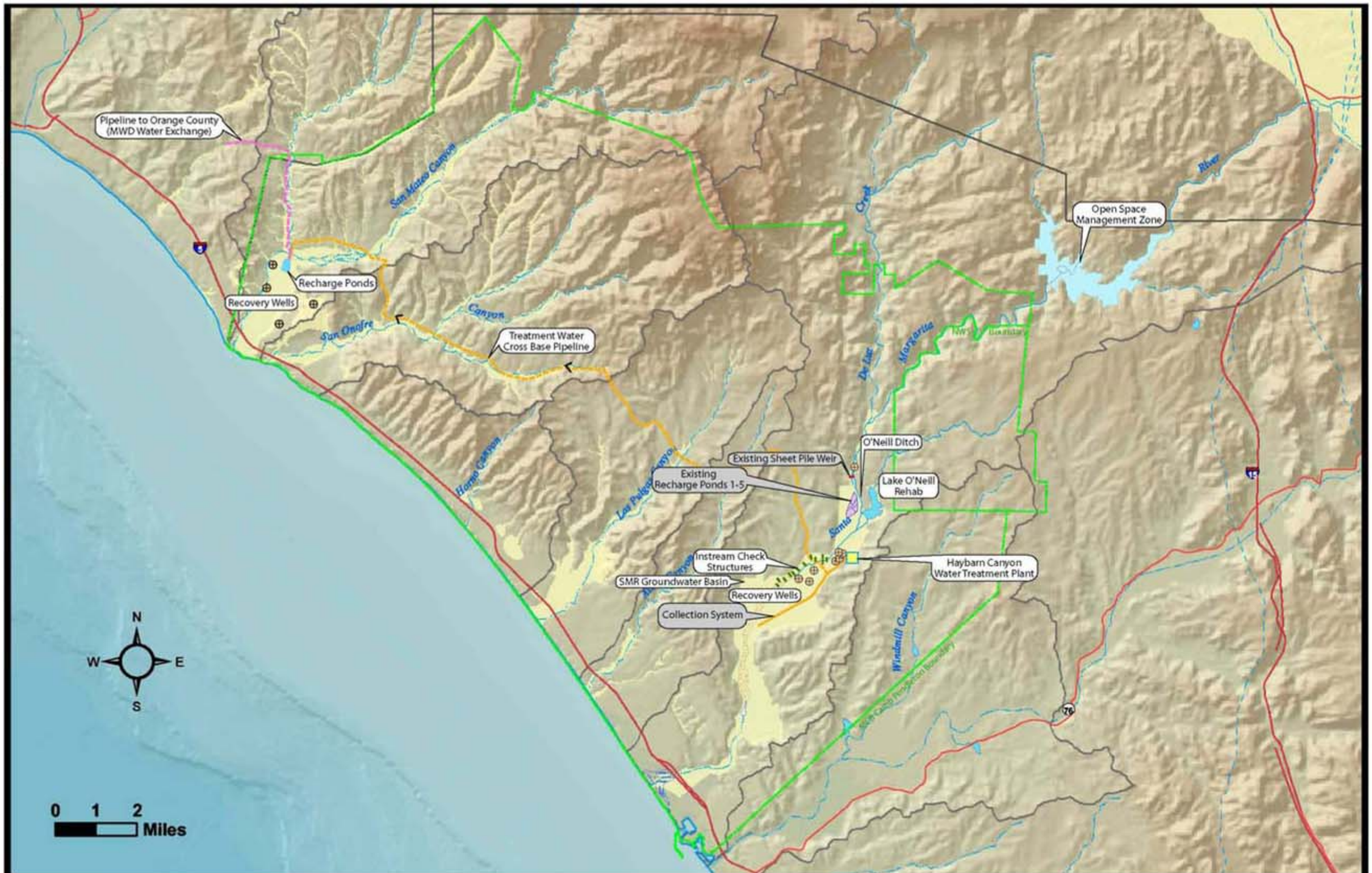
Details

New SMC/SOC production wells	3 wells
SMC/SOC wellhead treatment	8 cfs
Cross-base pipeline (Raw water pipeline from SMR to SMC)	104,000 feet, 40 cfs
SMC recharge pond	10 to 20 acres
Pipeline to Orange County	23,000 feet, 8 cfs

Sources

Santa Margarita River Recharge and Recovery Enhancement Program Permit 15000 Feasibility Study for Marine Corps Base Camp Pendleton, Stetson Engineers Inc., March 23, 2001.

Conjunctive Use Project for the Lower Santa Margarita River Basin, Supplemental Study to the Santa Margarita River Recharge and Recovery Enhancement Program: Permit 15000 Feasibility Study for Marine Corps Base Camp Pendleton, Stetson Engineers Inc., February 2002.



STETSON ENGINEERS INC.

Alternative 3d

Figure 5.19. Alternative 3d.

5.19 Alternative 3E

Figure 5.20 is a generalized map showing pre-feasibility Alternative 3e in plan view. Following is a description of and details regarding the components of Alternative 3e. Details include preliminary facility capacities and/or sizing. References are also provided to previous Stetson Engineers Inc. reports that served as the source of information used in the development of this alternative.

Description

Alternative 3a components plus:

Alternative 3e specific components:

- Treatment wetlands and reservoir on NWS
- Land outfall turnout and pipeline
- Denitrified pipeline to Santa Margarita River
- Spreading basin at Santa Margarita River

Details

Haybarn Canyon WTP	29 cfs
New SMR production wells	6 wells
Pump stations	
WTP to water tank	25 cfs
Pipeline from SMR to FPUD	20 cfs
Land outfall pipeline	9,000 feet, 12-inch diameter, 4 cfs
NWS treatment wetland	18 acres, 36 af volume
NWS storage reservoir	49 acres, 1,600 af volume
Denitrified pipeline	5,800 feet, 20-inch diameter, 9 cfs
Spreading basin	TBD acres

Sources

Santa Margarita River Recharge and Recovery Enhancement Program Permit 15000 Feasibility Study for Marine Corps Base Camp Pendleton, Stetson Engineers Inc., March 23, 2001.

Conjunctive Use Project for the Lower Santa Margarita River Basin, Supplemental Study to the Santa Margarita River Recharge and Recovery Enhancement Program: Permit 15000 Feasibility Study for Marine Corps Base Camp Pendleton, Stetson Engineers Inc., February 2002.

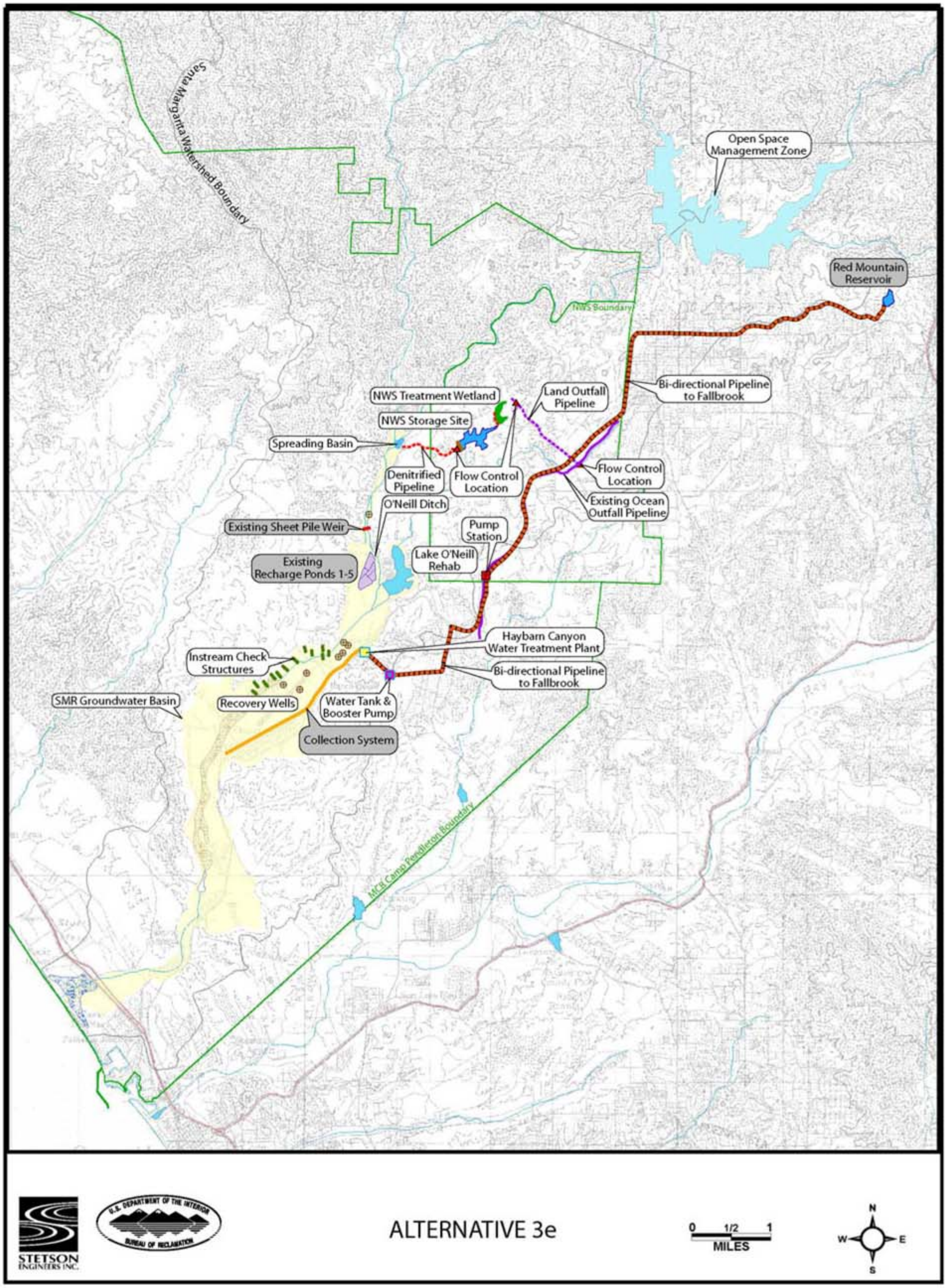


Figure 5.20. Alternative 3e.

5.20 Alternative 3F

Figure 5.21 is a generalized map showing pre-feasibility Alternative 3f in plan view. Following is a description of and details regarding the components of Alternative 3f. Details include preliminary facility capacities and/or sizing. References are also provided to previous Stetson Engineers Inc. reports that served as the source of information used in the development of this alternative.

Description

Alternative 3a components plus:

Alternative 3f specific components:

- Land outfall turnout and pipeline
- Camp Pendleton Pueblitos Canyon treatment wetland
- Denitrified pipeline from wetlands to Lower Ysidora sub-basin
- Spreading pipelines for ground-water recharge to prevent seawater intrusion

Details

Haybarn Canyon WTP	27 cfs
New SMR production wells	5 wells
Pump stations	
WTP to water tank	23 cfs
Pipeline from SMR to FPUD	18 cfs
Land outfall pipeline	18,400 feet, 16” diameter, 6 cfs
Pueblitos Canyon treatment wetland	33 acres, 90 af volume
Expansion area	12 acres, 33 af volume
Denitrified pipeline	5,700 feet, 16-inch diameter, 6 cfs
Ground-water recharge (spreading) pipeline	9,400 feet, 16-inch diameter, 6.3 cfs
Spreading basin	TBD acres

Sources

Santa Margarita River Recharge and Recovery Enhancement Program Permit 15000 Feasibility Study for Marine Corps Base Camp Pendleton, Stetson Engineers Inc., March 23, 2001.

Technical Engineering Report; Constructed Treatment Wetland Feasibility Study for Marine Corps Base Camp Pendleton, Stetson Engineers Inc., March 2003.

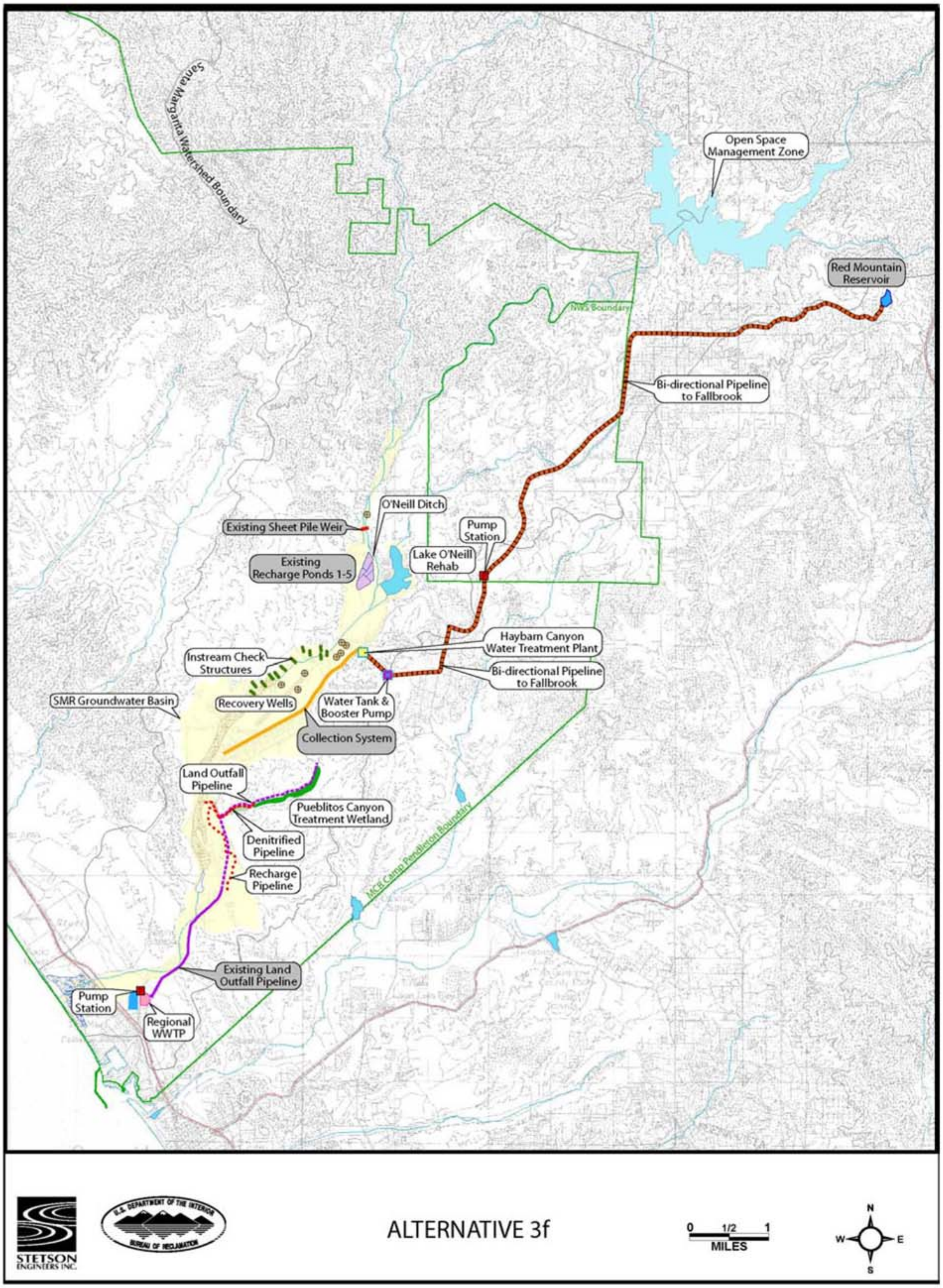


Figure 5.21. Alternative 3f.

