Table 7-20

Alternative 3 Estimated Regulatory Constraints

Regulation or Statute	Compliance or Permitting Requirement	Estimated Time
NEPA	An EIS would be required for this alternative due to the potential for significant adverse impacts from increased diversions to sensitive resources downstream of the proposed diversion, impacts to other sensitive biological resources, and public sensitivity to the project.	32 – 36 months
FESA	Direct and indirect impacts to listed species as a result of project actions would trigger consultation with the USFWS, development of a Biological Assessment, and development of reasonable and prudent alternatives. Consultation would result in a Biological Opinion specifying measures, which must be undertaken to avoid and minimize impacts. Consultation could be complicated by the proposed recharge ponds being located within areas identified as critical habitat for the SWFL.	Statutory maximum of 135 days. Actual time between 9 - 12 months.
CWA	Dredge and fill of "Waters of the U.S." will require compliance with the Clean Water Act. An individual permit, with accompanying alternatives analysis, will likely be required for this alternative. Public review and comment periods will dove tail with NEPA process. Must meet NEPA and FESA requirements prior to ACOE issuance.	Statutory maximum of 60 to 90 days. Average time possibly 4-6 months

Cultural Resources

The additional project features described for Alternative 3 would present further cultural resource constraints. Cultural resource sites exist within close proximity to the east side of proposed percolation pond 6 and directly within the footprint of proposed wells 4, 5, and 7. While there may be some flexibility in locating proposed wells, the percolation pond sites were selected to maximize the advantage of local slope and terrain and minimize impacts to sensitive habitats and species. A more detailed analysis will be required to examine the relative benefits and constraints of final placement of proposed pond number 6.

The requisite Section 106 consultation with SHPO would have similar constraints to those stated above for Alternative 2, and in Section 3.2.1, *Cultural Resources, Regulatory Framework*.

Hazardous Materials and Wastes

No known IR and UST sites are expected to be affected by implementation of Alternative 3.

Surface and Ground-water Resources

Alternative 3 would involve construction of each feature described in Alternative 2, plus two additional recharge ponds. Clean Water Act regulatory requirements for Alternative 3 would be similar to those under Alternatives 2. The time frame and cost for Section 404 permitting would not differ dramatically. Implementation of Alternative 3 would likely result in environmental constraints similar to those described under Alternative 2.

The aquifer that provides the Base's drinking water has been heavily pumped to supply the Base's potable water needs. Continuing this level of pumping without adequate recharge could further exacerbate migration of the existing MTBE (methyl tertiary butyl ether) plume in the Chappo Basin (described in Section 3.2.1, *Environmental Setting, Hazardous Materials and Wastes*). Implementation of Alternative 3 would result in a significant augmentation of the Chappo Basin's ground-water recharge capacity, which would reduce current excessive ground-water pumping, and thus help contain the plume's migration.

7.2.3.3 Surface Water Model Analysis for Alternative 3

A reservoir operations model was used to estimate the rate and amount of surface diversion from the Santa Margarita River to both the recharge ponds and Lake O'Neill for Alternative 3 projects. The model used 1980 to 1999 hydrology in order to construct streamflow at a point below the confluence of DeLuz Creek and the Santa Margarita River (Chapter 4). Applying daily estimates of streamflow and historical measurements of precipitation and evaporation, the reservoir operations model was used to predict the daily diversion during the historical period.

The Alternative 3 reservoir operations model was altered to reflect the effects of adding four major improvements to the system:

- new Obermeyer spillway gate system,
- expanded headgate diversion structure from 100 cfs to 200 cfs,
- expanded canal capacity from 60 cfs to 200 cfs.
- two new additional ground-water recharge ponds.

The reservoir operations model for Alternative 3 is similar to Alternative 2 except for the addition of two recharge ponds. The proposed ponds increase the total storage capacity of all recharge ponds by more than 240 AF and increase the area of infiltration by 46 acres. A schematic of the reservoir operations model can be seen in Figure 7-16.

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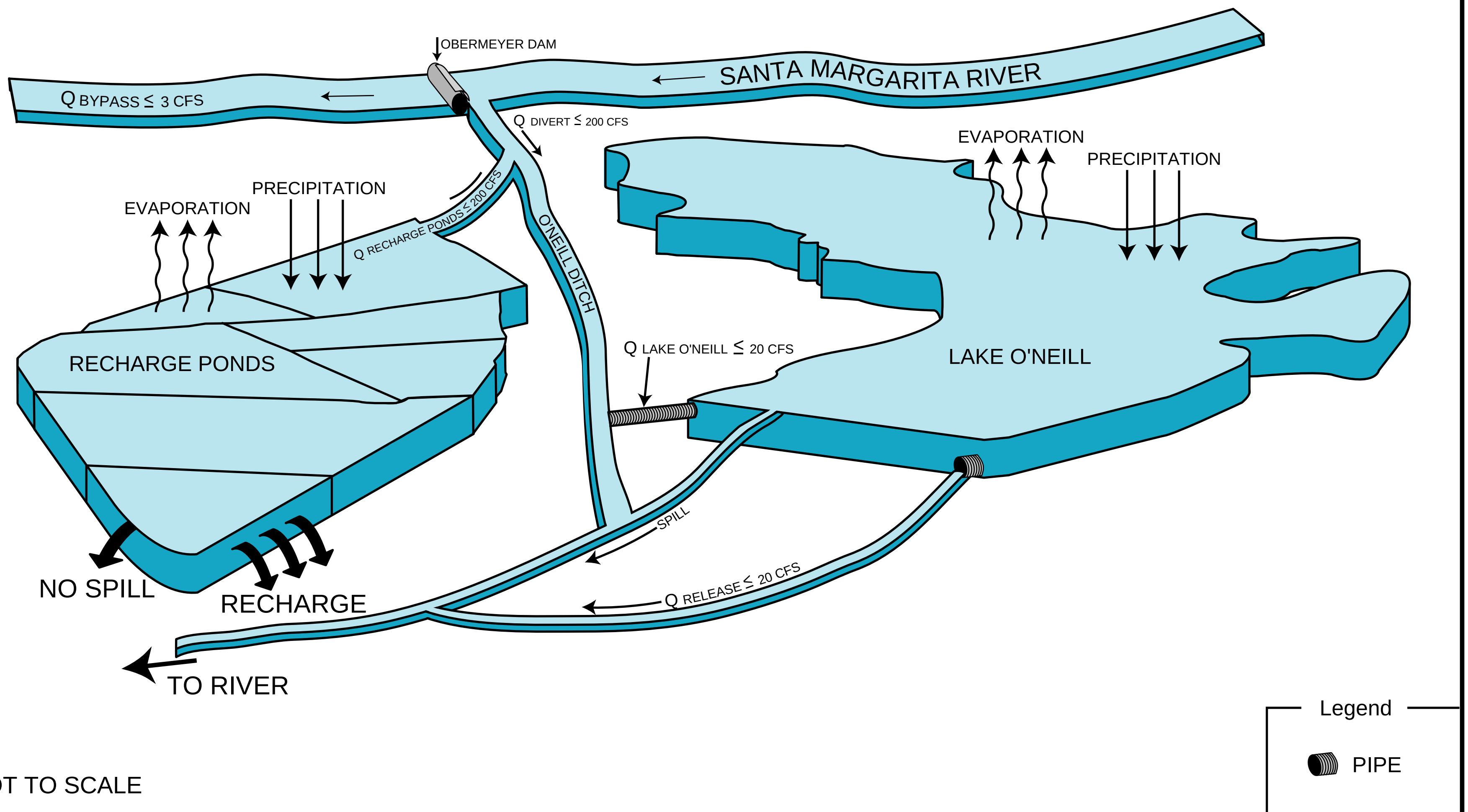


NOT TO SCALE

STETSON ENGINEERS INC.

Surface Water Analysis
Resevoir Operations Model

Alternative 3

New Diversion Dam
Expanded Headgate
Improved Canal
New Recharge Ponds

FIGURE 7-16

The diversion schedule to the recharge ponds is the same as in Alternative 2 (see Table 7-11). The addition of ponds 6 and 7 allows the Base to divert a greater quantity of water from the Santa Margarita River for use in the recharge ponds, due to the increased storage capacity and infiltration rate. Once the ponds have been filled from the initial storm event, the total volume diverted to the ponds is limited by the maximum infiltration potential. Due to the increase in wetter area and storage capacity, the future ponds will be able to infiltrate a sustained inflow of 80 cfs (during January and February) without spilling. The maximum sustained infiltration rate without the construction of the new ponds would be limited to 40 cfs.

The simulated performance of the reservoir operations model for Alternative 3 with augmented flows is shown in Table 7-21. The proposed recharge ponds make available an average of almost 7,000 AF of additional recharge to ground water as compared to the average augmented baseline condition. The incremental increase in the average water diverted to the recharge ponds is approximately 4,000 AFY greater than Alternative 1. The average annual diversions to Lake O'Neill increase by 1,000 AFY compared with Alternative 1.

TABLE 7-21
ALTERNATIVE 3 AUGMENTED FLOW
OBERMEYER DAM, NEW HEADGATE, IMPROVED CHANNEL, NEW RECHARGE PONDS

Model Years 1-20	Augmented Flow SMR (AF)	Total Diversion Max 200 cfs (AF)	Diversion to Lake O'Neill (AF)	Diversion to Recharge Ponds (AF)	Recharge to Ground Water (AF)	Net * Precip (+) Evap (-) (AF)
20 Yr. Total	**1,117,110**	**269,920**	**50,520**	**219,400**	**218,720**	**-8,120**
Average Annual	55,860	13,500	2,530	10,970	10,940	-410
Median Annual	30,740	13,270	2,610	10,650	10,590	-420
Min Annual	10,730	6,540	2,000	4,540	4,540	-290
Max Annual	226,230	21,840	2,640	19,220	19,190	-490