5.21 Alternative 3G

Figure 5.22 is a generalized map showing pre-feasibility Alternative 3g in plan view. Following is a description of and details regarding the components of Alternative 3g. Details include preliminary facility capacities and/or sizing. References are also provided to previous Stetson Engineers Inc. reports that served as the source of information used in the development of this alternative.

Description

Alternative 3a components plus:

Alternative 3g specific components:

- Land outfall turnout and pipeline
- Camp Pendleton Newton Canyon treatment wetlands
- Denitrified pipeline from wetlands to Lower Ysidora sub-basin
- Spreading pipelines for ground-water recharge to prevent seawater intrusion

Details

Haybarn Canyon WTP	27 cfs
New SMR production wells	5 wells
Pump stations	
WTP to water tank	23 cfs
Pipeline from SMR to FPUD	18 cfs
Land outfall pipeline	7,300 feet, 16-inch diameter, 6 cfs
Newton Canyon treatment wetland	35 acres, 97 af volume
Expansion area	11 acres, 32 af volume
Denitrified pipeline	20,600 feet, 16-inch diameter, 6 cfs
Ground-water recharge (spreading) pipeline	9,400 feet, 16-inch diameter, 6 cfs
Spreading basin	TBD acres

Sources

Santa Margarita River Recharge and Recovery Enhancement Program Permit 15000 Feasibility Study for Marine Corps Base Camp Pendleton, Stetson Engineers Inc., March 23, 2001.

Technical Engineering Report; Constructed Treatment Wetland Feasibility Study for Marine Corps Base Camp Pendleton, Stetson Engineers Inc., March 2003.

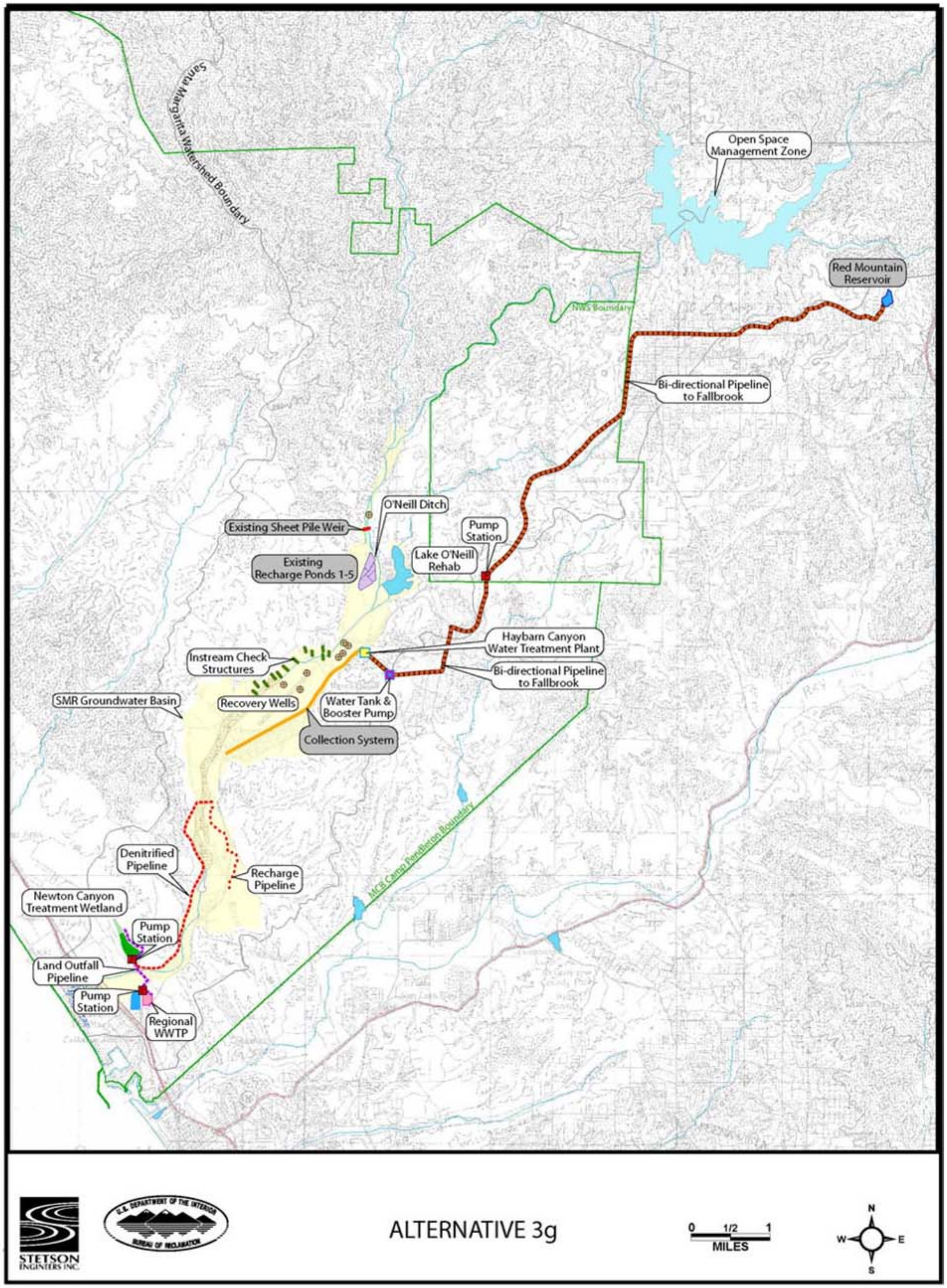


Figure 5.22. Alternative 3g.

5.22 Alternative 3H

Figure 5.23 is a generalized map showing pre-feasibility Alternative 3h in plan view. Following is a description of and details regarding the components of Alternative 3h. Details include preliminary facility capacities and/or sizing. References are also provided to previous Stetson Engineers Inc. reports that served as the source of information used in the development of this alternative.

Description

Alternative 3a components plus:

Alternative 3h specific components:

- Off-stream surface reservoir storage
- Bi-directional *raw water* pipeline between reservoir and pond No. 7

Details

Haybarn Canyon WTP	27 cfs
New SMR production wells	4 wells
Pump stations	
WTP to water tank	23 cfs
Pipeline from SMR to FPUD	18 cfs
Off-stream storage	55 acres, 4,800 af volume
Pipeline between reservoir and pond No. 7	12,000 feet, 36-inch diameter, 40 cfs
(Bi-directional *raw water*)	

Source

Santa Margarita River Recharge and Recovery Enhancement Program Permit 15000 Feasibility Study for Marine Corps Base Camp Pendleton, Stetson Engineers Inc., March 23, 2001.

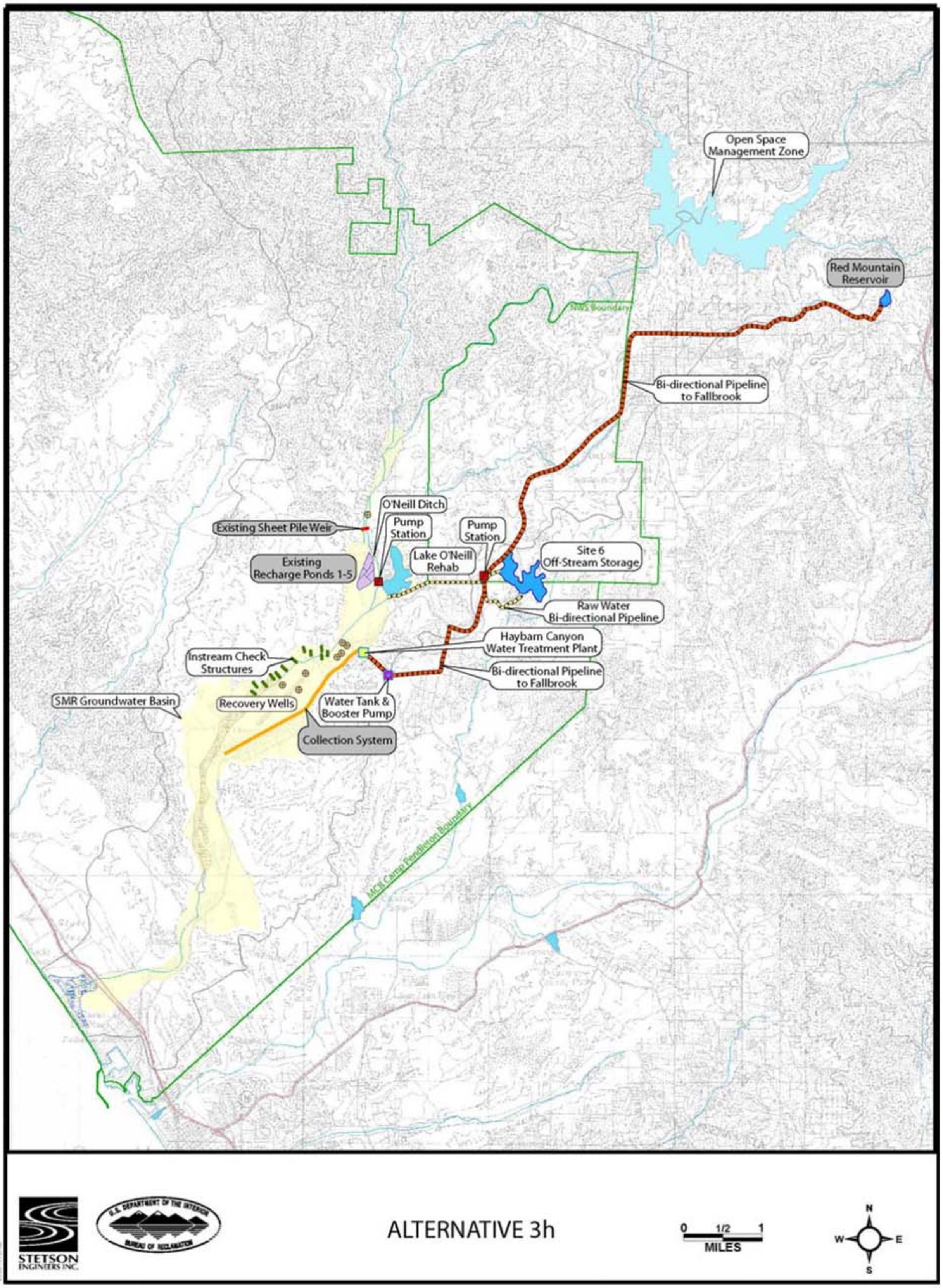


Figure 5.23. Alternative 3h.

5.23 Alternative 3I

Figure 5.24 is a generalized map showing pre-feasibility Alternative 3i in plan view. Following is a description of and details regarding the components of Alternative 3i. Details include preliminary facility capacities and/or sizing. References are also provided to previous Stetson Engineers Inc. reports that served as the source of information used in the development of this alternative.

Description

Alternative 3a components plus:

Alternative 3i specific components:

- Close production wells to provide enhanced extraction
- Pipeline and pump station to Haybarn Canyon WTP

Details

Alternative 1a details (previously shown, with following changes)

New SMR production wells	2 wells
Enhanced production pipeline	7,500 feet, 4 cfs

Source

Santa Margarita River Recharge and Recovery Enhancement Program Permit 15000 Feasibility Study for Marine Corps Base Camp Pendleton, Stetson Engineers Inc., March 23, 2001.

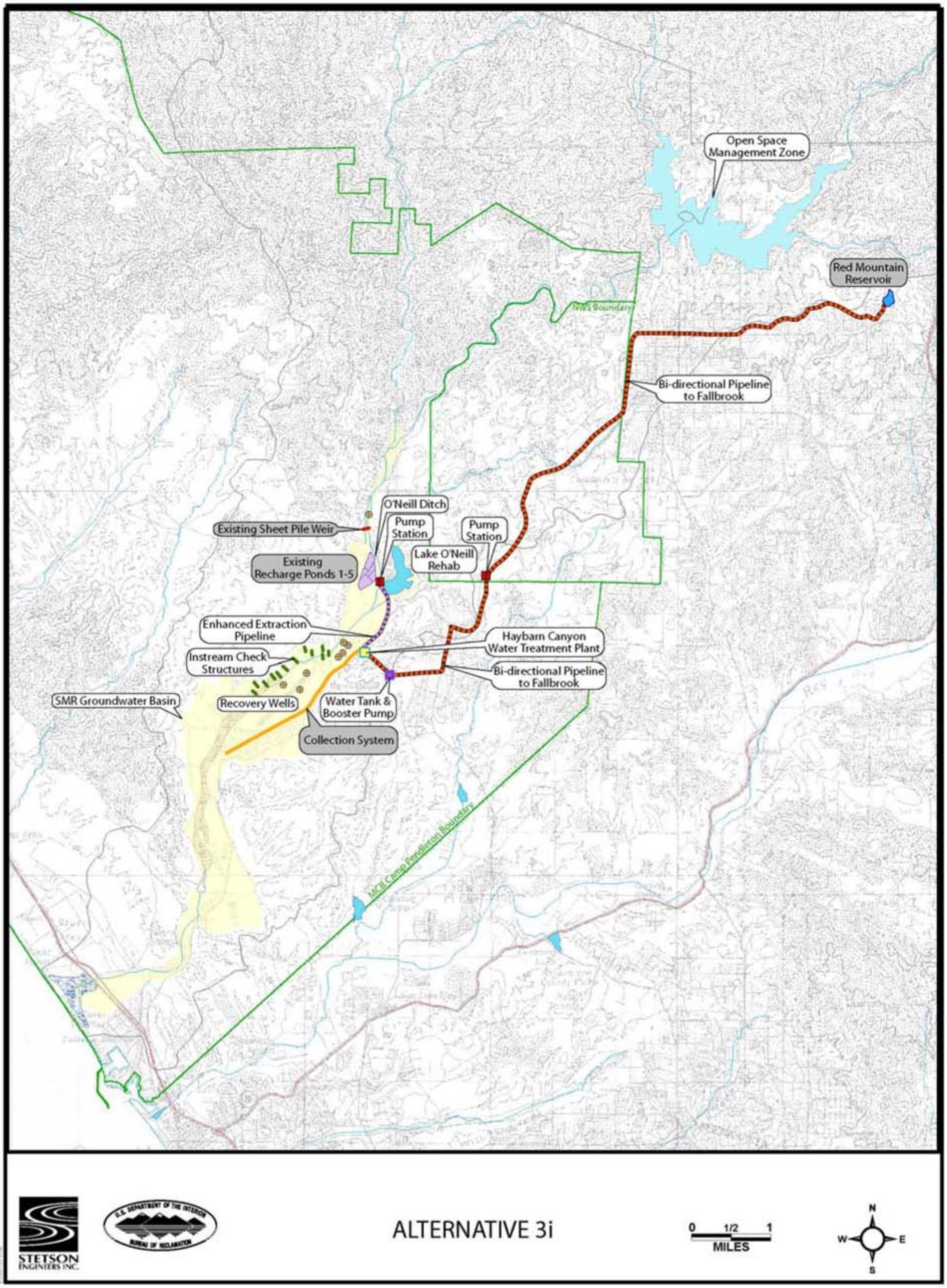


Figure 5.24. Alternative 3i.

6.0 Alternative Project Yields

Each pre-feasibility alternative produces a different water yield. For the purpose of this pre-feasibility study, there are two yield definitions of interest: (1) the amount of water delivered on an average annual basis and (2) the amount of water delivered on a median year basis. Median year yields are important because they indicate that in half of the years, the yield will be greater than the indicated yield and that in half the years, the yield will be less than the indicated yield. Stetson Engineers Inc. provided the yields for all the alternatives as presented in tables 6.1 through 6.3. Table 6.1 presents the estimated average annual and median year yields for Concept 1; table 6.2 presents the yields for Concept 2; and table 6.3 present yields for Concept 3. The descriptions of the alternatives in the tables identify the yield-producing features of each alternative in an additive fashion. The yields are also shown in an additive way whereby each number corresponds to the relative item in the description.

Concept 1 develops the largest yield of the three major concepts, with a median year yield of 14,100 acre-feet of water per year. Concept 3 develops the lowest median yield of 12,000 acre-feet per year. Concept 2 develops 12,600 acre-feet per year.

6.1 Net Yield of Alternatives

Each of the pre-feasibility alternatives incorporates advanced water treatment. The treatment process will result in an overall process recovery of 85 percent. The objective of advanced treatment would be to produce finished water with total dissolved solids (TDS) of 425 mg/L. The 85 percent process recovery implies that there will be a 15 percent loss in the form of a concentrate that would need to be discharged into the brine line described earlier in this document. As a result, the net yield for service delivery of each of the alternatives would be less than the yields presented in tables 6.1 thru 6.3. The net yields for all the alternatives are presented in table 6.4. These net yields reflect adjustments to yields based on the portions of project waters that would be run through the advanced treatment plant. No losses are assumed for water exchanged with Orange County or run through the primary treatment processes at the Fallbrook sump.

Table 6.1. Alternative 1 Project Yields

Concept 1		Annual Project Yield *		Source
		Median	Average	Notes
1a	Permit 15000 improvements (Alt 3) + pipeline from SMR to FPUD (Red Mountain) + Haybarn water treatment plant + Rehabilitation of Lake O'Neill + new production wells	**14,100**	**13,400**	(1) Alt 3
1b	Alt 1a + pipeline from SMC/SOC to Orange County (MWD transfer)	14,100 + 2,800 16,900	13,400 + 2,300 15,700	(1) Alt 3 (4) Table 5-2
1c	Alt 1a + 1direct raw water pipeline from SMC/SOC to SMR (w/ FPUD exchange)	14,100 + 2,800 16,900	13,400 + 2,300 15,700	(1) Alt 3 (4) Table 5-2
1d	Alt 1a [without pipeline from SMR to FPUD (Red Mt)] + Bi-directional pipeline from SMR to SMC/SOC + pipeline from SMC/SOC to Orange County (MWD transfer)	14,100 + 2,800 + 600 17,500	13,400 + 2,300 + 1,000 16,700	(1) Alt 3 (4) Table 5-2 (4) Table 5-4
1e	Alt 1a + NWS treatment wetland and storage	14,100 + 2,100 16,200	13,400 + 2,000 15,400	(1) Alt 3 (2) Alt 10
1f	Alt 1a + Pueblitos Canyon treatment wetland	14,100 + 1,000 15,100	13,400 + 1,000 14,400	(1) Alt 3 (3) Table 5-12 [a]
1g	Alt 1a + Newton Canyon treatment wetland	14,100 + 1,000 15,100	13,400 + 1,000 14,400	(1) Alt 3 (3) Table 5-12 [a]
1h	Alt 1a + Site 6 offstream storage (15000 Permit plan)	14,100 + 700 14,800	13,400 + 700 14,100	(1) Alt 3 (1) Alt 4 table 7-30
1i	Alt 1a + enhanced production (recovery wells)	14,100	13,400	(1) Alt 3 [b]

* SMR yield is based on the total yield of the project.
* SMC/SOC yield is based on the additional yield above 1980-2002 existing pumping.
[a] Estimated based on 2/3 recovery of 1,500 acre-feet of wastewater treatment wetland infiltration.
[b] Direct diversion equivalent to two ground-water wells results in same yield as Alt. 3 but different economics.

Source
(1) *Santa Margarita River Recharge and Recovery Enhancement Program: Permit 15000 Feasibility Study for Marine Corps Base Camp Pendleton*, Stetson Engineers Inc., March 23, 2001.
(2*) Conjunctive Use Project for the Lower Santa Margarita River Basin, Supplemental Study to the Santa Margarita River Recharge and Recovery Enhancement Program: Permit 15000 Feasibility Study for Marine Corps Base Camp Pendleton*, Stetson Engineers Inc., February 2002
(3) *Technical Engineering Report, Constructed Treatment Wetland Feasibility Study, Marine Corps Base Camp Pendleton California*, Stetson Engineers Inc., March 2003
(4) *Draft: Three Dimensional Groundwater Flow Model of the San Mateo and San Onofre Basins, USMC Base Camp Pendleton*, Stetson Engineers Inc., September 2004.

Table 6.2. Alternative 2 Project Yields

Concept 2		Annual Project Yield *		Source
		Median	**Average**	**Notes**
2a	Alt 1a [without pipeline from SMR to FPUD (Red Mt)] + pipeline from FPUD (Red Mt) sump diversion to Red Mtn + pipeline from Oceanside to Morro Hill (new)	**9,100** **+ 3,500** **12,600**	**9,100** **+ 3,400** **12,500**	Stetson FPUD Sump Analysis Joe Jackson, 12/6/04 Memo
2b	Alt 2a + Bi-direct pipeline from SMR to SMC/SOC + pipeline from SMC/SOC to Orange County (MWD transfer) + existing connection from Oceanside to Morro Hill	12,600 + 2,800 + 600 16,000	12,500 + 2,300 + 1,000 15,800	Stetson FPUD Sump Analysis Joe Jackson, 12/6/04 Memo (4) Table 5-2 (4) Table 5-4
2c	Alt 2a + Pueblitos Canyon treatment wetland	12,600 + 1,000 13,600	12,500 + 1,000 13,500	Stetson FPUD Sump Analysis Joe Jackson, 12/6/04 Memo (3) Table 5-12 [a]
2d	Alt 2a + Newton Canyon treatment wetland	12,600 + 1,000 13,600	12,500 + 1,000 13,500	Stetson FPUD Sump Analysis Joe Jackson, 12/6/04 Memo (3) Table 5-12 [a]

* SMR yield is based on the total yield of the project.
* SMC/SOC yield is based on the additional yield above 1980-2002 existing pumping.
[a] Estimated based on 2/3 recovery of 1,500 AF of wastewater treatment wetland infiltration.
[b] Direct diversion equivalent to two ground- water wells results in same yield as Alt. 3 but different economics.

Source
(1) *Santa Margarita River Recharge and Recovery Enhancement Program: Permit 15000 Feasibility Study for Marine Corps Base Camp Pendleton*, Stetson Engineers Inc., March 23, 2001.
(2) *Conjunctive Use Project for the Lower Santa Margarita River Basin, Supplemental Study to the Santa Margarita River Recharge and Recovery Enhancement Program: Permit 15000 Feasibility Study for Marine Corps Base Camp Pendleton*, Stetson Engineers Inc., February 2002
(3) *Technical Engineering Report, Constructed Treatment Wetland Feasibility Study, Marine Corps Base Camp Pendleton California*, Stetson Engineers Inc., March 2003
(4) *Draft: Three Dimensional Groundwater Flow Model of the San Mateo and San Onofre Basins, USMC Base Camp Pendleton*, Stetson Engineers Inc., September 2004.

Table 6.3. Alternative 3 Project Yields

Concept 3		Annual project yield* Median	Annual project yield* Average	Source Notes
3a	Permit 15000 M&R + pipeline from SMR to FPUD (Red Mt) + Haybarn Water Treatment Plant + Rehabilitation of Lake O'Neill + recovery wells + instream structures	**11,900 + 100 12,000**	**11,200 + 300 11,500**	(2) Alt 1a table 8-7 + Check structures (TBD)
3b	Alt 3a + pipeline from SMC/SOC to Orange County (MWD transfer)	11,900 + 100 + 2,800 14,800	11,200 + 300 + 2,300 13,800	(2) Alt 1a table 8-7 + Check structures (TBD) (4) Table 5-2
3c	Alt 3a + 1-direct raw water pipeline from SMC/SOC to SMR (w/ FPUD exchange)	11,900 + 100 + 2,800 14,800	11,200 + 300 + 2,300 13,800	(2) Alt 1a table 8-7 + Check structures (TBD) (4) Table 5-2
3d	Alt 3a [without pipeline from SMR to FPUD (Red Mt) + Bi-direct pipeline from SMR to SMC/SOC + pipeline from SMC/SOC to Orange County (MWD transfer)	11,900 + 100 + 2,800 + 600 15,400	11,200 + 300 + 2,300 + 1,000 14,800	(2) Alt 1a table 8-7 + Check structures (TBD) (4) Table 5-2 (4) Table 5-4
3e	Alt 3a + NWS TW & Storage	11,900 + 100 + 2,100 14,100	11,200 + 300 + 2,000 13,500	(2) Alt 1a able 8-7 + Check structures (TBD) (2) Alt 10
3f	Alt 3a + Pueblitos Canyon treatment wetland	11,900 + 100 + 1,000 13,000	11,200 + 300 + 1,000 12,500	(2) Alt 1a table 8-7 + Check structures (TBD) (3) Table 5-12 [a]
3g	Alt 3a + Newton Canyon treatment wetland	11,900 + 100 + 1,000 13,000	11,200 + 300 + 1,000 12,500	(2) Alt 1a table 8-7 + Check structures (TBD) (3) Table 5-12 [a]
3h	Alt 3a + Site 6 offstream storage (15000 Permit plan)	11,900 + 100 + 700 12,700	11,200 + 300 + 700 12,200	(2) Alt 1a table 8-7 + Check structures (TBD) (1) Alt 4 table 7-30
3i	Alt 3a + enhanced production (recovery wells)	11,900 + 100 12,000	11,200 + 300 11,500	(2) Alt 1a table 8-7 + Check structures (TBD)

* SMR yield is based on the total yield of the project.
* SMC/SOC yield is based on the additional yield above 1980-2002 existing pumping.
[a] Estimated based on 2/3 recovery of 1,500 acre-feet of wastewater treatment wetland infiltration.
[b] Direct diversion equivalent to two ground -water wells results in same yield as Alt. 3 but different economics.

Source
(1) *Santa Margarita River Recharge and Recovery Enhancement Program: Permit 15000 Feasibility Study for Marine Corps Base Camp Pendleton*, Stetson Engineers Inc., March 23, 2001.
(2) *Conjunctive Use Project for the Lower Santa Margarita River Basin, Supplemental Study to the Santa Margarita River Recharge and Recovery Enhancement Program: Permit 15000 Feasibility Study for Marine Corps Base Camp Pendleton*, Stetson Engineers Inc., February 2002.
(3) *Technical Engineering Report, Constructed Treatment Wetland Feasibility Study, Marine Corps Base Camp Pendleton California*, Stetson Engineers Inc., March 2003.
(4) Draft: Three Dimensional Groundwater Flow Model of the San Mateo and San Onofre Basins, USMC Base Camp Pendleton, Stetson Engineers Inc., September 2004.

Table 6.4. Net project yields due to 85-percent advanced water treatment recovery

Alternative	Median project yield (af/yr)	Median net project yield (af/yr)
1a	14,100	11,985
1b	16,900	14,785
1c	16,900	14,365
1d	17,500	14,875
1e	16,200	13,770
1f	15,100	12,835
1g	15,100	12,835
1h	14,800	12,580
1i	14,100	11,985
2a	12,600	10,710
2b	16,000	14,020
2c	13,600	11,560
2d	13,600	11,560
3a	12,000	10,200
3b	14,800	13,000
3c	14,800	12,580
3d	15,400	13,090
3e	14,100	11,985
3f	13,000	11,050
3g	13,000	11,050
3h	12,700	10,795
3i	12,000	10,200

6.2 Hydraulic Structure Capacities

The hydraulic capacities of each of the hydraulic structures in the pre-feasibility alternatives were developed by Stetson Engineering. The conceptual designs and cost estimates presented in this document are based on estimated maximum monthly capacities provided by Stetson. **Table 6.5** summarizes the design capacities for all facilities in each of the 22 alternatives.

Table 6.5. Pre-feasibility alternative hydraulic facility maximum monthly design capacities.