*Note: Includes lake and pond surfaces

7.2.3.4 Ground-Water Model Analysis for Alternative 3

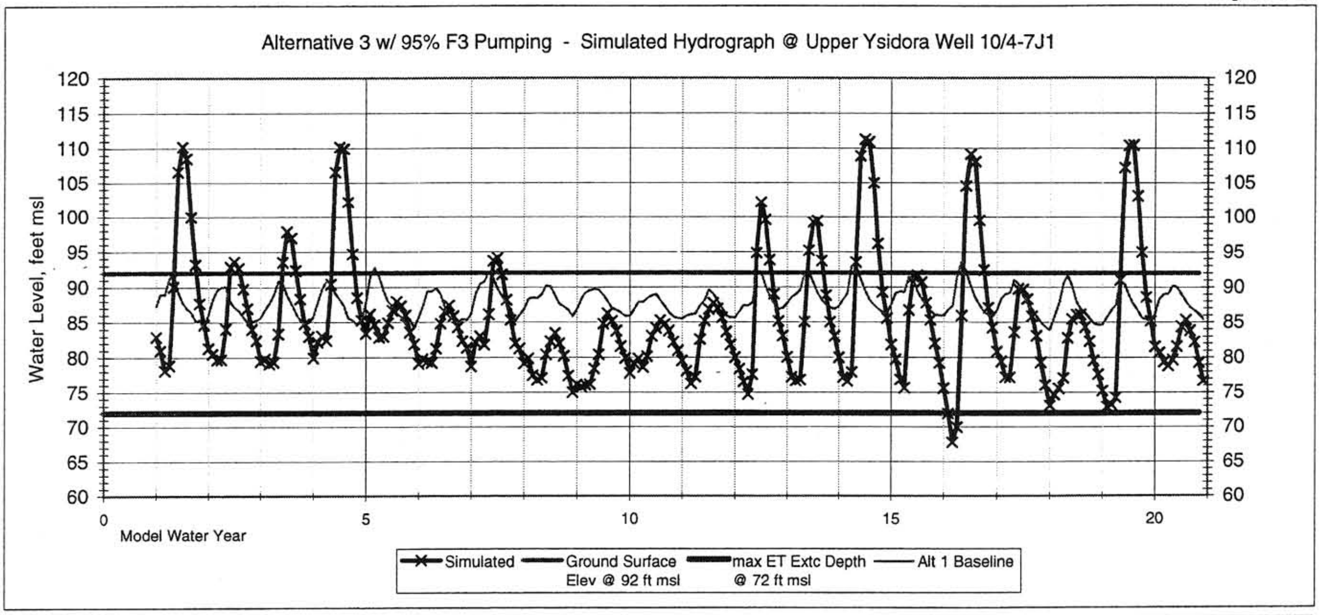
The ground-water model analysis for Alternative 3 compares Alternative 1 baseline conditions with the simulated results from the two additional ponds, two additional production wells and system improvements. The 95% F3 pumping schedule proposed for Alternative 3 produces 2.4 times the water as the baseline condition, and almost 1.2 times the water produced in Alternative 2. The water table is drawn down in the wintertime by the seasonal pumping thereby creating more aquifer storage capacity in winter months when water is available for diversion. Combining the additional pumping with expanded ground-water recharge capacity by approximately doubling the existing recharge ponds, is predicted to yield an average diversion of 10,970 AFY. This is 2.7 times the diversions to the ponds considered in the baseline, Alternative 1, and almost 1.4 times the diversions to the ponds under Alternative 2.

Three different pumping scenarios were considered under Alternative 3 to minimize impacts of ground-water level drawdown on riparian vegetation. Of the three pumping scenarios, the 95% F3 pumping schedule (discussed in section 7.2.3.1) produced the most water for the least environmental impact to the ground-water basins. Appendix D describes the results from the consideration of F2, F3 and 90% F3 pumping scenarios for Alternative 3.

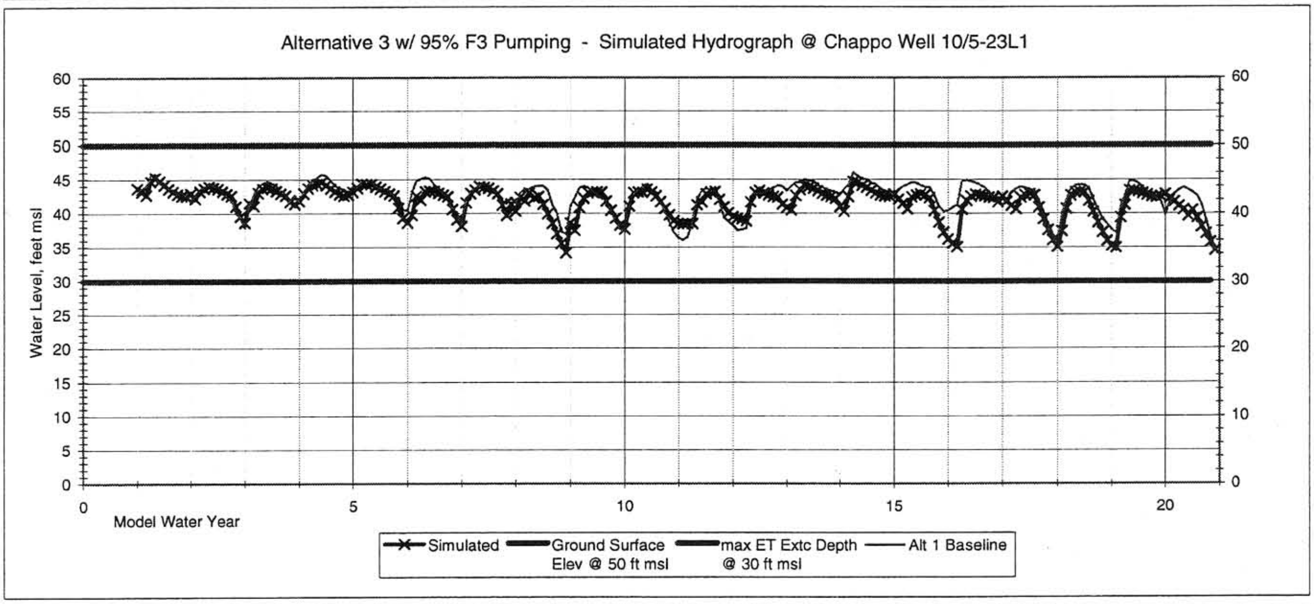
The largest water level drop observed in the three simulated monitoring wells during Alternative 3 model run occurred during Dec, MY 16 (corresponding to historic December 1994 climatic conditions) in the Upper Ysidora sub-basin with water level dropping to 67.8 feet, msl. There are three instances, all during winter months, where the water level drops close to or below the maximum extinction depth (20 feet bgs). This water level drop is probably tolerable because winter is a time when the vegetation is considered less stressed, and water levels recover during spring months.

Figure 7-17 shows baseline ground-water level data compared to model simulated results for Alternative 3 for all three sub-basins. The time shift where the low water levels in the Upper Ysidora occur in the winter months can be attributed to the increased ground-water production in the winter months combined with the larger diversions. Ground-water level highs occur in the summer during lower pumping and the lag time of infiltrated water from the recharge ponds reaching simulated monitoring well 10/4-7J1. Water level changes under Alternative 3 from baseline conditions are minimal in the Chappo (well 10/5-23L1) except in the winter of MY 16, and do not appear to effect ground-water levels in the Lower Ysidora (well 10/5-35K5). The lack of response at the Lower Ysidora monitoring well is considered a good indicator that there will be no ill effects on the estuary or salt-water intrusion into the ground-water basin from implementation of Alternative 3. Simulated and baseline monthly streamflows observed at the Ysidora gage near Basilone Road and the southwest boundary in the Lower Ysidora sub-basin are shown in Figure 7-18. The model predicts that Alternative 3 will have minimal impact on streamflow at these areas.

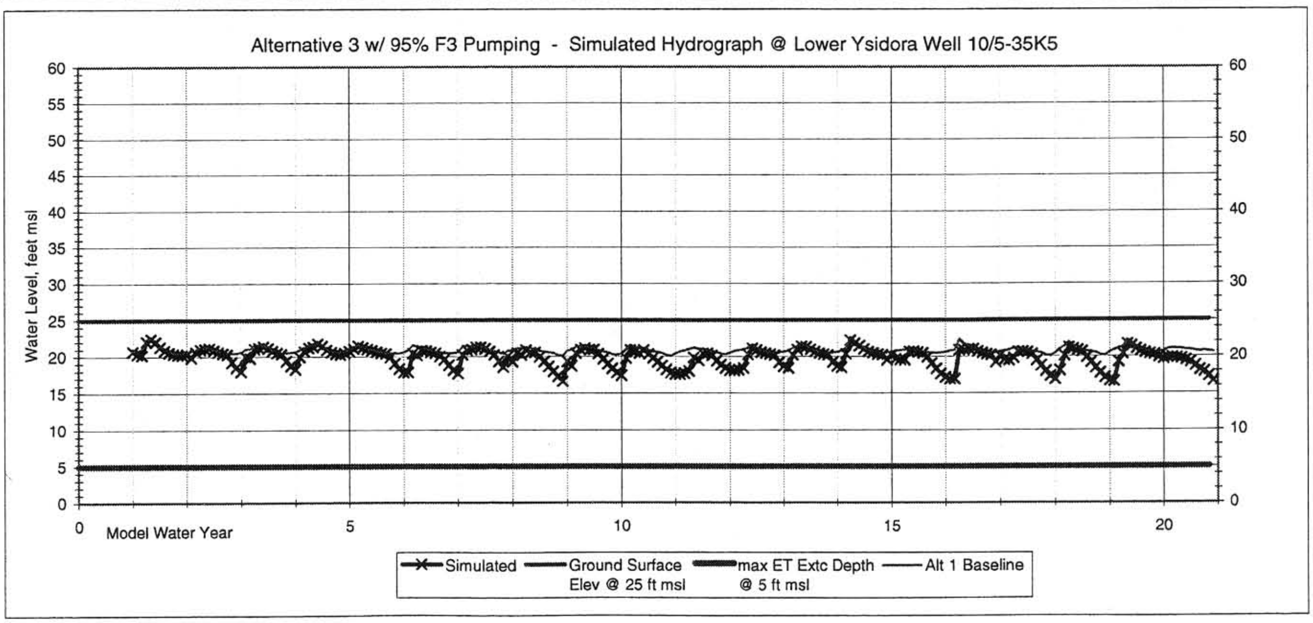
Alternative 3 model run is summarized in the water budget presented in Table 7-22. The Model provides calculated numbers for underflow, stream flow out of the model area, and evapotranspiration. Measured and estimated model input data provide water volumes for streamflow into the model domain, diversion to and release/spill from Lake O'Neill, ground-water pumping, and recoverable water from precipitation.