Maximum Monthly Capacity	UNITS	Alt 1a	Alt 1b	Alt 1c	Alt 1d	Alt 1e	Alt 1f	Alt 1g	Alt 1h	Alt 1i	Alt 2a	Alt 2b	Alt 2c	Alt 2d	Alt 3a	Alt 3b	Alt 3c	Alt 3d	Alt 3e	Alt 3f	Alt 3g	Alt 3h	Alt 3i
Total Project Yield (median)	[AFY]	14,100	16,900	16,900	17,500	16,200	15,100	15,100	14,800	14,100	12,600	16,000	13,600	13,600	12,000	14,800	14,800	15,400	14,100	13,000	13,000	12,700	12,000
Haybarn Canyon Water Treatment Plant (WTP) for RO	[cfs]	29	29	29	29	33	30	30	30	29	21	22	23	23	25	25	25	25	29	27	27	27	25
Reject Water to Brine Line 15%	[cfs]	4	4	4	4	5	5	5	5	4	3	3	3	3	4	4	4	4	4	4	4	4	4
SMR at Fallbrook Sump to Primary WTP and Red Mountain	[cfs]	0	0	0	0	0	0	0	0	0	5	5	5	5	0	0	0	0	0	0	0	0	0
Total SMC/SOC Well Pumps	[cfs]	0	11	11	12	0	0	0	0	0	0	12	0	0	0	11	11	12	0	0	0	0	0
New Extraction Wells (SMR) [1(a)]	[# wells]	6	6	6	6	8	7	7	6	4	4	6	7	7	4	4	4	4	6	5	5	4	2
New Extraction Wells (SMC/SOC) [1(a)]	[# wells]	0	2	2	3	0	0	0	0	0	0	3	0	0	0	2	2	3	0	0	0	0	0
5 cfs diversion at FPUD Sump [1(b)]	[# wells]	0	0	0	0	0	0	0	0	0	5	5	5	5	0	0	0	0	0	0	0	0	0
Enhanced Extraction Pipeline (to Haybarn WTP)	[cfs]	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	4
Diversion Dam	[cfs]	200	200	200	200	200	200	200	200	200	200	200	200	200	100	100	100	100	100	100	100	100	100
Canal to Lake O'Neill	[cfs]	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
O'Neill Ditch	[cfs]	200	200	200	200	200	200	200	200	200	200	200	200	200	100	100	100	100	100	100	100	100	100
Recharge Ponds 1-5	[acres]/[AF]	49/312	49/312	49/312	49/312	49/312	49/312	49/312	49/312	49/312	49/312	49/312	49/312	49/312	49/312	49/312	49/312	49/312	49/312	49/312	49/312	49/312	49/312
Recharge Pond 6 & 7	[acres]/[AF]	46/242	46/242	46/242	46/242	46/242	46/242	46/242	46/242	46/242	46/242	46/242	46/242	46/242	0	0	0	0	0	0	0	0	0
CPEN Southern Water System Demand -Year 2005 [2]	[cfs]	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
CPEN Northern Water System Demand -Year 2005 [3]	[cfs]	n/a	4	4	4	n/a	n/a	n/a	n/a	n/a	n/a	4	n/a	n/a	n/a	4	4	4	n/a	n/a	n/a	n/a	n/a
WTP to Tanks	[cfs]	24	24	24	24	28	26	26	26	24	18	18	20	20	21	21	21	21	25	23	23	23	21
Booster Pump Station and FPUD pipeline	[cfs]	19	19	19	0	23	21	21	21	19	0	0	0	0	16	16	16	0	20	18	18	18	16
Chloramination Well Head Treatment and Pipeline to Orange County (MWD Transfer)	[cfs]	0	7	0	8	0	0	0	0	0	0	8	0	0	0	7	0	8	0	0	0	0	0
Cross Base Pipeline	[cfs]	0	0	7	40	0	0	0	0	0	0	40	0	0	0	0	7	40	0	0	0	0	0
Diversion Weir at FPUD Sump		0	0	0	0	0	0	0	0	0	yes	yes	0	0	0	0	0	0	0	0	0	0	0
Pipeline FPUD sump to Red Mt	[cfs]	0	0	0	0	0	0	0	0	0	5	5	5	5	0	0	0	0	0	0	0	0	0
Emergency Supply Pipeline from Morro Hill [4]	[cfs]	0	0	0	0	0	0	0	0	0	20	0 [5]	20	20	0	0	0	0	0	0	0	0	0
SMC Recharge Pond	[acres]	0	0	0	10-20	0	0	0	0	0		10-20	0	0	0	0	0	10-20	0	0	0	0	0
Dam on Naval Weapon Station (NWS)	[-]	0	0	0	0	yes	0	0	0	0	0	0	0	0	0	0	0	0	yes	0	0	0	0
Pipeline btw Wetland & NWS Proposed Reservoir	[cfs]	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0
NWS Reservoir	[acres]/[AF]	0	0	0	0	49/1600	0	0	0	0	0	0	0	0	0	0	0	0	49/1600	0	0	0	0
Wetland Pump Station	[cfs]	0	0	0	0		6	6	0	0	0	0	6	6	0	0	0	0		6	6	0	0
Land Outfall Pipeline to Wetland (purple dashed)	[cfs]	0	0	0	0	4	6	6	0	0	0	0	6	6	0	0	0	0	4	6	6	0	0
Denitrified Land Outfall Pipeline (red dashed)	[cfs]	0	0	0	0	9	6	6	0	0	0	0	6	6	0	0	0	0	9	6	6	0	0
Groundwater Recharge Pipeline	[cfs]	0	0	0	0		6	6	0	0	0	0	6	6	0	0	0	0		6	6	0	0
Treatment Wetland	[acres]/[AF]	0	0	0	0	18/36	33/90	35/97	0	0	0	0	33/90	35/97	0	0	0	0	18/36	33/90	35/97	0	0
Recharge Pond Pump Station (to Off-Stream Storage)	[cfs]	0	0	0	0	0	0	0	40	0	0	0	0	0	0	0	0	0	0	0	0	40	0
Off-Stream Storage Raw Water Bi-Directional Pipeline	[cfs]	0	0	0	0	0	0	0	40	0	0	0	0	0	0	0	0	0	0	0	0	40	0
Off-Stream Storage Dams	[cfs]	0	0	0	0	0	0	0	yes	0	0	0	0	0	0	0	0	0	0	0	0	yes	0
Site 6 Off-Stream Storage Reservoir	[acres]/[AF]	0	0	0	0	0	0	0	55/4800	0	0	0	0	0	0	0	0	0	0	0	0	55/4800	0
Instream Check dams [6]	[-]	0	0	0	0	0	0	0	0	0	0	0	0	0	yes	yes	yes	yes	yes	yes	yes	yes	yes
NET PROJECT YIELD	[AFY]	11,985	14,785	14,365	14,875	13,770	12,835	12,835	12,580	11,985	10,710	14,020	11,560	11,560	10,200	13,000	12,580	13,090	11,985	11,050	11,050	10,795	10,200

[1(a)] Assume capacity of new wells is 1.6 cfs per well, which accounts for 80% operation efficiency.

[1(b)] Joe Jackson 12.06.04 memorandum

[2] Assume Camp Pendleton's demand during maximum pumping month in Year 2005 is 250 AF (5.3 cfs including 80% operation efficiency) for the Southern Water System

[3] Assume Camp Pendleton's demand during maximum pumping month in Year 2005 is 200 AF (4.2 cfs including 80% operation efficiency) for the Northern Water System

[4] Emergency pipeline sized to meet CPEN Southern Water System maximum monthly demand at build-out.

[5] Morrow Hill emergency pipeline capacity available from Cross-Base Pipeline

[6] Check Dam Structure details per Jennifer Bountry's HEC-RAS modeling data

7.0 Water Treatment

Three treatment processes were considered in cost analysis of the pre-feasibility alternatives:

- Advanced water treatment
- Minimal water treatment
- Chloramination

Advanced and minimal water treatment were considered separately in all alternatives. Chloramination was applied to alternatives involving deliveries to Orange County for water exchange purposes. In these exchange alternatives, the chloramination process was assumed to be incorporated as well head treatment on water produced and delivered from the San Mateo Creek basin.

Where advanced or minimal treatment is assumed at Haybarn Canyon, it is assumed that such treatment would be integrated with the Base's existing iron and manganese removal plant.

Reclamation developed a cost model for desalination and other water treatment processes in the 1990s. Collaborators over this period have been the National Institute for Standards and Technology; I. Moch & Associates, Inc.; the American Membrane Technology Association (AMTA); the Colorado School of Mines; and the University of Houston. The objective of this program is to estimate the cost of water treatment technologies based only on the water analysis and desired capacity. Inputs define the specific equipment used, but reasonable defaults are provided for use in the planning phase. Initially, the model existed as a spreadsheet application, which formed the basis for WTCost©. Many of the same methods are used, but they are put into a user-friendly visual basic format.

WTCost© was applied to estimate the advanced water treatment and minimal treatment process costs of the 22 pre-feasibility sub-alternatives. Following is a description of the equipment and processes incorporated into the treatment costs.

7.1 Advanced Water Treatment

This section describes the water treatment equipment used for the cost estimates of the pre-feasibility alternatives. This summary includes a description of treatment plants designed with capacities of 5, 10, and 25 cfs using the processes, as shown in **table 7.1.** See section 12.0 for references cited.

Table 7.1. Advanced water treatment plant processes
Processes description
Chemical feeds:
Acidification
Antiscalants
Media filtration:
Granular activated carbon (GAC)
Separation process/desalting:
Reverse osmosis (RO)
Post-treatment
Chlorine
Miscellaneous equipment
Clearwell storage
Finished water pumping-centrifugal pumps

Chemical Feed Systems

Chemical feed systems include acidification and antiscalants.

Acidification

Acidification is a water treatment method used to increase the acidity of the proposed water to be treated, thus altering the pH of the water. This alteration can be useful in subsequent operations for water treatment [see Reference 1].

Antiscalants

Antiscalants are used as a pretreatment chemical addition to prevent scaling and inorganic membrane fouling. The presence of antiscalants enables maximum performance by lowering the solubility product of the sparingly soluble salt. Lowered solubility prevents the membranes from plugging reducing the need for frequent cleaning.

Media Filtration

Media filtration includes granular activated carbon.

Granular Activated Carbon (GAC)

Granular activated carbon is used to remove the organic constituents, such as herbicides and pesticides, in the water. GAC systems typically consist of steel vessels which contain the carbon and allow the water to be finely dispersed over a bed of carbon. The contaminants are adsorbed onto the carbon as the water flows through it until no adsorption sites remain. Once there are no more adsorption sites, the carbon must be removed and regenerated [2].

Separation Process/Desalting

Separation process/desalting includes reverse osmosis.

Reverse Osmosis (RO)
Reverse osmosis (RO) is a pressure-driven separation system using a flat sheet of membrane spirally wound inside pressure vessels. The product stream has been designed to produce 425 mg/L of dissolved solids. RO is a process by which water moves across a semi-permeable membrane from a low to a high concentration of solute. RO depends on a selective membrane that allows the solvent (water) of a solution to pass through the membrane but does not allow the solutes (contaminants, salts) to pass [6].

Post-Treatment
Post treatment includes chlorination.

Chlorination
Disinfection is required to kill or inactivate any pathogenic microorganisms found in the water. Chlorine has been the most widely used disinfectant in the United States. Chlorine, in gaseous form, is an effective disinfectant that is readily available, economical, and requires a fairly simple feed system [2].

Miscellaneous Equipment
Miscellaneous equipment includes clearwell storage and centrifugal pumps.

Clearwell Storage
A clearwell storage is a steel tank used as a means of flow equalization. This tank can be placed either underground or above ground, depending on the project's specific needs. The level in the clearwell storage tank may be used to pace polymer and chlorine feed rates or to regulate the plant inflow. This clearwell may also act as a chlorine or ozone contact tank [2].

Centrifugal Pumps
Finished water pumping is accomplished by 12-horsepower centrifugal pumps based on 500 feet of total dynamic head.

Advanced Treatment Cost Assumptions
The construction, operation, and maintenance cost estimates developed for the advanced treatment plant were based on the following assumptions:

- 85-percent overall process recovery
- 90-percent plant availability
- 24-hour-per-day planned operation

Table 7.2 presents the assumptions used for each unit process. The cost of electricity was assumed to be $0.11 per kilowatt hour (kWh). **Table 7.3** shows the water quality used in the WTCost© program. **Figure 7.1** describes the indices used to calculate the construction costs. These assumptions were combined in the WTCost© program to generate a cost analysis of each plant.

Table 7.2. Assumptions used in calculating costs per each unit process

Process	Unit	Assumption
Chemical feed systems	Acidification	93% H2SO4 $120/ton
	Antiscalant	20 mg/L alternate dose $750/pound
	Potassium permanganate	$2/pound 1 mg/L alternate dose
Media filtration	GAC	12-month bed life
	Greensand filtration	5 gallon/minute ft^2 loading rate 5.5 ft media depth 1 wash cycle 3 filters 0 alternate bed area $1,620/$yd^3$ of greensand
Separation process	Reverse osmosis	Standard membrane Element flow = 11,000 gallons per day Fouling factor = 0.9 175 psi feed pressure 50 psi pressure drop Flow allowed to bypass RO 1 RO train $800 per module $3,000 per pressure vessel 10% membrane replacement rate per year
Post-treatment	Chlorination	Chlorine dose =1 mg/L Chlorine cost = $365/ton
Miscellaneous equipment	Clearwell and storage	Above-ground steel storage capacity calculated based on the daily production
	Centrifugal pumps	1 pump 6.56 ft = height differential Discharge pressure = 44.98 psi Pump efficiency = 75% Velocity = 8.20 ft/s Motor efficiency = 95% Length of inlet pipe = 32.18 ft Coupling efficiency = 100% Inlet pressure = 44.98% Capacity/pump = 74.82 gallons/sec 12 horsepower 71,192 kilowatt hour/year power

Table 7.3. Santa Margarita River basin ground-water quality

Parameter	Units	Average	Minimum	Maximum	Maximum contaminant level (MCL)
Alkalinity	mg/L	205	120	280	NS
Calcium	mg/L	81	69	91	NS
Chloride	mg/L	159	10	335	250
Conductivity	mmhos/cm/L	1156	1000	1390	NS
Copper	mg/L	ND	ND	ND	1
Fluoride	mg/L	0.51	0.11	6.4	2
Hardness	mg/L	330	268	390	NS
Iron	mg/L	157	50	700	300
Lead	mg/L	0.99	0.8	1	NS
Magnesium	mg/L	31	23	39	NS
Manganese	mg/L	334	10	950	50
Nitrate as N	mg/L	0.58	0.1	8	45S
Sodium	mg/L	113	83	140	NS
Sulfate	mg/L	164	100	400	250
Total dissolved solids	mg/L	701	325	830	500
Total organic carbon	mg/L	6	1	12	NS
Color	Color units	10	ND	72	15
Odor	Ton	0.04	0	1	3
pH	pH units	7.4	7.1	7.9	6.5-8.5
Turbidity	NTU	0.95	0	7	NS

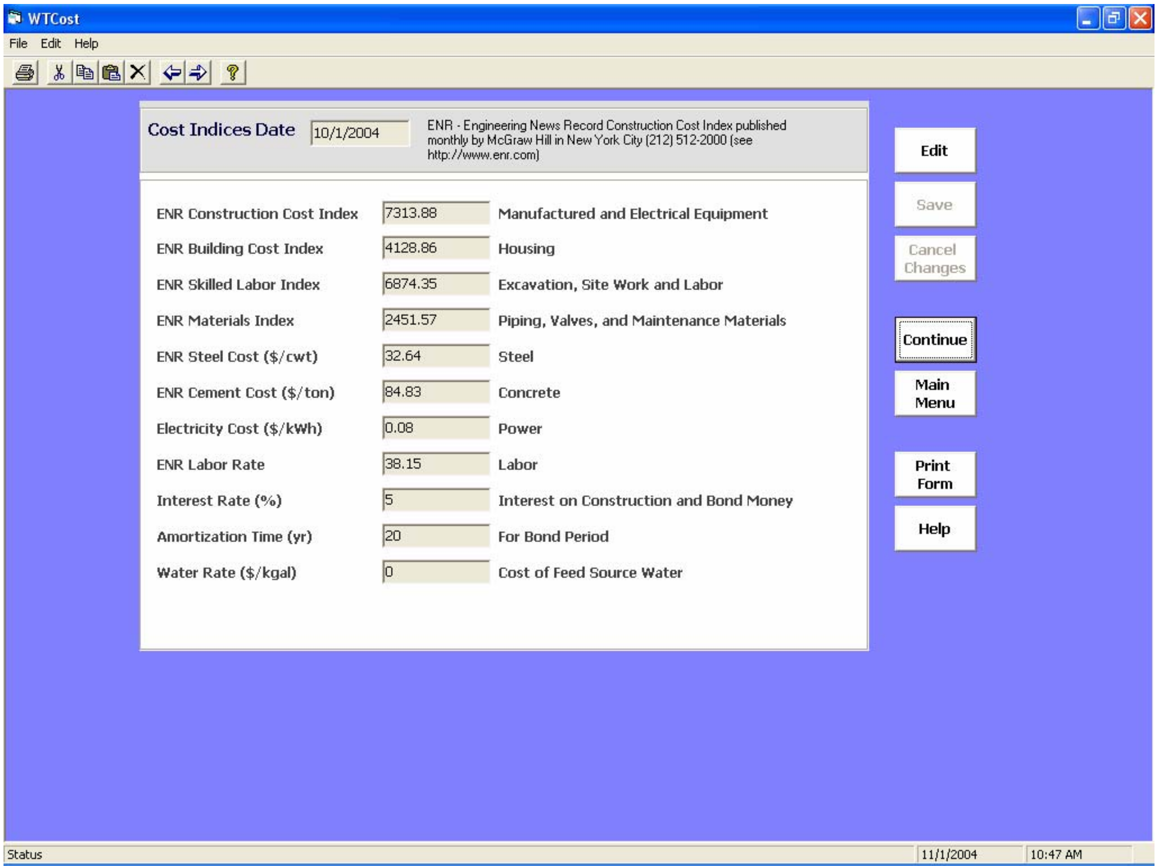


Figure 7.1 Cost indices current as of October 2004 (www.enr.com).

7.2 Minimal Water Treatment

A plant similar in size to the full advanced plant is assumed to include only rapid sand filtration followed by chlorination, filtration, finished water pumping, and indirect capital costs.

Filtration

Gravity filtration is typically used to remove suspended material in the water. Sand media gravity filter can be expected to remove nearly all microorganisms, some organic material, turbidity, color, and suspended material in the water. The filter consists of a steel or concrete structure that includes sand media. An air and water backwash periodically cleans the filter media automatically based on an increase in the head loss across the filter, or a pre-set timed interval. The combination of using air and water for backwashing allows the media to be cleaned more thoroughly and consumes less water than a backwash system using only water [2].

Chlorination
Disinfection is required to kill or inactivate any pathogenic microorganisms found in the water. Chlorine gas has been the most widely used disinfectant in the United States. Chlorine, in gaseous form, is an effective disinfectant, which is readily available, economical, and requires a fairly simple feed system [2]. A dose of 1 mg/L is assumed. Chlorine cost is assumed at $365 per ton.

Clearwell and Pumping
An above-ground steel storage tank is planned. The size of the tank, estimated at 3.2 million gallons, is assumed large enough for all flow conditions.

7.3 Chloramination

Chloramination is a form of disinfection that uses a mixture of chlorine gas and ammonia gas in an approximate ratio of 3:1 chlorine to ammonia. Unlike chlorine gas alone, chloramine produces a combined residual of chlorine that does not react as freely with organic substances in the water. Research has shown that when present in sufficient quantities, organic material can react with free chlorine and form potential cancer-causing byproducts called trihalomethanes, which is a regulated contaminant in drinking water supplies.

Chloramination was applied to alternatives involving deliveries to Orange County for water exchange purposes. In these exchange alternatives, the chloramination process was assumed to be incorporated as well head treatment on water produced and delivered from the San Mateo Creek basin.

8.0 Alternatives Cost Analyses

8.1 Cost Assumptions for Hydraulic Systems

Following is a general discussion of the assumptions included in the pre-feasibility alternative pipelines and pumping plant design costs.

Pipelines

A typical pipe trench was assumed to be 3 feet wider than the outside diameter of the pipe. On average, fill was assumed to be 4 feet deep to ensure a minimum 3-foot earth cover over the pipe, and trench sidewalls were assumed to be strong enough to support the pipe using a controlled low-strength slurry embedment mixture. All pipe trench excavation was assumed achievable using common excavating equipment. No blasting was assumed.

Pipeline costs were developed assuming a generic pressure pipe placed in the typical earth trench described above. A typical pipeline right-of-way would be about 100 feet wide (impacted temporarily for pipeline burial). Pipeline cost estimates are based on limited road or facility crossings; no unusual construction was assumed. Pipeline excavations are assumed to be above the ground-water table, except for the brine line extension. Cost estimates were developed on an installed per 1,000-foot basis using common unit costs for excavation, pipe materials, controlled low-strength slurry pipe support embedment, and backfill. Cost estimate equations are shown on the **figure 8.1** graph for pipe wall thicknesses simulating pressure classes of approximately 250 (T1), 550 (T2), and 800 (T3) foot maximum internal pressure heads.

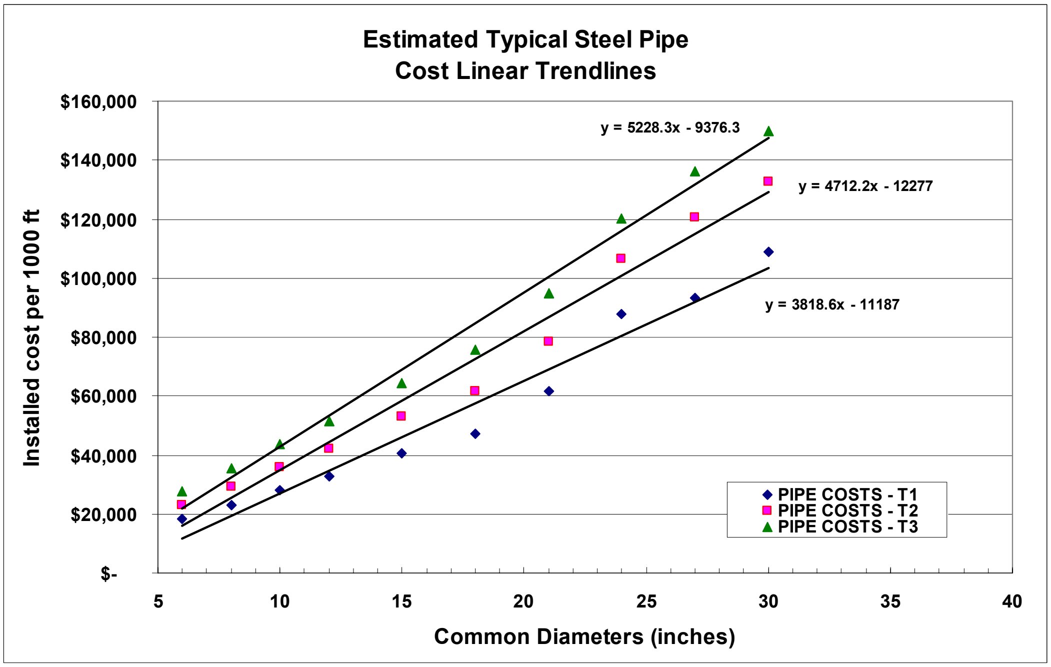


Figure 8.1. Pipeline installed cost versus diameter for various wall thicknesses.

Simulation of pressure classes was based on using standard steel wall thicknesses from the American Water Works Association Manual 11. Plate thicknesses increase head capacities. Three plate thicknesses were estimated to cover typical pressure class ranges. Thickness "T1" represents the lower pressure class, and thickness "T3" represents the upper pressure class. Costs for installing pipe were obtained via a steel weight per foot. Other pipe types, such as plastic, ductile iron, or concrete pipe hybrids were assumed analogous in costs. Note that pipe costs increase when the internal head requirements increase.

Hydraulic Profiles and Pumping

Pipe was sized for internal velocities of about 5 feet per second. At this velocity, hydraulic friction losses would be about 2.5 to 4 feet of loss per thousand feet of installed pipe. The profiles were checked to determine whether pumping would be required and what internal pressure classes the pipe system would need. Pressure class reaches were estimated as a percentage of the pipeline length.

Where pumping plants were determined necessary, pumping plant costs were estimated based on the desired product delivery flow in cubic feet per second. No hydraulic transient studies were performed for pumped systems because this would be beyond the scope of this pre-feasibility study. However, estimates were made for hydraulic transient arresting devices by prorating the system flow and pipeline length to a similar air chamber analyzed.

Where applicable, water storage requirements were sized on 1-day flow. Storage tanks were assumed to be ground-level steel storage tanks. Costs for these features were estimated on a per gallon basis.

Pipeline Appurtenances

Appurtenant items such as air valves, drains, or special road crossings were not individually itemized. For an appraisal level study, these costs are assumed to be covered by the unlisted items. For all the estimates, unlisted items were set at 15 percent of capital costs.

8.2 Open Space Management Zone

The Open Space Management Zone is intended to protect watershed resources and will be managed for open space and passive recreation to maintain watershed resources.

All pre-feasibility alternatives include 1,383 acres of open space currently held by FPUD. This land is expected to be included in any preferred alternative for environmental mitigation and to help protect the water quality of the Santa Margarita River. Fallbrook has estimated the value of the land to be about $10,000 per acre. This is a rough estimate that is not based upon an appraisal.

8.3 Operation and Maintenance Costs

Pipeline systems were assumed to have an annual operation and maintenance cost of 1 percent of the capital costs. This cost includes items such as painting, repairing occasional breaks, exercising valves, and corrosion monitoring. An additional annual operation cost was applied to systems that require pumping water. This annual cost was computed on the flow, pumped head estimate, and electrical power value. Present worth values of all annual costs were added to capital costs for a total cost analysis.

Pipeline Systems

Pipeline systems were assumed to have an annual operation and maintenance cost of 1 percent of the itemized capital costs. This cost would cover items such as painting above-ground storage tanks, repairing occasional pipe breaks, exercising valves, and corrosion monitoring.

Pumping Plants

Pumping plants were assumed to have an annual operation and maintenance cost of 1 percent of the capital cost. Pumps and motors have life spans of about 20 to 30 years, depending on water quality. This cost would cover occasional replacement parts and repairs.

Water Treatment Plants

Water treatment plants were assumed to have annual operation costs for chemicals, personnel, and capital recovery. This cost was calculated on a basis of annual flow rate. An additional working recovery fund was set at 4 percent of the capital cost for occasional replacement of the treatment equipment.

Wetlands

Wetlands were assumed to have an annual operation cost of $1,300 per acre. This cost could vary between about $600 to $5,000 per acre, depending upon the degree of monitoring and testing.

Embankment Dams

Dams were assumed to have an annual operation and maintenance cost of 1 percent of the capital cost. This cost would cover monitoring seepage observation wells and upkeep for the outlet works appurtenances.

8.4 Pre-Feasibility Total Cost Analysis

Percentages of the construction costs were added to estimate total costs. Mobilization/demobilization costs were estimated as 5 percent of the construction costs, and unlisted items were estimated as 15 percent. The cost for unlisted items accounts for ancillary features of the project that are not detailed or quantified at the conceptual design level. These costs were added to the construction cost to obtain a contract cost.

A contingency of 25 percent of the contract cost was added to obtain a field cost. The contingency accounts for items that may cost more once the design is further developed, or when construction is complete (e.g. changed conditions costs).

To obtain the total project cost, the estimated cost of the open space management zone and non-contract costs amounting to 33 percent of the field costs were added. Costs for the open space management zone were included in this fashion because there would be no mobilization, unlisted items, or contingencies associated with including the management zone in a project. Non-contract costs would include permitting, engineering, construction management, owner's administration, legal, and other costs.

A net present value (NPV) for the pre-feasibility alternatives was developed by assuming annual maintenance costs as described over an assumed 50-year project life. The "plan formulation and evaluation" interest rate for fiscal year 2005 of 5.375 percent was applied in the present value calculations.

Total costs for water for each of the pre-feasibility alternatives were developed by dividing the NPV of each alternative by the net yield and again dividing by 50 years.

Summaries of the line item construction costs for each alternative, assuming use of advanced water treatment technologies, are presented in Appendix A. Also included in Appendix A are tables showing the operation and maintenance cost, as well as the total cost analyses for each alternative, assuming advanced water treatment.