Alternative 3 w/ 95% F3 Pumping - Simulated Hydrograph @ Upper Ysidora Well 10/4-7J1
Water Level, feet msl
Model Water Year
Simulated
Ground Surface Elev @ 92 ft msl
max ET Extc Depth @ 72 ft msl
Alt 1 Baseline



Alternative 3 w/ 95% F3 Pumping - Simulated Hydrograph @ Chappo Well 10/5-23L1
Water Level, feet msl
Model Water Year
Simulated
Ground Surface Elev @ 50 ft msl
max ET Extc Depth @ 30 ft msl
Alt 1 Baseline



Alternative 3 w/ 95% F3 Pumping - Simulated Hydrograph @ Lower Ysidora Well 10/5-35K5
Water Level, feet msl
Model Water Year
Simulated
Ground Surface Elev @ 25 ft msl
max ET Extc Depth @ 5 ft msl
Alt 1 Baseline

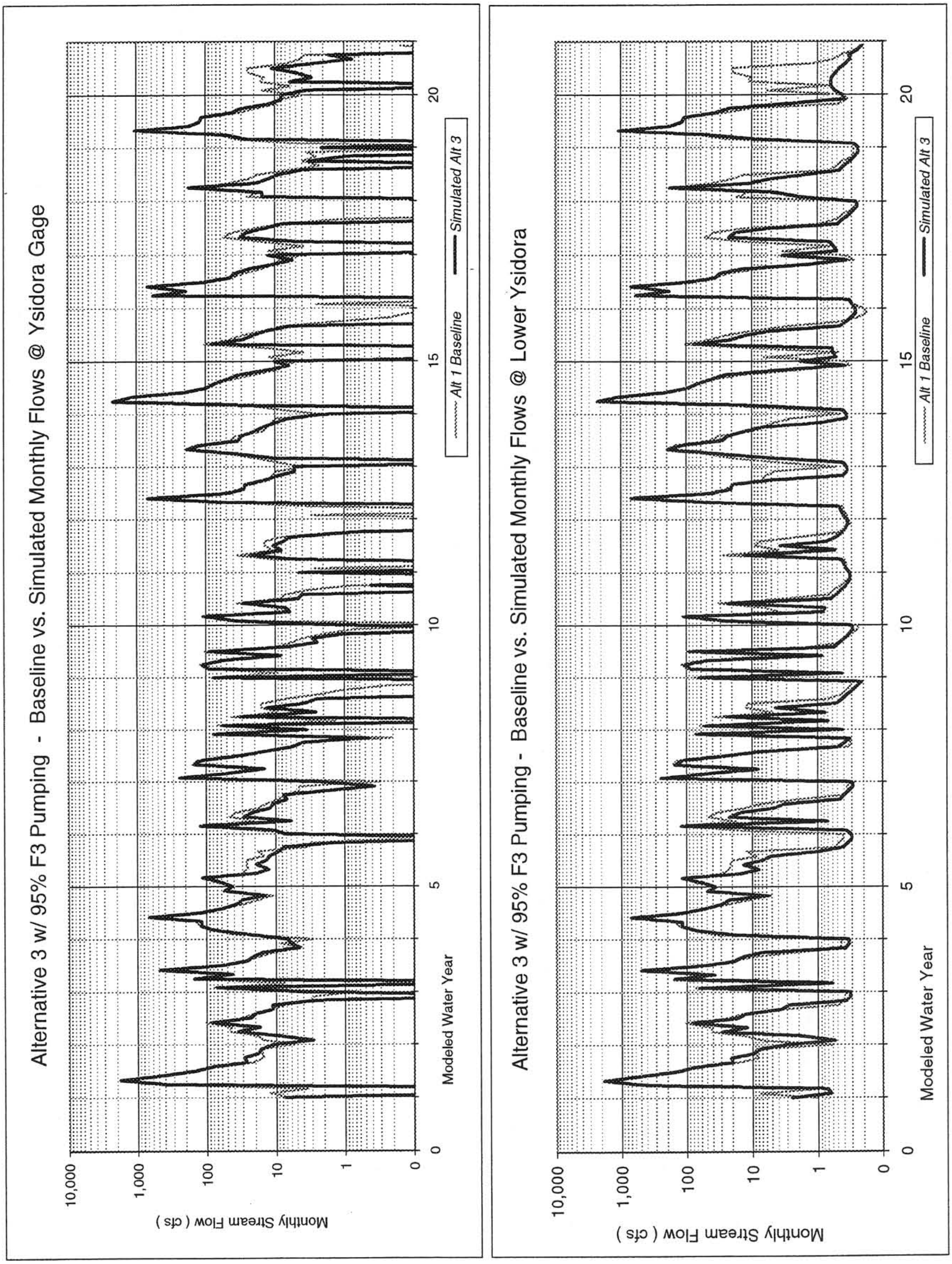

Alternative 3 w/ 95% F3 Pumping - Baseline vs. Simulated Monthly Flows @ Ysidora Gage
Monthly Stream Flow (cfs)
10,000
1,000
100
10
1
0
0
5
10
15
20
Modeled Water Year
Alt 1 Baseline
Simulated Alt 3
Alternative 3 w/ 95% F3 Pumping - Baseline vs. Simulated Monthly Flows @ Lower Ysidora
Monthly Stream Flow (cfs)
10,000
1,000
100
10
1
0
0
5
10
15
20
Modeled Water Year
Alt 1 Baseline
Simulated Alt 3

TABLE 7-22
ALTERNATIVE 3 -- AVERAGE ANNUAL WATER BUDGET FOR MY 1 - 20 (AF/WY)

		Alt 1 -Baseline		Alt 3 - 95% F3 Pumping	
		Average Annual	*Median Annual*	*Average Annual*	*Median Annual*
Inflow:	Subsurface Underflow	830	810	1,320	1,340
	Santa Margarita River Inflow	55,860	30,740	55,860	30,740
	Lake O'Neill Spill and Release	1,080	1,060	2,060	2,150
	Fallbrook Creek Bypass[1]	1,930	1,370	1,930	1,370
	Minor Tributary Drainages[1]	2,120	1,720	2,120	1,720
	Waste Water Discharge[1]	0	0	0	0
	Direct Precipitation	710	500	710	500
	Total Inflow:	62,530	36,200	64,000	37,820
Outflow:	Subsurface Underflow	230	220	220	220
	Santa Margarita River Outflow	50,080	24,420	47,480	19,740
	Ground-Water Pumping	5,550	5,870	13,350	14,060
	Evapotranspiration	2,790	2,700	2,580	2,420
	Diversions to Lake O'Neill	1,500	1,500	2,530	2,610
	Total Outflow:	60,150	34,710	66,160	39,050
	Net change in GW and SW Storage:	2,380	1,490	2,160	1,230
Water Exchange within Model Domain					
	Net Infiltration from Recharge Ponds	4,010	4,010	10,940	10,590
	Net Stream Recharge to GW	3,240	3,330	2,780	4,150

[1] Table revised on 10/2/03 in memo sent to Larry Carlson.

Though the net stream recharge to ground water is lower in Alternative 3 compared with the baseline, the average annual flow between the stream and ground water is greater. The simulated average annual seepage from all reaches of the stream to the ground-water aquifer is 8,430 AFY for Alternative 3, compared with 6,050 AFY under baseline conditions. During this same Model run, the average simulated annual gaining to all reaches of the stream from the ground-water aquifer is 5,650 AFY for Alternative 3, compared with 2,960 AFY under baseline conditions. There are more gaining sections of the stream during summer months under Alternative 3 compared with the baseline, due to the higher water table during some of the summer months.

Evapotranspiration from vegetation averages 210 AFY less on an annual basis for all three sub-basins under Alternative 3 compared with Alternative 1. This reduced ET appears to occur in winter months when the vegetation is either dormant or less stressed. It may be necessary to curtail pumping during observed critical months, though simulated water levels do not indicate any prolonged low ground-water level conditions.

7.2.3.5 Expected Additional Yield

The annual ground-water yield and maximum surface diversion expected from the construction of Alternative 3 facilities are listed below in Table 7-23. The maximum annual surface diversion required to provide a median annual ground-water yield of 14,100 AFY is 21,800 AF. Of this amount, the unused portion of Permit 15000 would require a maximum annual diversion rate of 16,300 AF, after attributing for diversions under the existing license and pre-1914 water rights. The median annual ground-water yield attributed to Application 21471B, Permit 1500, would be 5,500 AFY. The location of the point of diversion for the unused portion of Permit 15000 would be at the identical location of the existing point of diversion.

TABLE 7-23

ALTERNATIVE 3 – ANNUAL GROUND-WATER YIELD AND MAXIMUM SURFACE DIVERSION

WATER RIGHT	ALTERNATIVE 1 (AFY)	ALTERNATIVE 3 (AFY)
Maximum Existing License Yield	4,000	4,000
Maximum Pre-1914 Rights Yield	1,100	1,100
Maximum Alternative Riparian Water Right Yield	3,200	3,700
Minimum Additional Ground-Water Yield (AFY)	N/A	5,500
Total Annual Project Yield	**8,300**	**14,100**
Maximum Additional Surface Water Diversion (AFY)	N/A	16,300

7.2.3.6 Capital and Operation and Maintenance Costs

Cost estimates shown in Table 7-24 are given for Alternative 3 in terms of capital cost, annual operation and maintenance (O&M) cost, and unit cost per additional volume of water achieved from constructing the project. The estimates reflect year 2000 costs and are based on budgetary quotes from equipment suppliers and local contractors, construction bids for similar projects, unit cost databases published by McMahon (1995) and R.S. Means (2000), and other sources. The cost estimates reflect the level of accuracy that allows for an evaluation and comparison of project alternatives. Verification of certain assumptions is recommended to refine the cost estimates to the pre-design level.

The total capital cost estimate for Alternative 3 is $5.5 million, including the installation of the Obermeyer dam, expansion of the headgate capacity, expansion of the canal, improvements to the existing recharge ponds, and construction of two additional ground-water recharge ponds. The estimated capital costs of the new Obermeyer Dam, expansion of the headgate and conveyance facilities, expansion of the flow control between recharge ponds, and construction of the new recharge ponds is $2.5 million, including contingencies and engineering design. Adding the construction and installation of six additional ground-water extraction wells, the estimated capital cost for Alternative 3 increases to $5.5 million. This capital and operation and maintenance cost for this alternative is shown in Table 7-24. The estimate covers the cost of project planning, design, management and construction of the project facilities.