Summaries of the line item construction costs for each alternative, assuming use of minimal water treatment technologies, are presented in Appendix B. Also included in Appendix B are tables showing the operation and maintenance cost, as well as the total cost analyses for each alternative, assuming minimal water treatment.

Table 8.1 presents the cost per acre-foot for each alternative, assuming advanced water treatment. Table 8.2 presents the cost per acre-foot for each alternative, assuming minimal water treatment. The cost of water with advanced water treatment ranges by alternative from $560 to $850 per acre-foot. The cost of water with minimal water treatment ranges by alternative from $190 to $300 per acre-foot. Figures 8.2 and 8.3 present graphically the cost of water for each alternative with advanced and minimal water treatment, respectively.

Table 8.1. Cost of water per acre-foot with advanced water treatment

Alternative	Net Project Yield (af)	Cost per acre-foot ($/af)
1A	11,985	$ 699
1B	14,785	$ 592
1C	14,365	$ 635
1D	14,875	$ 623
1E	13,770	$ 687
1F	12,835	$ 682
1G	12,835	$ 686
1H	12,580	$ 769
1I	11,985	$ 698
2A	10,710	$ 627
2B	14,020	$ 581
2C	11,560	$ 600
2D	11,560	$ 605
3A	10,200	$ 763
3B	13,000	$ 628
3C	12,580	$ 678
3D	13,090	$ 672
3E	11,985	$ 741
3F	11,050	$ 746
3G	11,050	$ 751
3H	10,795	$ 848
3I	10,200	$ 762
	Average	**$ 685**
	Minimum	**$ 581**
	Maximum	**$ 848**

Table 8.2. Cost of water per acre-foot with minimal water treatment

Alternative	Net Project Yield (af)	Cost per acre-foot ($/af)
1A	14,100	$ 224
1B	16,900	$ 210
1C	16,900	$ 231
1D	17,500	$ 231
1E	16,200	$ 227
1F	15,100	$ 225
1G	15,100	$ 229
1H	14,800	$ 292
1I	14,100	$ 224
2A	12,600	$ 215
2B	16,000	$ 250
2C	13,600	$ 203
2D	13,600	$ 207
3A	12,000	$ 225
3B	14,800	$ 209
3C	14,800	$ 233
3D	15,400	$ 241
3E	14,100	$ 228
3F	13,000	$ 230
3G	13,000	$ 234
3H	12,700	$ 307
3I	12,000	$ 224
	Average	**$ 232**
	Minimum	**$ 203**
	Maximum	**$ 307**

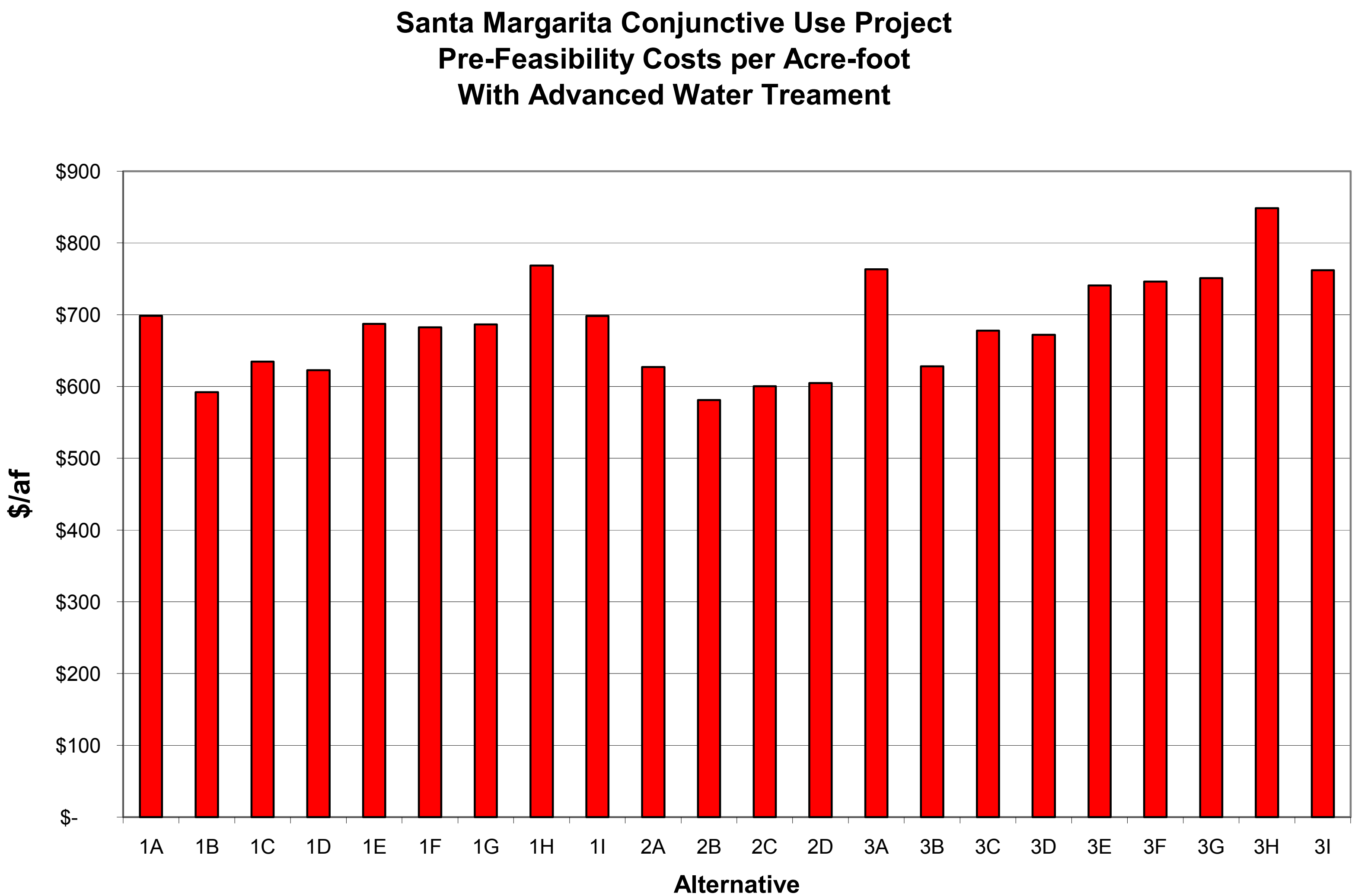


Figure 8.2. Cost of water per acre-foot with advanced water treatment.

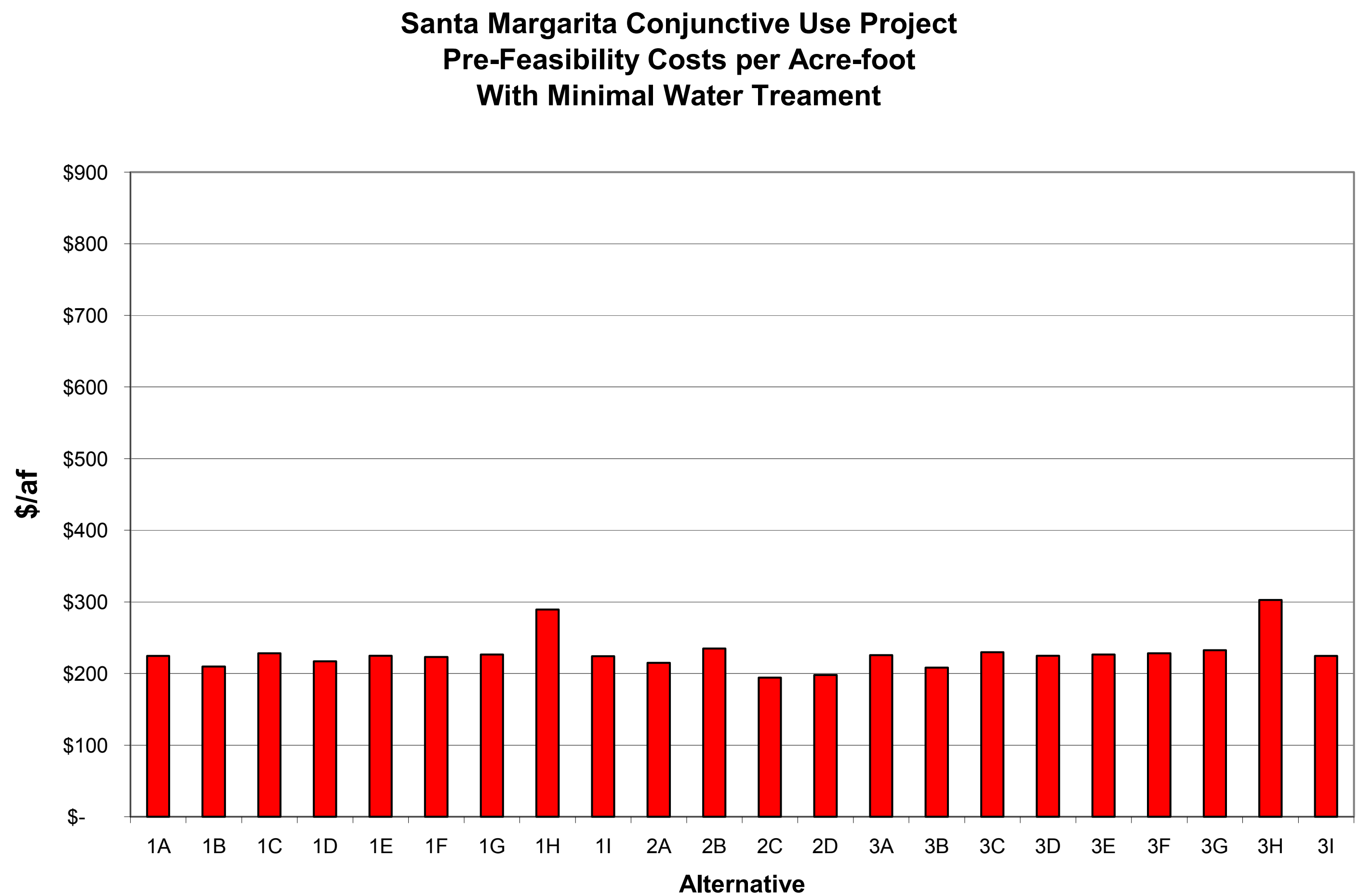


Figure 8.3. Cost of water per acre-foot with minimal water treatment.

9.0 Screening of Alternatives

Each pre-feasibility alternative was screened and scored against a set of criteria developed during the pre-feasibility alternatives workshop discussed previously. These criteria were placed into a matrix for each major alternative. Separate matrices were prepared assuming that advanced water treatment and minimal water treatment are incorporated into the alternatives. The screening matrices are tools that can be used in selection of the most suitable alternatives for further evaluation during the feasibility study.

Tables 9.1 through 9.3 show screening matrices for all sub-alternatives to alternative concepts 1, 2, and 3, respectively, assuming that advanced water treatment is incorporated into the alternatives. Tables 9.4 through 9.6 show screening matrices for all sub-alternatives to alternative concepts 1, 2, and 3, respectively, assuming that minimal water treatment is incorporated into the alternatives. Each factor in the matrices contains weights that were assigned by workshop participants. During the scoring process, each alternative was assigned a rating for each factor. These ratings ranged from 1 to 5; 1 represents the lowest rating; 5 represents the highest. The ratings were then multiplied by the weights to develop a score for each factor. At the bottom of each alternative is a total score representing a sum of the scores of all factors.

Figure 9.1 presents screening scores with advanced water treatment. Figure 9.2 presents screening scores for each of the alternatives assuming minimal water treatment.

Information from the screening matrices will be used to help develop a decision memorandum. This decision memorandum will identify the alternatives for feasibility study, document the reasons for their selection, and propose a feasibility plan of study.

Table 9.1. Concept 1 screening matrix assuming advanced water treatment.

With Advanced Water Treatment

			ALTERNATIVE NUMBERS																	
			1a		1b		1c		1d		1e		1f		1g		1h		1i	
Factor	Range[1]	Weight	Rating	Score	Rating	Score	Rating	Score	Rating	Score	Rating	Score	Rating	Score	Rating	Score	Rating	Score	Rating	Score
Net Project Yield																				
Meets Comb Demand	1 to 5	0.200	1	0.20	4	0.80	4	0.80	4	0.80	3	0.60	2	0.40	2	0.40	2	0.40	1	0.20
Project Cost																				
Cost per af of water	1 to 5	0.170	2	0.34	3	0.51	2	0.34	2	0.34	2	0.34	2	0.34	2	0.34	1	0.17	2	0.34
Water Supply Reliability																				
FPUD	1 to 5	0.100	4	0.40	5	0.50	5	0.50	3	0.30	5	0.50	4	0.40	4	0.40	5	0.50	4	0.40
CPEN	1 to 5	0.100	4	0.40	5	0.50	4.5	0.45	5	0.50	4.5	0.45	4	0.40	4	0.40	4.5	0.45	4	0.40
Water Quality																				
Potable Water Quality	1 to 5	0.050	5	0.25	5	0.25	5	0.25	5	0.25	5	0.25	5	0.25	5	0.25	5	0.25	5	0.25
Environmental Effects																				
Estuarine Resources	1 to 5	0.020	5	0.10	2	0.04	2	0.04	2	0.04	5	0.10	4	0.08	4	0.08	5	0.10	5	0.10
Upland	1 to 5	0.020	2	0.04	1	0.02	2	0.04	1	0.02	2	0.04	1	0.02	1	0.02	1	0.02	2	0.04
Riparian	1 to 5	0.020	3	0.06	3	0.06	3	0.06	3	0.06	3	0.06	2	0.04	2	0.04	3	0.06	3	0.06
Aquatic	1 to 5	0.020	5	0.10	2	0.04	2	0.04	2	0.04	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10
Aesthetics	1 to 5	0.010	3	0.03	3	0.03	3	0.03	3	0.03	3	0.03	3	0.03	3	0.03	3	0.03	3	0.03
Cultural/Archeological	1 to 5	0.020	3	0.06	2	0.04	1	0.02	1	0.02	1	0.02	1	0.02	1	0.02	2	0.04	3	0.06
Regulatory	1 to 5	0.030	4	0.12	1	0.03	1	0.03	1	0.03	2	0.06	1	0.03	1	0.03	3	0.09	3	0.09
Impacts to Water of US	1 to 5	0.030	4	0.12	2	0.06	2	0.06	2	0.06	2	0.06	2	0.06	1	0.03	4	0.12	3	0.09
Mitigation	1 to 5	0.040	4	0.16	1	0.04	1	0.04	1	0.04	2	0.08	1	0.04	1	0.04	3	0.12	3	0.12
Legal																				
Maximum Use of Permits	1 to 5	0.050	1	0.05	4	0.20	4	0.20	4	0.20	3	0.15	2	0.10	2	0.10	2	0.10	1	0.05
Assist in Settlement of Case 1247	1 to 5	0.040	3.5	0.14	4	0.16	5	0.20	3	0.12	4	0.16	4	0.16	4	0.16	4.5	0.18	3.5	0.14
Acceptability																				
Public (Non-Regulatory)	1 to 5	0.025	5	0.13	5	0.13	5	0.13	5	0.13	3	0.08	4	0.10	4	0.10	5	0.13	5	0.13
Institutional	1 to 5	0.025	4	0.10	4.5	0.11	5	0.13	3	0.08	1.5	0.04	4	0.10	4	0.10	1.5	0.04	4	0.10
Socio-economic Issues																				
Growth inducement	1 to 5	0.010	5	0.05	5	0.05	5	0.05	5	0.05	5	0.05	5	0.05	5	0.05	5	0.05	5	0.05
Environmental Justice	1 to 5	0.010	3	0.03	3	0.03	3	0.03	3	0.03	3	0.03	3	0.03	3	0.03	3	0.03	3	0.03
Construction short-term stimulus	1 to 5	0.000	1	0.00	3	0.00	4	0.00	4	0.00	3	0.00	3	0.00	3	0.00	5	0.00	2	0.00
Indian trust assets	1 to 5	0.010	3	0.03	3	0.03	3	0.03	3	0.03	3	0.03	3	0.03	3	0.03	3	0.03	3	0.03
Totals		1.000		2.91		3.63		3.46		3.16		3.22		2.78		2.75		3.00		2.81

Note: Values chosen to differentiate alternatives are not indicative of one category's importance over another.
[1]Ratings range from 1 to 5. A "1" is the least acceptable while those with a "5" are the most acceptable.

With Advanced Water Treatment

Factor	Range[1]	Weight	2a Rating	2a Score	2b Rating	2b Score	2c Rating	2c Score	2d Rating	2d Score
Net Project Yield										
Meets Comb Demand	1 to 5	0.200	1	0.20	4	0.80	1	0.20	1	0.20
Project Cost										
Cost per af of water	1 to 5	0.170	2	0.34	3	0.51	3	0.51	3	0.51
Water Supply Reliability										
FPUD	1 to 5	0.100	1	0.10	2	0.20	1	0.10	1	0.10
CPEN	1 to 5	0.100	2	0.20	4	0.40	2	0.20	2	0.20
Water Quality										
Potable Water Quality	1 to 5	0.050	5	0.25	5	0.25	5	0.25	5	0.25
Environmental Effects										
Estuarine Resources	1 to 5	0.020	5	0.10	2	0.04	4	0.08	4	0.08
Upland	1 to 5	0.020	3	0.06	1	0.02	1	0.02	2	0.04
Riparian	1 to 5	0.020	1.5	0.03	1	0.02	1.5	0.03	1.5	0.03
Aquatic	1 to 5	0.020	2	0.04	1	0.02	2	0.04	2	0.04
Aesthetics	1 to 5	0.010	3	0.03	3	0.03	3	0.03	3	0.03
Cultural/Archeological	1 to 5	0.020	3	0.06	1	0.02	1	0.02	1	0.02
Regulatory	1 to 5	0.030	1	0.03	1	0.03	1	0.03	1	0.03
Impacts to Water of US	1 to 5	0.030	1	0.03	1	0.03	1	0.03	1	0.03
Mitigation	1 to 5	0.040	1	0.04	1	0.04	1	0.04	1	0.04
Legal										
Maximum Use of Permits	1 to 5	0.050	1	0.05	2	0.10	1	0.05	1	0.05
Assist in Settlement of Case 1247	1 to 5	0.040	2	0.08	2	0.08	2	0.08	2	0.08
Acceptability										
Public (Non-Regulatory)	1 to 5	0.025	1	0.03	1	0.03	1	0.03	1	0.03
Institutional	1 to 5	0.025	1	0.03	1	0.03	1	0.03	1	0.03
Socio-economic Issues										
Growth inducement	1 to 5	0.010	5	0.05	5	0.05	5	0.05	5	0.05
Environmental Justice	1 to 5	0.010	3	0.03	3	0.03	3	0.03	3	0.03
Construction short-term stimulus	1 to 5	0.000	2	0.00	5	0.00	2	0.00	3	0.00
Indian trust assets	1 to 5	0.010	3	0.03	3	0.03	3	0.03	3	0.03
Totals		1.000		1.80		2.75		1.87		1.89

Note: Values chosen to differentiate alternatives are not indicative of one category's importance over another.
[1]Ratings range from 1 to 5. A "1" is the least acceptable while those with a "5" are the most acceptable.

Table 9.2. Concept 2 screening matrix assuming advanced water treatment.

Table 9.3. Concept 3 screening matrix assuming advanced water treatment.

With Advanced Water Treatment

Factor	Range[1]	Weight	3a Rating	3a Score	3b Rating	3b Score	3c Rating	3c Score	3d Rating	3d Score	3e Rating	3e Score	3f Rating	3f Score	3g Rating	3g Score	3h Rating	3h Score	3i Rating	3i Score
Net Project Yield																				
Meets Comb Demand	1 to 5	0.200	1	0.20	3	0.60	2	0.40	3	0.60	1	0.20	1	0.20	1	0.20	1	0.20	1	0.20
Project Cost																				
Cost per af of water	1 to 5	0.170	1	0.17	2	0.34	2	0.34	2	0.34	1	0.17	1	0.17	1	0.17	1	0.17	1	0.17
Water Supply Reliability																				
FPUD	1 to 5	0.100	4	0.40	5	0.50	5	0.50	3	0.30	5	0.50	4	0.40	4	0.40	5	0.50	4	0.40
CPEN	1 to 5	0.100	4	0.40	5	0.50	4.5	0.45	5	0.50	4.5	0.45	4	0.40	4	0.40	4.5	0.45	4	0.40
Water Quality																				
Potable Water Quality	1 to 5	0.050	5	0.25	5	0.25	5	0.25	5	0.25	5	0.25	5	0.25	5	0.25	5	0.25	5	0.25
Environmental Effects																				
Estuarine Resources	1 to 5	0.020	2	0.04	1	0.02	1	0.02	1	0.02	2	0.04	1	0.02	1	0.02	2	0.04	2	0.04
Upland	1 to 5	0.020	2	0.04	1	0.02	2	0.04	1	0.02	2	0.04	1	0.02	1	0.02	1	0.02	2	0.04
Riparian	1 to 5	0.020	1	0.02	1	0.02	1	0.02	1	0.02	1	0.02	1	0.02	1	0.02	1	0.02	1	0.02
Aquatic	1 to 5	0.020	2	0.04	1	0.02	1	0.02	1	0.02	2	0.04	2	0.04	2	0.04	2	0.04	2	0.04
Aesthetics	1 to 5	0.010	3	0.03	3	0.03	3	0.03	3	0.03	3	0.03	3	0.03	3	0.03	3	0.03	3	0.03
Cultural/Archeological	1 to 5	0.020	2.5	0.05	2	0.04	1	0.02	1	0.02	1.5	0.03	1	0.02	1	0.02	2.5	0.05	3	0.06
Regulatory	1 to 5	0.030	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03
Impacts to Water of US	1 to 5	0.030	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03
Mitigation	1 to 5	0.040	1	0.04	1	0.04	1	0.04	1	0.04	1	0.04	1	0.04	1	0.04	1	0.04	1	0.04
Legal																				
Maximum Use of Permits	1 to 5	0.050	1	0.05	3	0.15	2	0.10	3	0.15	1	0.05	1	0.05	1	0.05	1	0.05	1	0.05
Assist in Settlement of Case 1247	1 to 5	0.040	3.5	0.14	4	0.16	5	0.20	3	0.12	4	0.16	4	0.16	4	0.16	4.5	0.18	3.5	0.14
Acceptability																				
Public (Non-Regulatory)	1 to 5	0.025	5	0.13	5	0.13	5	0.13	5	0.13	3	0.08	4	0.10	4	0.10	5	0.13	5	0.13
Institutional	1 to 5	0.025	4	0.10	4.5	0.11	5	0.13	3	0.08	1.5	0.04	4	0.10	4	0.10	1.5	0.04	4	0.10
Socio-economic Issues																				
Growth inducement	1 to 5	0.010	5	0.05	5	0.05	5	0.05	5	0.05	5	0.05	5	0.05	5	0.05	5	0.05	5	0.05
Environmental Justice	1 to 5	0.010	3	0.03	3	0.03	3	0.03	3	0.03	3	0.03	3	0.03	3	0.03	3	0.03	3	0.03
Construction short-term stimulus	1 to 5	0.000	1	0.00	2	0.00	3	0.00	3	0.00	2	0.00	2	0.00	2	0.00	4	0.00	1	0.00
Indian trust assets	1 to 5	0.010	3	0.03	3	0.03	3	0.03	3	0.03	3	0.03	3	0.03	3	0.03	3	0.03	3	0.03
Totals		1.000		2.27		3.10		2.85		2.80		2.30		2.19		2.19		2.37		2.28

Note: Values chosen to differentiate alternatives are not indicative of one category's importance over another.

[1]Ratings range from 1 to 5. A "1" is the least acceptable while those with a "5" are the most acceptable.

Table 9.4. Concept 1 screening matrix assuming minimal water treatment.

With Minimal Water Treatment

			ALTERNATIVE NUMBERS																	
			1a		1b		1c		1d		1e		1f		1g		1h		1i	
Factor	Range[1]	Weight	Rating	Score	Rating	Score	Rating	Score	Rating	Score	Rating	Score	Rating	Score	Rating	Score	Rating	Score	Rating	Score
Net Project Yield																				
Meets Comb Demand	1 to 5	0.200	3	0.60	5	1.00	5	1.00	5	1.00	4	0.80	4	0.80	4	0.80	3	0.60	3	0.60
Project Cost																				
Cost per af of water	1 to 5	0.170	4	0.68	4	0.68	4	0.68	4	0.68	4	0.68	4	0.68	4	0.68	2	0.34	4	0.68
Water Supply Reliability																				
FPUD	1 to 5	0.100	4	0.40	5	0.50	5	0.50	3	0.30	5	0.50	4	0.40	4	0.40	5	0.50	4	0.40
CPEN	1 to 5	0.100	4	0.40	5	0.50	4.5	0.45	5	0.50	4.5	0.45	4	0.40	4	0.40	4.5	0.45	4	0.40
Water Quality																				
Potable Water Quality	1 to 5	0.050	3	0.15	3	0.15	3	0.15	3	0.15	3	0.15	3	0.15	3	0.15	3	0.15	3	0.15
Environmental Effects																				
Estuarine Resources	1 to 5	0.020	5	0.10	2	0.04	2	0.04	2	0.04	5	0.10	4	0.08	4	0.08	5	0.10	5	0.10
Upland	1 to 5	0.020	2	0.04	1	0.02	2	0.04	1	0.02	2	0.04	1	0.02	1	0.02	1	0.02	2	0.04
Riparian	1 to 5	0.020	3	0.06	3	0.06	3	0.06	3	0.06	3	0.06	2	0.04	2	0.04	3	0.06	3	0.06
Aquatic	1 to 5	0.020	5	0.10	2	0.04	2	0.04	2	0.04	5	0.10	5	0.10	5	0.10	5	0.10	5	0.10
Aesthetics	1 to 5	0.010	3	0.03	3	0.03	3	0.03	3	0.03	3	0.03	3	0.03	3	0.03	3	0.03	3	0.03
Cultural/Archeological	1 to 5	0.020	3	0.06	2	0.04	1	0.02	1	0.02	1	0.02	1	0.02	1	0.02	2	0.04	3	0.06
Regulatory	1 to 5	0.030	4	0.12	1	0.03	1	0.03	1	0.03	2	0.06	1	0.03	1	0.03	3	0.09	3	0.09
Impacts to Water of US	1 to 5	0.030	4	0.12	2	0.06	2	0.06	2	0.06	2	0.06	2	0.06	1	0.03	4	0.12	3	0.09
Mitigation	1 to 5	0.040	4	0.16	1	0.04	1	0.04	1	0.04	2	0.08	1	0.04	1	0.04	3	0.12	3	0.12
Legal																				
Maximum Use of Permits	1 to 5	0.050	1	0.05	4	0.20	4	0.20	4	0.20	3	0.15	2	0.10	2	0.10	2	0.10	1	0.05
Assist in Settlement of Case 1247	1 to 5	0.040	3.5	0.14	4	0.16	5	0.20	3	0.12	4	0.16	4	0.16	4	0.16	4.5	0.18	3.5	0.14
Acceptability																				
Public (Non-Regulatory)	1 to 5	0.025	5	0.13	5	0.13	5	0.13	5	0.13	3	0.08	4	0.10	4	0.10	5	0.13	5	0.13
Institutional	1 to 5	0.025	4	0.10	4.5	0.11	5	0.13	3	0.08	1.5	0.04	4	0.10	4	0.10	1.5	0.04	4	0.10
Socio-economic Issues																				
Growth inducement	1 to 5	0.010	5	0.05	5	0.05	5	0.05	5	0.05	5	0.05	5	0.05	5	0.05	5	0.05	5	0.05
Environmental Justice	1 to 5	0.010	3	0.03	3	0.03	3	0.03	3	0.03	3	0.03	3	0.03	3	0.03	3	0.03	3	0.03
Construction short-term stimulus	1 to 5	0.000	1	0.00	3	0.00	4	0.00	4	0.00	3	0.00	3	0.00	3	0.00	5	0.00	2	0.00
Indian trust assets	1 to 5	0.010	3	0.03	3	0.03	3	0.03	3	0.03	3	0.03	3	0.03	3	0.03	3	0.03	3	0.03
Totals		1.000		3.55		3.90		3.90		3.60		3.66		3.42		3.39		3.27		3.45

Note: Values chosen to differentiate alternatives are not indicative of one category's importance over another.
[1]Ratings range from 1 to 5. A "1" is the least acceptable while those with a "5" are the most acceptable.