TABLE 7-24
COST ESTIMATE FOR ALTERNATIVE NO. 3 – NEW RECHARGE PONDS

Item	Cost
Obermeyer Diversion Dam Items	$621,000
O'Neill Ditch Enlargement Items	108,000
Recharge Pond Nos. 1-5 (additional flow structures)	200,000
New Recharge Pond Nos. 6 and 7	
Clear, Scrape, Grade, and Construct Levees	433,000
Flow Control and Measurement Structures between Recharge Ponds (12 @ $20,000 each)	240,000
Subtotal (New Recharge Ponds)	**673,000**
Subtotal (all items above)	**1,602,000**
Contingencies and Unlisted Items @ 25%	401,000
Subtotal	**$2,003,000**
Planning, Engineering, and Design @ 15%	300,000
Project Management and Administration @ 10%	200,000
Subtotal	**$2,503,000**
Ground-water wells (6 @ $500,000 each)	**$3,000,000**
Total Estimated Capital Cost	**$5,503,000**
Amortized Capital Cost [1.]	489,000
Annual Operation and Maintenance Cost	75,300
Total Estimated Annual Cost	**$564,300**
Unit Cost [2.]	**$100**

1. Capital costs amortized over 30 years at 8 percent interest.

2. Unit cost based on 5,500 AF per year increase in ground-water yield.

The annual O&M cost estimate for Alternative 3 is $75,300. Operations costs include labor and equipment needed to patrol the project area, monitor conditions, and operate the systems. Maintenance costs cover labor and equipment to maintain and make repairs to the mechanical and electrical components of the system, remove accumulated sediment and maintain the condition of O'Neill diversion ditch, and clean and maintain the ground-water recharge ponds.

The annual unit cost per additional volume of water achieved from constructing the Alternative 3 project facilities is $100. The unit cost is based on the sum of the amortized capital cost of constructing the project ($5.5 mil) and the annual operations and maintenance cost ($75,300) divided by 5,500 AF of additional water diversion achieved from constructing the project.

7.2.4 ALTERNATIVE 4 – DIVERSION WEIR, DITCH IMPROVEMENTS, AND CONSTRUCTION OF NEW RECHARGE PONDS AND OFF-STREAM RESERVOIRS

Alternative 4 involves replacement of the existing sheet pile diversion weir on the Santa Margarita River with an Obermeyer spillway, new sluice gates at the river diversion, and relocation of the existing diversion headgate. Alternative 4 also includes enlarging the capacity of O'Neill diversion ditch from 60 cfs to 200 cfs and constructing two new ground-water recharge Pond Nos. 6 and 7 with flow control and continuous flow measuring capability. Additionally, Alternative 4 involves constructing an off-stream storage reservoir, pump station, and pipeline to convey surplus river diversions from the ground-water recharge pond system to the proposed reservoir site. The construction of the new off-stream storage reservoir will provide Camp Pendleton with 4,800 AF of storage capacity. The increase in project yield to ground-water storage and recovery is an average annual value of 6,000 AF at an initial capital investment cost of $47.7 million. The annually amortized cost per acre-foot of this project is approximately $730.

Similar to Alternatives 2 and 3, surface water is diverted from the Santa Margarita River to the ground-water recharge ponds at a rate of 200 cfs. The addition of the off-stream reservoir will provide the Base with the flexibility to capture flows that would have spilled from the recharge ponds. A 40 cfs pump station located in ground-water recharge Pond #6 lifts excess water to the off-stream storage reservoir located on the Naval Weapons Station. Water is then released from the reservoir during prolonged dry periods in order to support ground-water levels in the Lower Santa Margarita basin.

7.2.4.1 Alternative 4--Project Design and Operation

Obermeyer Dam

The Obermeyer spillway gate system consists of a row of steel gate panels supported on their downstream side by inflatable air bladders. The dam is designed to deflate during high flow storm events, allowing sediment and debris to flow to the ocean. Following the passing of the peak event, the dam is inflated to allow water to be impounded and diverted into the O'Neill Ditch. The dam is designed to impound water five feet above the headgate invert elevation, providing 200 cfs of flow into the ditch. A more detailed explanation of the Obermeyer Dam is provided in Chapter 7.2.2.

Ditch Improvement

The capacity of the existing ditch is limited to 60 cfs at the upper road crossing located southwest of the Naval Hospital. Similar to Alternative 2 and 3, the existing ditch must be enlarged to 200 cfs in order to allow high flow events to recharge the existing ponds. Restrictions in the ditch limit the amount of water that can reach the recharge ponds, limiting the amount of water that may be diverted from the Santa Margarita River.

A detailed description of the required improvements to the ditch are found in Chapter 7.2.2 and are summarized below:

- Enlarge the M & R repaired headgate from 100 cfs to 200 cfs.
- Replace the two 36-inch road-crossing culverts (first crossing) with two 60-inch diameter culverts.
- Replace the two 36-inch control gates at the first road crossing with two 60-inch steel slide gates.
- Enlarge the 400-foot section of ditch downstream of the road crossing.
- Enlarge the existing upper Parshall flume.
- Install two new 60-inch turnouts to the existing ground-water recharge ponds.

Existing Recharge Pond Improvements

Due to 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 five ponds. Similar to the measuring and control weirs discussed in the M & R section of this report, ten additional weirs will be required to increase the instantaneous flow between each of the existing five recharge ponds from 100 cfs to 200 cfs.

The new control structures will 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 will provide the means for controlling pond water levels such that flow from one pond will cascade to another without backwater effects between ponds that are in series. Refer to Alternative 2 (Chapter 7.2.2) for a detailed discussion on the operation of the new control weirs and monitoring devices.

New Ground-Water Recharge Pond Nos. 6 and 7

In addition to constructing the Obermeyer spillway diversion dam and enlarging the capacity of O'Neill Ditch from 60 to 200 cfs, Alternative 4 includes expansion of the existing ground-water recharge pond system to include two additional recharge ponds. The two new recharge ponds (Pond Nos. 6 and 7) will occupy approximately 46 acres of land adjacent and downstream to Pond Nos. 3 and 4, bringing the total recharge pond area to 95 acres. The new recharge ponds will add an additional surface water storage capacity of approximately 242 AF to the ground-water recharge system and will allow an average of 3,000 AF of additional water to infiltrate into the ground-water basin annually.

Off-Stream Storage Reservoir

In addition to constructing the Obermeyer spillway diversion dam, enlarging the capacity of O'Neill Ditch from 60 to 200 cfs, and expanding the recharge pond system to include new recharge Pond Nos. 6 and 7, Alternative 4 involves the construction of an off-stream storage reservoir. The facilities associated with the off-stream storage reservoir will include a 40 cfs pump station located adjacent to recharge Pond No. 6 and a 36-inch pipeline from the pump station to the proposed reservoir. The pump station will deliver surplus river diversions from Pond No. 6 to an off-stream reservoir located in the upper reaches of Pilgrim Creek, approximately two miles west of the ground-water recharge pond system. The location of the proposed reservoir, pipeline and pump station is shown in Figure 7-19.

The location selected for the off-stream storage reservoir is the result of a reconnaissance level investigation that considered numerous potential reservoir sites and evaluated each site in terms of storage capacity, construction cost, environmental concerns, and project feasibility. Additional investigations and studies of soils, geology, foundation adequacy and other site characteristics would be required to further evaluate constructing a reservoir at the site selected for this study. The results of the off-stream reservoir site analysis are summarized in Appendix G.

As shown in Figure 7-19, the proposed reservoir consists of two earth embankment dams and three smaller earthen levees. The embankments of the dams will consist of impervious cores, flanked by zones of compacted sand, gravel and miscellaneous fill. A cut-off trench will be extended below the creek channels and a grout curtain will extend from the bottom of the cut-

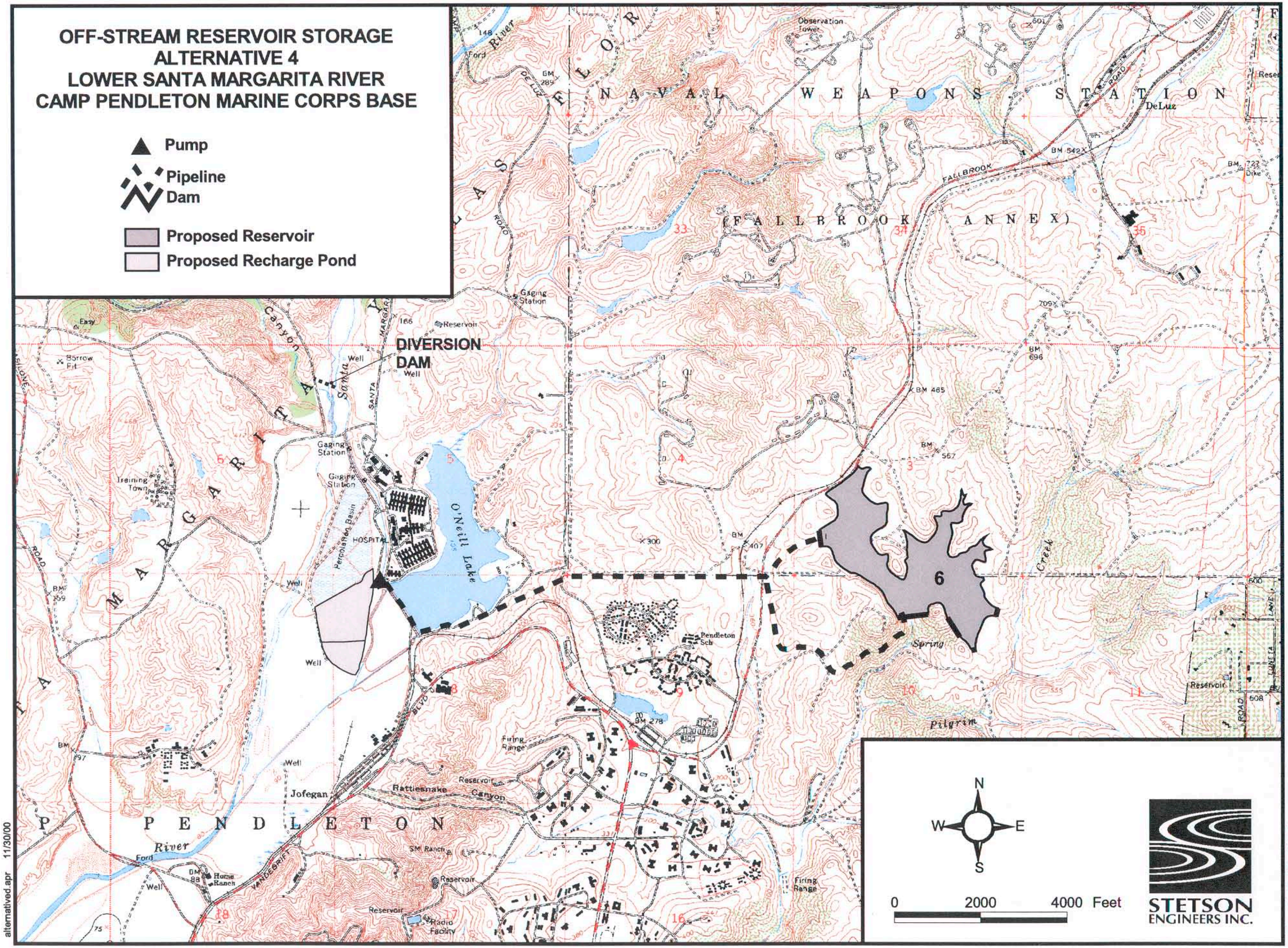


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FIGURE 7-19

off trench to bedrock. A fuse plug type spillway and earthen overflow channel will be constructed at the location shown by the eastern most reservoir levee. It is assumed that most of the material required for the dam embankments will be available locally from within the proposed reservoir site or from the excavation work associated with construction of the new ground-water recharge ponds. The total volume of material required for construction of the dam embankments will be approximately 975,000 cubic yards.

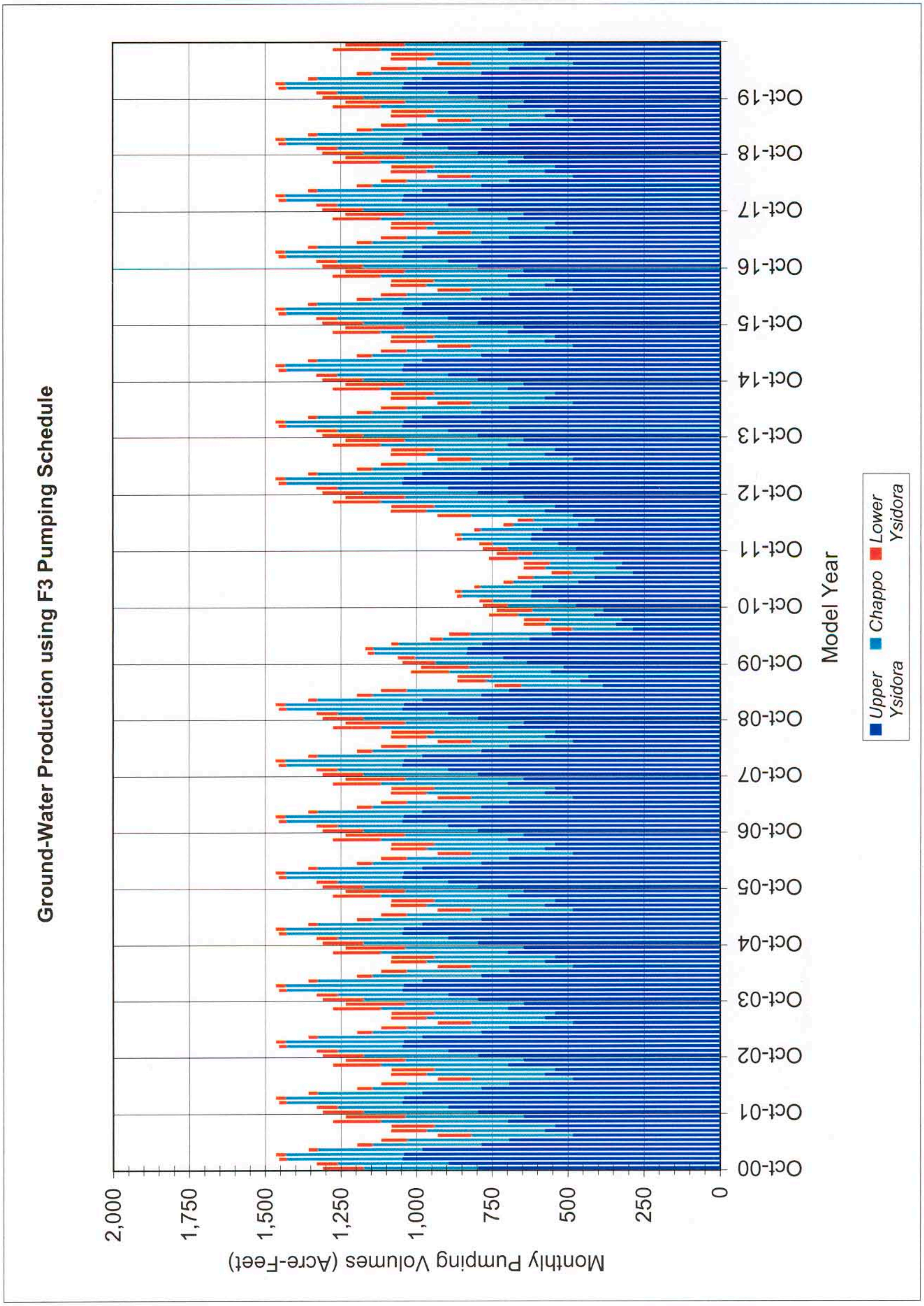
The proposed reservoir will have a storage capacity of approximately 4,800 AF with a water surface elevation at 460 feet mean sea level (msl). The surface area of the reservoir with a water level at capacity will be approximately 55 acres. The proposed reservoir will be filled primarily with surplus river water diversions pumped directly from surface storage in the newly constructed ground-water recharge Pond No. 6. Water pumped directly from the pond will be conveyed in a buried steel pipeline running generally east along the southern boundary of the Fallbrook Naval Annex. The pumping plant will lift Santa Margarita River water 360 feet through approximately 12,000 feet of pipeline. The capacity of the pipeline will be approximately 40 cfs.

At a pumping rate of 40 cfs, approximately 80 AF of Santa Margarita River water can be diverted to the reservoir per day. However, based on historical records of streamflow, addition of augmented flows, and under the proposed river diversion and ground-water pumping scenario of Alternative 4, the average annual supply available for pumping to the proposed off-stream reservoir will be approximately 3,7000 AFY.

Water stored in the off-stream reservoir can be returned back to Pond No. 6 by gravity through a pipeline connecting the outlet works of the dam to the same pipeline that will be used to pump water up to the reservoir. Gravity return flows from the reservoir back to ground-water recharge Pond No. 6 are expected to take place primarily during periods when flow in the Santa Margarita River is too low for diversions to the recharge pond system. Additional uses for the off-stream reservoir system, which are beyond the scope of this report, should also be investigated.

New Ground-Water Recovery Wells for Alternative 4

Proposed new ground-water recovery wells are located in the Upper Ysidora and Chappo sub-basins. Figure 7-20 shows the F3 monthly pumping schedule proposed for Alternative 4. To achieve the necessary aquifer storage and minimize the environmental impact on riparian vegetation, four new production wells are proposed for the Upper Ysidora (PW-1, PW-2, PW-3 and PW-6), and two new production wells are proposed for the Chappo (PW-4, and PW-5). F3 ground-water production management practices curtail pumping during dry years. During the second consecutive below normal hydrologic year, pumping is reduced by 3,000 AF/month (May


Ground-Water Production using F3 Pumping Schedule
2,000
1,750
1,500
1,250
1,000
750
500
250
0
Monthly Pumping Volumes (Acre-Feet)
Oct-00
Oct-01
Oct-02
Oct-03
Oct-04
Oct-05
Oct-06
Oct-07
Oct-08
Oct-09
Oct-10
Oct-11
Oct-12
Oct-13
Oct-14
Oct-15
Oct-16
Oct-17
Oct-18
Oct-19
Model Year
Upper Ysidora
Chappo
Lower Ysidora

of MY 9). Management practices during the third consecutive below normal hydrologic conditions, reduces pumping by an additional 3,000 AF/month (May of MY 10). The reduced ground-water pumping would continue until an Above Normal hydrologic year occurred. Table 7-25 shows the different water year pumping volumes during a normal and below normal period.

TABLE 7-25
F3 PUMPING VOLUMES (AF/WY)

MY	F3 Pumping Volume	Condition
8	14,800	First year of Below Normal Hydrologic Conditions
9	13,670	Second year of Below Normal Hydrologic Conditions; decrease annual pumping by 3,000 AF from May MY 9 through April MY 10
10	10,670	Third year of Below Normal Hydrologic Conditions; decrease annual pumping by 6,000 AF from May MY 10 through April MY 11
11	8,800	Fourth year of Below Normal Hydrologic Conditions; decrease annual pumping by 6,000 AF from May MY 11 through April MY 12
12	11,070	First year of Above Normal Hydrologic Conditions
13	14,800	Second year of Above Normal Hydrologic Conditions

Note: The F3 Pumping Volume represents a January through December annual pumping average.

7.2.4.2 Environmental Opportunities and Constraints Analysis

Environmental Constraints

Alternative 4 would involve construction of each feature described in Alternatives 2 and 3 plus construction of an off-stream reservoir and dams, a pipeline connecting the reservoir to the two proposed percolation ponds, and construction of associated support facilities (including six ground-water wells) and structures, including a pump station in recharge pond number 6, roads, transmission lines, and gaging stations.

Biological Resources

As stated in the Alternative 2 and 3 discussion, improving diversion and control structures in the ditch and recharge ponds, enhancing the conveyance structure, and increasing the capacity of the diversion headgate would result in minimal ground disturbance. However, dam replacement and installation of the six proposed ground-water wells would result in disturbance within the Santa Margarita River channel in the Southern Cottonwood/Willow Riparian Forest and Southern Willow Scrub vegetative communities. The two proposed recharge ponds would be constructed entirely within ruderal lands classified as "Developed" by the Base. Construction of the proposed reservoir and associated facilities and access roads would result in permanent loss of non-native grassland and Diegan Coastal Sage Scrub vegetative communities. Construction of the current pipeline alignment connecting the reservoir to existing and new recharge ponds would result in disturbance to Southern Willow Scrub, non-native grassland, Diegan Coastal Sage Scrub and possibly Southern Cottonwood/Willow Riparian Forest communities.

Alternative 4 would also involve construction of up to five dams along headwater and tributary streams, primarily on the southwest portion of the Fallbrook Naval Weapons Station and the Camp Pendleton border. Construction of these five dams and the reservoir itself would result in substantial dredge and fill activities within Waters of the U.S.

Table 7-26 describes those vegetative communities potentially affected by construction of Alternative 4. These communities provide breeding, foraging and cover for the Least Bell's Vireo, Southwestern Willow Flycatcher, Coastal California Gnatcatcher, Arroyo Toad, and Stephen's Kangaroo Rat. Table 7-27 describes the regulatory constraints associated with compliance with regulations and statutes for implementation of the Alternative 4 project.

Cultural Resources

As previously discussed, Alternative 4 includes all features in previous alternatives plus construction of an off-stream reservoir and dams, a pipeline connecting the reservoir to the two proposed percolation ponds, and construction of associated support facilities (including six ground-water wells) and structures, including a pump station in recharge pond number 6, roads, transmission lines, and gaging stations. Current surveys have documented cultural resource sites along the proposed pipeline alignment. The proposed alignment transects several sites and is within close proximity to a few others. Additional constraints analysis will be required to determine an optimal alignment that minimizes or avoids both cultural and biological sensitive resource features.