With minimal water treatment

Factor	Range[1]	Weight	2a Rating	2a Score	2b Rating	2b Score	2c Rating	2c Score	2d Rating	2d Score
Net Project Yield										
Meets Comb Demand	1 to 5	0.200	2	0.40	4	0.80	3	0.60	3	0.60
Project Cost										
Cost per af of water	1 to 5	0.170	4	0.68	3	0.51	5	0.85	5	0.85
Water Supply Reliability										
FPUD	1 to 5	0.100	1	0.10	2	0.20	1	0.10	1	0.10
CPEN	1 to 5	0.100	2	0.20	4	0.40	2	0.20	2	0.20
Water Quality										
Potable Water Quality	1 to 5	0.050	5	0.25	5	0.25	5	0.25	5	0.25
Environmental Effects										
Estuarine Resources	1 to 5	0.020	5	0.10	2	0.04	4	0.08	4	0.08
Upland	1 to 5	0.020	3	0.06	1	0.02	1	0.02	2	0.04
Riparian	1 to 5	0.020	1.5	0.03	1	0.02	1.5	0.03	1.5	0.03
Aquatic	1 to 5	0.020	2	0.04	1	0.02	2	0.04	2	0.04
Aesthetics	1 to 5	0.010	3	0.03	3	0.03	3	0.03	3	0.03
Cultural/Archeological	1 to 5	0.020	3	0.06	1	0.02	1	0.02	1	0.02
Regulatory	1 to 5	0.030	1	0.03	1	0.03	1	0.03	1	0.03
Impacts to Water of US	1 to 5	0.030	1	0.03	1	0.03	1	0.03	1	0.03
Mitigation	1 to 5	0.040	1	0.04	1	0.04	1	0.04	1	0.04
Legal										
Maximum Use of Permits	1 to 5	0.050	1	0.05	2	0.10	1	0.05	1	0.05
Assist in Settlement of Case 1247	1 to 5	0.040	2	0.08	2	0.08	2	0.08	2	0.08
Acceptability										
Public (Non-Regulatory)	1 to 5	0.025	1	0.03	1	0.03	1	0.03	1	0.03
Institutional	1 to 5	0.025	1	0.03	1	0.03	1	0.03	1	0.03
Socio-economic Issues										
Growth inducement	1 to 5	0.010	5	0.05	5	0.05	5	0.05	5	0.05
Environmental Justice	1 to 5	0.010	3	0.03	3	0.03	3	0.03	3	0.03
Construction short-term stimulus	1 to 5	0.000	2	0.00	5	0.00	2	0.00	3	0.00
Indian trust assets	1 to 5	0.010	3	0.03	3	0.03	3	0.03	3	0.03
Totals		1.000		2.34		2.75		2.61		2.63

Note: Values chosen to differentiate alternatives are not indicative of one category's importance over another.
[1]Ratings range from 1 to 5. A "1" is the least acceptable while those with a "5" are the most acceptable.

Table 9.5. Concept 2 screening matrix assuming minimal water treatment.

Table 9.6. Concept 3 screening matrix assuming minimal water treatment.

With Minimal Water Treatment

			3a		3b		3c		3d		3e		3f		3g		3h		3i	
Factor	Range[1]	Weight	Rating	Score	Rating	Score	Rating	Score	Rating	Score	Rating	Score	Rating	Score	Rating	Score	Rating	Score	Rating	Score
Net Project Yield																				
Meets Comb Demand	1 to 5	0.200	1	0.20	3	0.60	3	0.60	4	0.80	3	0.60	2	0.40	2	0.40	2	0.40	1	0.20
Project Cost																				
Cost per af of water	1 to 5	0.170	4	0.68	4	0.68	3	0.51	4	0.68	4	0.68	4	0.68	3	0.51	1	0.17	4	0.68
Water Supply Reliability																				
FPUD	1 to 5	0.100	4	0.40	5	0.50	5	0.50	3	0.30	5	0.50	4	0.40	4	0.40	5	0.50	4	0.40
CPEN	1 to 5	0.100	4	0.40	5	0.50	4.5	0.45	5	0.50	4.5	0.45	4	0.40	4	0.40	4.5	0.45	4	0.40
Water Quality																				
Potable Water Quality	1 to 5	0.050	3	0.15	3	0.15	3	0.15	3	0.15	3	0.15	3	0.15	3	0.15	3	0.15	3	0.15
Environmental Effects																				
Estuarine Resources	1 to 5	0.020	2	0.04	1	0.02	1	0.02	1	0.02	2	0.04	1	0.02	1	0.02	2	0.04	2	0.04
Upland	1 to 5	0.020	2	0.04	1	0.02	2	0.04	1	0.02	2	0.04	1	0.02	1	0.02	1	0.02	2	0.04
Riparian	1 to 5	0.020	1	0.02	1	0.02	1	0.02	1	0.02	1	0.02	1	0.02	1	0.02	1	0.02	1	0.02
Aquatic	1 to 5	0.020	2	0.04	1	0.02	1	0.02	1	0.02	2	0.04	2	0.04	2	0.04	2	0.04	2	0.04
Aesthetics	1 to 5	0.010	3	0.03	3	0.03	3	0.03	3	0.03	3	0.03	3	0.03	3	0.03	3	0.03	3	0.03
Cultural/Archeological	1 to 5	0.020	2.5	0.05	2	0.04	1	0.02	1	0.02	1.5	0.03	1	0.02	1	0.02	2.5	0.05	3	0.06
Regulatory	1 to 5	0.030	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03
Impacts to Water of US	1 to 5	0.030	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03	1	0.03
Mitigation	1 to 5	0.040	1	0.04	1	0.04	1	0.04	1	0.04	1	0.04	1	0.04	1	0.04	1	0.04	1	0.04
Legal																				
Maximum Use of Permits	1 to 5	0.050	1	0.05	3	0.15	2	0.10	3	0.15	1	0.05	1	0.05	1	0.05	1	0.05	1	0.05
Assist in Settlement of Case 1247	1 to 5	0.040	3.5	0.14	4	0.16	5	0.20	3	0.12	4	0.16	4	0.16	4	0.16	4.5	0.18	3.5	0.14
Acceptability																				
Public (Non-Regulatory)	1 to 5	0.025	5	0.13	5	0.13	5	0.13	5	0.13	3	0.08	4	0.10	4	0.10	5	0.13	5	0.13
Institutional	1 to 5	0.025	4	0.10	4.5	0.11	5	0.13	3	0.08	1.5	0.04	4	0.10	4	0.10	1.5	0.04	4	0.10
Socio-economic Issues																				
Growth inducement	1 to 5	0.010	5	0.05	5	0.05	5	0.05	5	0.05	5	0.05	5	0.05	5	0.05	5	0.05	5	0.05
Environmental Justice	1 to 5	0.010	3	0.03	3	0.03	3	0.03	3	0.03	3	0.03	3	0.03	3	0.03	3	0.03	3	0.03
Construction short-term stimulus	1 to 5	0.000	1	0.00	2	0.00	3	0.00	3	0.00	2	0.00	2	0.00	2	0.00	4	0.00	1	0.00
Indian trust assets	1 to 5	0.010	3	0.03	3	0.03	3	0.03	3	0.03	3	0.03	3	0.03	3	0.03	3	0.03	3	0.03
Totals		1.000		2.68		3.34		3.12		3.24		3.11		2.80		2.63		2.47		2.69

Note: Values chosen to differentiate alternatives are not indicative of one category's importance over another.
[1]Ratings range from 1 to 5. A "1" is the least acceptable while those with a "5" are the most acceptable.

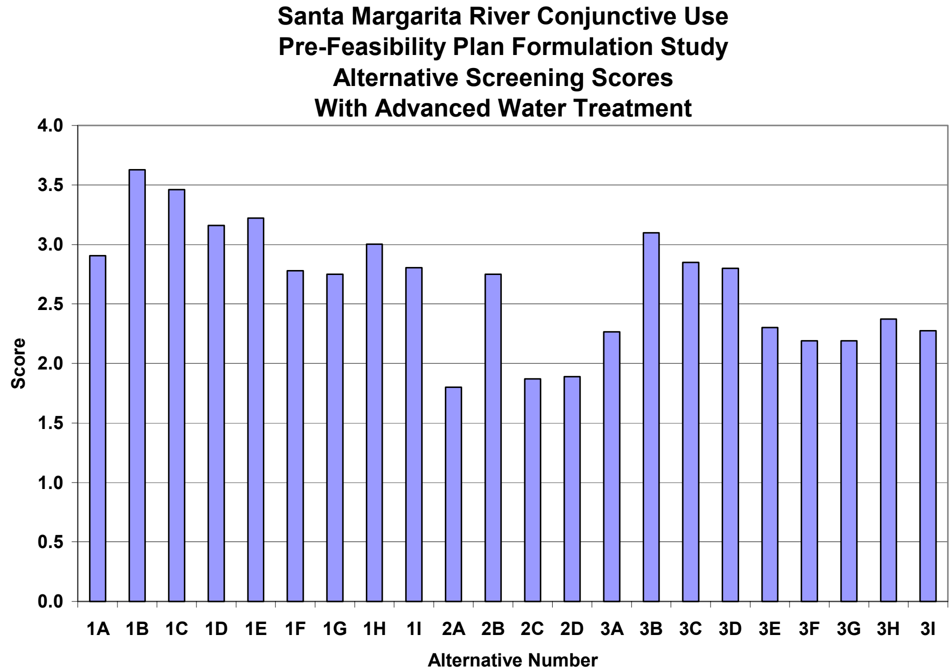


Figure 9.1. Alternative screening scores assuming advanced water treatment.

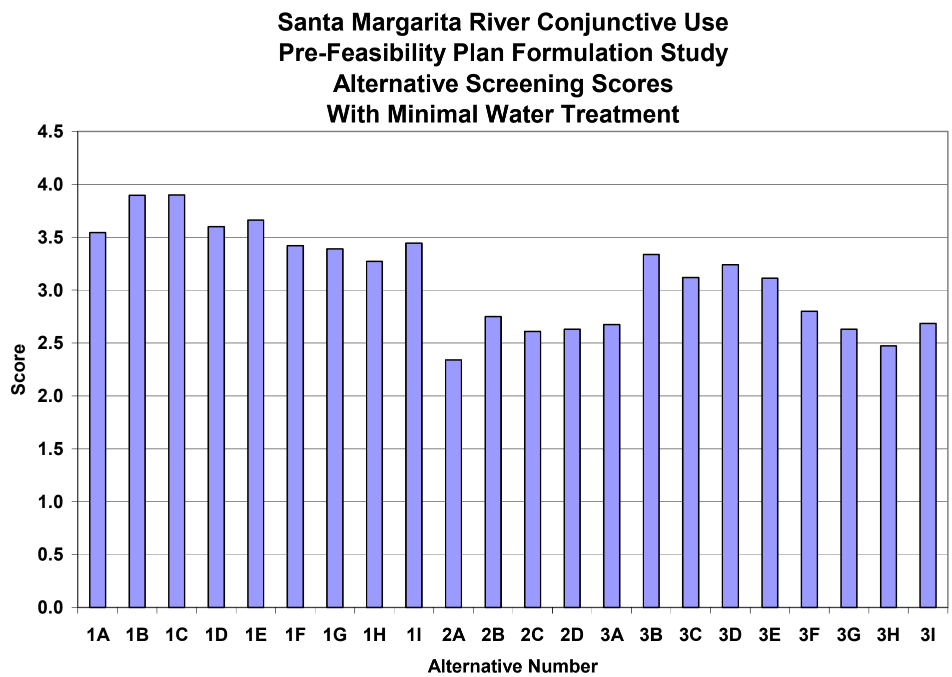


Figure 9.2. Alternative screening scores assuming minimal water treatment.

10.0 References

FPUD, June 1994. *Conjunctive Use Study: Lower Santa Margarita River Basin*.

Leedshill-Herkenoff, Inc., September 1988. *Basewide Water Requirement/Availability Study, Marine Corps Base Camp Pendleton*.

Malloy, September 2000. Personal communication. Camp Pendleton, Office of Water Resources.

Reclamation, August 2004. *Proposed Obermeyer Modifications to O'Neill Diversion Weir on Santa Margarita River, California.*

Reclamation, April 1984. *Santa Margarita Project, San Diego County, California*, Draft Supplemental Environmental Statement.

Stetson Engineers Inc., March 23, 2001. *Santa Margarita River Recharge and Recovery Enhancement Program: Permit 15000 Feasibility Study for Marine Corps Base Camp Pendleton*.

Stetson Engineers Inc., February 2002. *Conjunctive Use Project for the Lower Santa Margarita River Basin, Supplemental Study to the Santa Margarita River Recharge and Recovery Enhancement Program: Permit 15000 Feasibility Study for Marine Corps Base Camp Pendleton*.

Stetson Engineers Inc., March 2003. *Technical Engineering Report, Constructed Treatment Wetland Feasibility Study, Marine Corps Base Camp Pendleton California,*

Stetson Engineers Inc., February 2005. *Three Dimensional Groundwater Flow Model of the San Mateo and San Onofre Basins, USMC Base Camp Pendleton*.

The Environmental Company, April 2004. *Environmental Impact Statement for the Tertiary Treatment Plant and Associated Facilities, Marine Corps Base Camp Pendleton*.

Troxell and Hofmann, July 1954. *Surface Water Resources* In *Geology and Ground Water Resources of Camp Pendleton, California* by Worts and Boss.

[1] "Treatment Techniques," 2003 May 7, [cited 2004 November 1], Available http://www.epa.gov/region03/acidification/treatment.htm

[2] U.S. Bureau of Reclamation, Denver Office, Appraisal Cost Estimate for the Irrigation Drainwater Treatment Alternatives for the North Side Pumping Division Drainwater Management Study, October 1991, (Rev 1992 January).

[3] "Water Treatment Chemicals," [cited 2004 November 1], Available http://www.greensboronc.gov/water/Supply/chemicals.htm#potassium%20permanganate

[4] "Permitting Strategy for Greensand Filtration Water Treatment Plants," 2004 January, [cited 2004 November 1], Available http://66.102.7.104/search?q=cache:VbAsw0uY_1MJ:h2o.enr.state.nc.us/NPDES/documents/greensandpermitting_000.doc+greensand+filtration&hl=en

[5] James M. Montgomery, Water Treatment Principles and Design, New York, NY: A Wily-Interscience Publication, 1985.

[6] Robert A. Corbitt, Standard Handbook of Environmental Engineering, 2nd ed., New York: McGraw