The portion of the proposed reservoir site on the Base has been recently surveyed and supports no known cultural resource sites. However, additional surveys may be required to assess potential cultural resource constraints on the Naval Weapons Center portion of the proposed reservoir site.

TABLE 7-26

VEGETATIVE COMMUNITIES POTENTIALLY AFFECTED BY ALTERNATIVE 4 PROJECT FEATURES

Vegetative Community	Occurrence in Alternative 4 Project Area	Alternative 4 Project Features	Associated Focus Species[1]
Southern Cottonwood/Willow Riparian Forest	Within the primary floodplain of the Santa Margarita River and associated alluvium	Obermeyer Dam, and 2 Proposed Wells	LBVI, SWFL, ARTD
Southern Willow Scrub	Inter-mixed with Southern Cottonwood/Willow Riparian Forest and in disturbed areas on the margins of riparian habitat	Conveyance Ditch, and 1 Proposed Well	LBVI, SWFL, ARTD
Diegan Coastal Sage Scrub	Significant stands occur south of the Base and Fallbrook NWS boundary, southeast of O'Neill Lake	Proposed Reservoir, Pipeline, Associated Facilities	CAGN, SKR
Non-Native Grassland	South of O'Neill Lake and the proposed dam site	Proposed Wells	None
Developed	Immediately northwest of the southern end of O'Neill Lake	Recharge Ponds	LBVI, SWFL, ARTD

[1] LBVI=Least Bell's Vireo; SWFL=Southwestern Willow Flycatcher; CAGN=Coastal California Gnatcatcher; SKR=Stephen's Kangaroo Rat; ARTD=Arroyo Toad

TABLE 7-27
ALTERNATIVE 4 ESTIMATED REGULATORY CONSTRAINTS

Regulation or Statute	Compliance or Permitting Requirement	Estimated Time
NEPA	Alternative 4 would require an EIS due to the possibility of significant adverse effects and the controversial nature of the project. Substantial technical studies in support of a NEPA analysis would be required to measure levels of anticipated take.	32 - 36 months
FESA	Direct and indirect impacts to listed species as a result of project actions would trigger consultation with the USFWS, development of a Biological Assessment, and development of reasonable and prudent alternatives. Consultation would result in a Biological Opinion specifying measures, which must be undertaken to avoid and minimize impacts. Consultation would be complex and protracted due to the proposed percolation ponds being located within areas identified as critical habitat for the SWFL, the reservoir site located within CAGN critical habitat, and the number of imperiled species that would likely lose habitat as a result of Alternative 4.	Statutory maximum of 135 days. Actual time between 18 - 24 months.
CWA	Dredge and fill of "Waters of the U.S." will require compliance with the Clean Water Act. An individual permit will be required for this alternative. A separate, detailed alternatives analysis may be required depending upon final reservoir and/or storage facility design. Public review and comment periods will dove tail with NEPA process. Must meet NEPA and FESA requirements prior to ACOE issuance of permit.	Statutory maximum of 60 to 90 days. Average time possibly 4-6 months
MBTA (Migratory Bird Treaty Act)	Direct impacts to migratory birds must be avoided under this act. Currently, no MBTA permit process is in place under this act, so requirements would be demonstration of avoidance within a NEPA or FESA process of compliance.	N/A

The additional required cultural resource surveys would trigger the need for Section 106 consultation with SHPO which would take between three-to-six months (personal communication, Mr. Stan Berryman, Archaeological Resources Branch Head, November 2000). In contract to Alternatives 2 and 3, Alternative 4 would necessitate a SHPO-mandated cultural records search, field surveys, and compliance monitoring report.

Hazardous Materials and Wastes

There are no known IR or UST sites along the proposed water conveyance pipeline route that runs from proposed recharge pond number 6 to the upland, off-stream reservoir. At this time it is not known if any IR or UST sites are present on the southwest corner of the Fallbrook Naval Weapons Station.

Implementation of Alternative 4 would require further studies to determine if any IR or UST sites occur in and around the proposed 55-acre upland, off-stream reservoir that straddles the Camp Pendleton/Naval Weapons Station border. This would take time (approximately two months) and further increase the cost of implementing Alternative 4.

Surface and Ground-water Resources

Potential IR or UST sites on the Naval Weapons Center portion of the proposed reservoir site, or within unsurveyed or documented areas of the Base, could result in contamination of surface water stored in the proposed reservoir. In addition, accumulation of TDS and nitrates, currently present at high concentrations in the Santa Margarita River, could result in degradation of reservoir water.

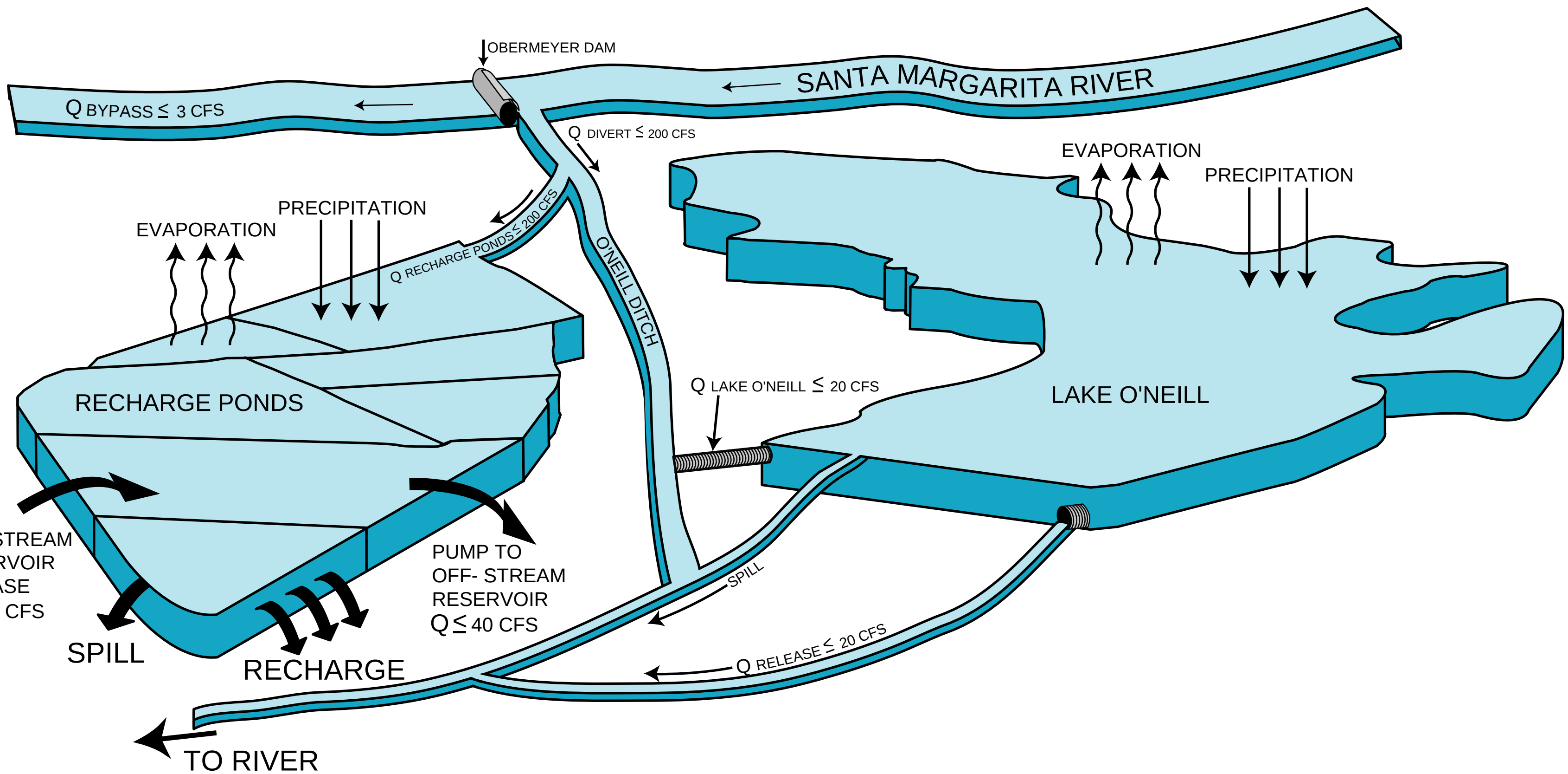
Close coordination with the Naval Weapons Center and a thorough evaluation of information maintained by the Base will be required to fully assess actual constraints to development of surface water storage facilities.

7.2.4.3 Surface Water Model Analysis for Alternative 4

The reservoir operations model for Alternative 4 is the same as for Alternative 3 with a maximized diversion scheme to allow the final recharge pond to overflow and spill. This spilled water will be pumped out of the Pond No. 6 to be made available for off-stream storage. This alternative maximizes the amount of water diverted from the Santa Margarita River to fill Lake O'Neill and the recharge ponds while sending any excess water to the 4,800 AF of off-stream storage reservoir for use during drought periods. A schematic of the reservoir operations model can be seen in Figure 7-21.

The diversion schedule and total diversion to Lake O'Neill remains the same as in Alternative 2 and 3. The ground-water recharge pond volumes and infiltration rates also remain the same as in Alternative 3. Diversions to the recharge ponds are maximized such that excess water may be pumped to the reservoir at a rate up to 162-cfs (channel capacity minus the minimum infiltration flow rate), as shown in Table 7-28.

1828-324LakeGraph4.ai



NOT TO SCALE

STETSON ENGINEERS INC.

Surface Water Analysis
Resevoir Operations Model

Alternative 4

New Diversion Dam
Expanded Headgate
Improved Canal
New Recharge Ponds
Off Stream Storage

FIGURE 7-21

TABLE 7-28
DIVERSION SCHEDULE TO RECHARGE PONDS & OFF-STREAM STORAGE

Month	Activity	Rate	Reservoir	Water Right
Nov	Fill w/ 100% Q_{divert}	$Q_{recharge\ ponds}$ <= 200 cfs	RSVR <= 162 cfs	Permit 15000
Dec to Jan	Fill w/ $Q_{divert} - Q_{lake\ O'Neill}$	$Q_{recharge\ ponds}$ <= 200 cfs	RSVR <= 162 cfs	Permit 15000
Feb to May	Fill w/ 100% Q_{divert}	$Q_{recharge\ ponds}$ <= 200 cfs	RSVR <= 162 cfs	Permit 15000
Jun	Fill w/ $Q_{divert} - Q_{lake\ O'Neill}$	$Q_{recharge\ ponds}$ <= 200 cfs	RSVR <= 162 cfs	Permit 15000
Jul to Sept	No Diversion	$Q_{recharge\ ponds}$ = 0 cfs	N/A	N/A
Oct	Fill w/ $Q_{divert} - Q_{lake\ O'Neill}$	$Q_{recharge\ ponds}$ <= 200 cfs s	RSVR <= 162 cfs	Permit 15000

Note: 4,000 AFY is diverted under license 21471A. The remaining diversion would be appropriated under 21471B.

The simulated performance of the reservoir operations model for Alternative 4 with augmented flows is shown in Table 7-29.

TABLE 7-29
ALTERNATIVE 4 AUGMENTED FLOW
OBERMEYER DAM, NEW HEADGATE, IMPROVED CHANNEL, NEW RECHARGE PONDS, AND OFF-STREAM STORAGE WITH F3 PUMPING

Model Years 1-20	Augmented Flow SMR (af)	Total Diversions Max 200 cfs (af)	Diversion to Lake O'Neill (af)	Diversion to Recharge Ponds (af)	Diversion to Reservoir (af)	Release from Reservoir to Pond 6 (af)	Recharge to Ground Water** (af)	Net * Precip(+) Evap (-) (af)
20 Yr Total	117,110	298,640	50,520	219,950	28,170	22,890	241,600	-14,590
Average Annual	55,860	14,930	2,530	11,000	1,410	1,140	12,080	-730
Median Annual	30,740	13,730	2,610	10,650	350	900	11,760	-720
Min Annual	10,730	6,540	2,000	4,540	0	0	4,540	-430
Max Annual	226,230	26,500	2,640	19,220	4,850	3,590	19,810	-1,090

* includes lake, pond, and reservoir surfaces
** includes Reservoir release to Pond 6

The average diversions from the Santa Margarita River increased 9,200 AFY from the augmented baseline conditions. The total diversion to Lake O'Neill remains the same as in Alternatives 2 and 3. The proposed recharge ponds and off-stream storage operation make available an average of 8,000 AFY of additional recharge to ground water as compared to the average augmented baseline condition. Based on the added diversions, there is the potential to store an average annual volume of 1,440 AFY in off- stream storage. Note that the diversion and spill from the recharge ponds is presented in the above table as potential diversion and spill. The off-stream storage operations model described below will articulate the diversion limitations for Alternative 4.

Off-Stream Storage Operations Model

The off-stream storage operations model accounts for the pumping of water from the recharge ponds to the reservoir when the ponds reach a maximum capacity. A 40 cfs pump relieves the recharge ponds of their excess water, and may pump water to the reservoir until it fills its 4,800 AF capacity. The reservoir is not annually drained. Water is allowed to accumulate through out wet years so that is may be available during periods of drought. Water from the reservoir is released to the recharge ponds when the ground-water table is low.

The release of water from the reservoir back into the recharge ponds (reservoir yield) is governed by the ground-water model's simulation of ground-water levels. If the water surface elevation in the Upper Ysidora sub-basin falls below 80 feet msl (12 feet below ground surface) in any month, the reservoir will release 10 cfs (19.8 AF/day) to Recharge Pond 6 during that month. Subsequently, If the water surface elevation in the Upper Ysidora index well falls below 75 feet msl (17 feet below ground surface) in any month, the reservoir will release 15 cfs (29.8 AF/day) to Recharge Pond 6 during that month. Water will be released from the reservoir to ease the depleted ground- water levels as long as water is available.

The reservoir yield that is released into Pond 6 experiences minimal loses. Since the minimum infiltration rate of Pond 6 is 15.1 cfs (Appendix E,), the pond will be able to exercise its maximum infiltration flow rate to allow for complete recharge of all reservoir releases. At no time does Pond 6 reach a maximum capacity at the same time as the reservoir release fills it. Therefore, there is always room for the reservoir releases to recharge to the ground water. The allowable flow from the recharge ponds is limited to the ability of the pump to transfer water to the off-stream storage reservoir as well as the capability of the reservoir to store the excess water. The GIS contours of the reservoir design provided a surface area to volume curve used to calculate the change in storage (Figure 7-22). Fluctuations in the storage volume for the reservoir, due to the effective evaporation and precipitation, may provide more room for the pumped water from the recharge ponds, or cause a limited amount of spill due to rain falling on the already full reservoir.

7.2.4.4 Ground-Water Model Analysis for Alternative 4

The ground-water model analysis for Alternative 4 compares Alternative 1 baseline conditions with the simulated results from releasing available water from a reservoir into recharge Pond 6 and additional ground-water production at existing and proposed wells in addition to Alternative 3 system improvements. The F3 pumping schedule (Section 7.2.4.1) proposed for Alternative 4 produces 2.5 times the water as the baseline condition, and approximately 1.05 times the water produced in Alternative 3.

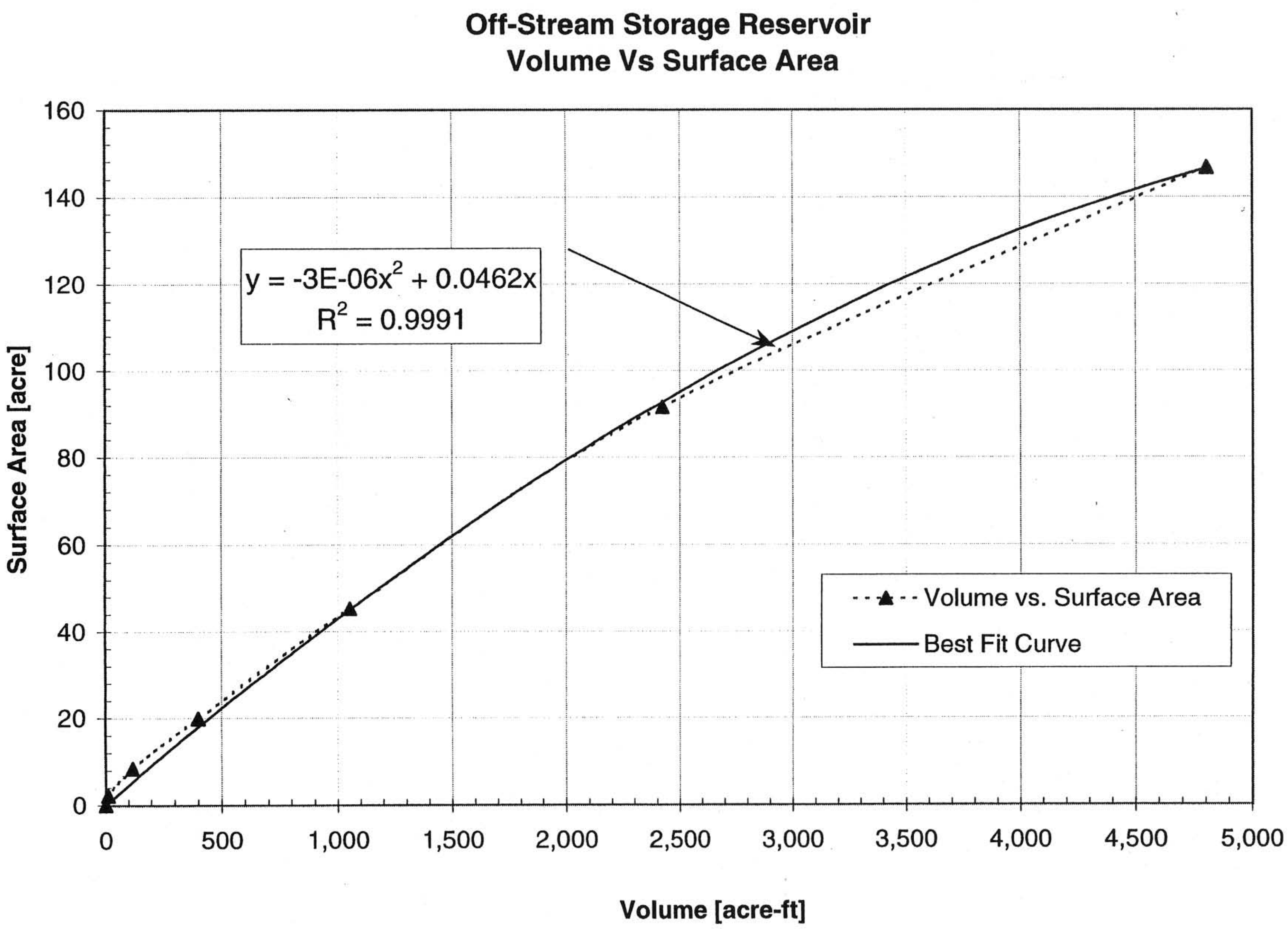

Off-Stream Storage Reservoir
Volume Vs Surface Area
y = -3E-06x2 + 0.0462x
R2 = 0.9991
Volume vs. Surface Area
Best Fit Curve
Surface Area [acre]
Volume [acre-ft]
0
20
40
60
80
100
120
140
160
0
500
1,000
1,500
2,000
2,500
3,000
3,500
4,000
4,500
5,000

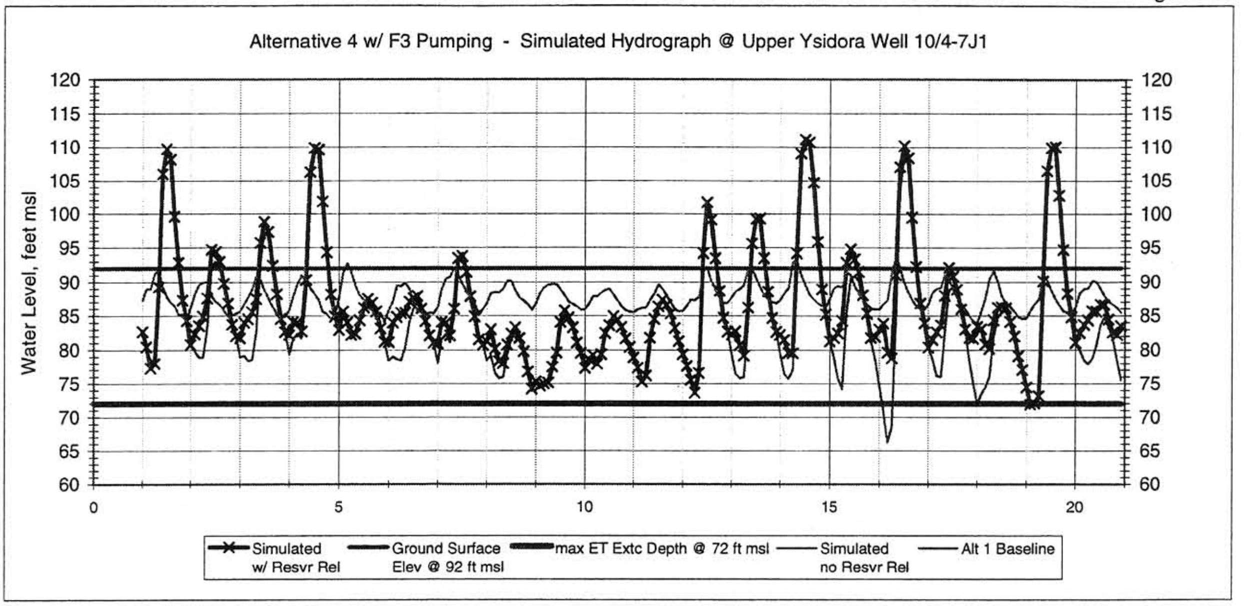
FIGURE 7-22

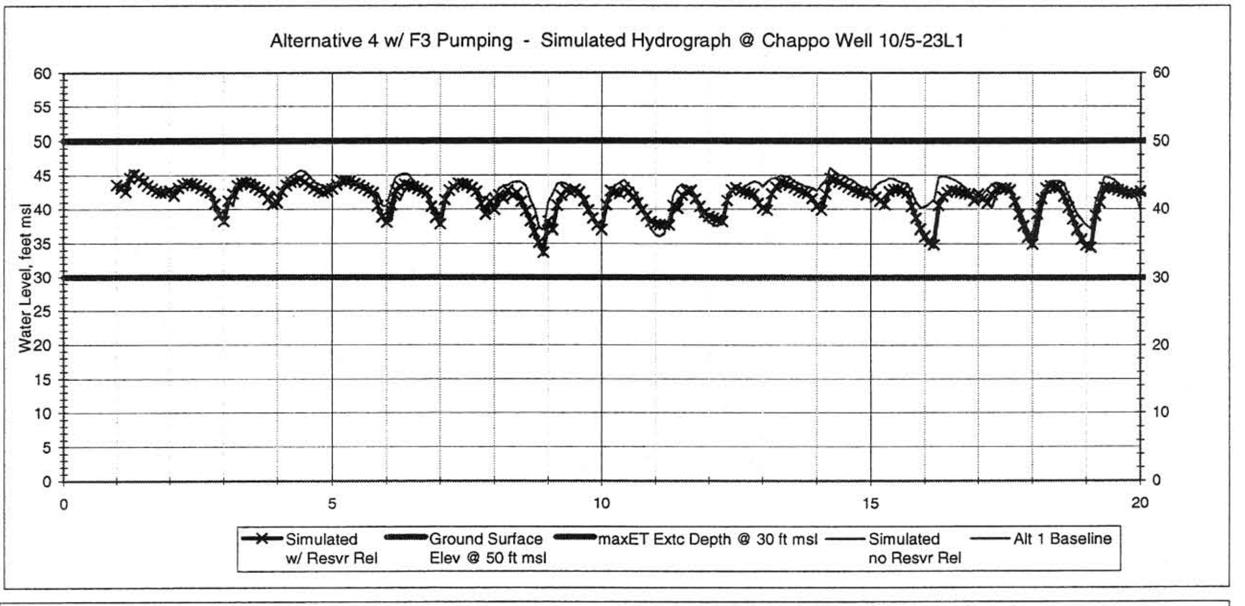
In Alternative 4, similar to Alternative 3, the water table is drawn down in the winter time by the seasonal pumping thereby creating more aquifer storage capacity in winter months when water is available for diversion. The Model was run first to determine when water levels would drop below 80 feet msl, triggering a release of 10 cfs from the reservoir, and when water levels would drop below 75 feet msl, triggering a release of 15 cfs from the reservoir if the reservoir contained water. The Model then added these additional ground-water recharge volumes to the initial infiltration volume of Recharge Pond 6, and was run a second time to get simulated results for Alternative 4. The ability to release available water from reservoir storage during months when water levels drop by six feet in the Upper Ysidora, is predicted to yield an additional 1,144 AF water for recharging ground water on an annual average basis. This reservoir release ranges from 0 AFY (MY 1, 5, 10, 11, 12 and 19) to 3,590 AFY in MY 20, depending on available water in the reservoir.

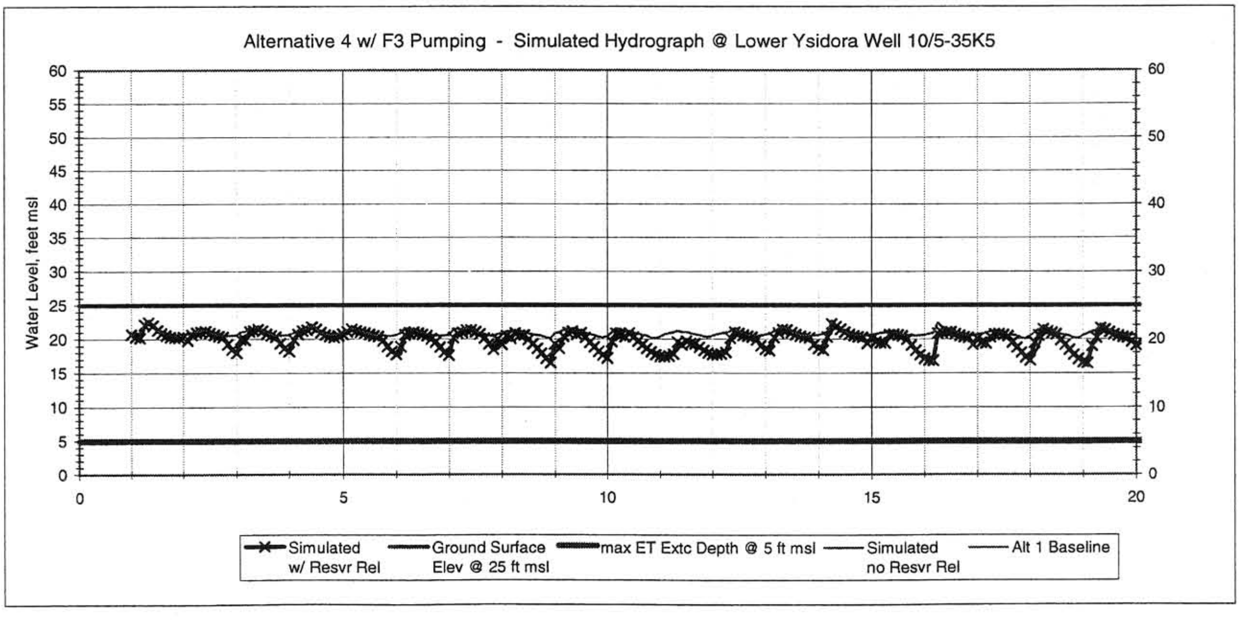
Three different pumping schedules were considered under Alternative 4 to minimize impacts of ground-water level drawdown on riparian vegetation, (described in Appendix D). Of the three pumping scenarios modeled for Alternative 4, the F3 pumping schedule (discussed in section 7.2.4.1) produced the most water for the least environmental impact to the ground-water basins. Appendix D describes the results from the consideration of F2, F3 and 90% F3 pumping scenarios for Alternative 4.

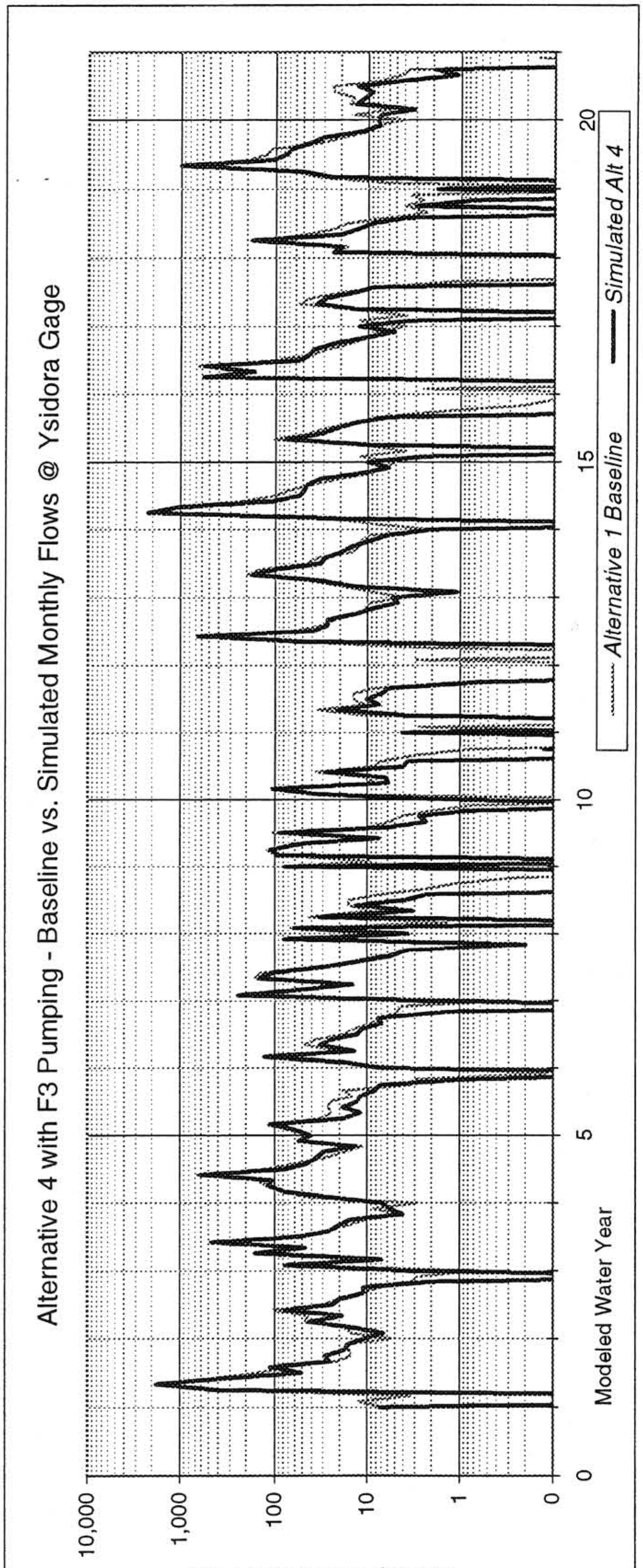
The largest water level drop observed in the three simulated monitoring wells during Alternative 4 model run occurred during Dec, MY 16 (corresponding to historic December 1994 climate conditions) in the Upper Ysidora sub-basin with water level dropping to 67.78 feet, msl. There are three instances, all during winter months, where the water level drops close to or below the maximum extinction depth (20 feet bgs). Winter is a time when the vegetation is considered less stressed.

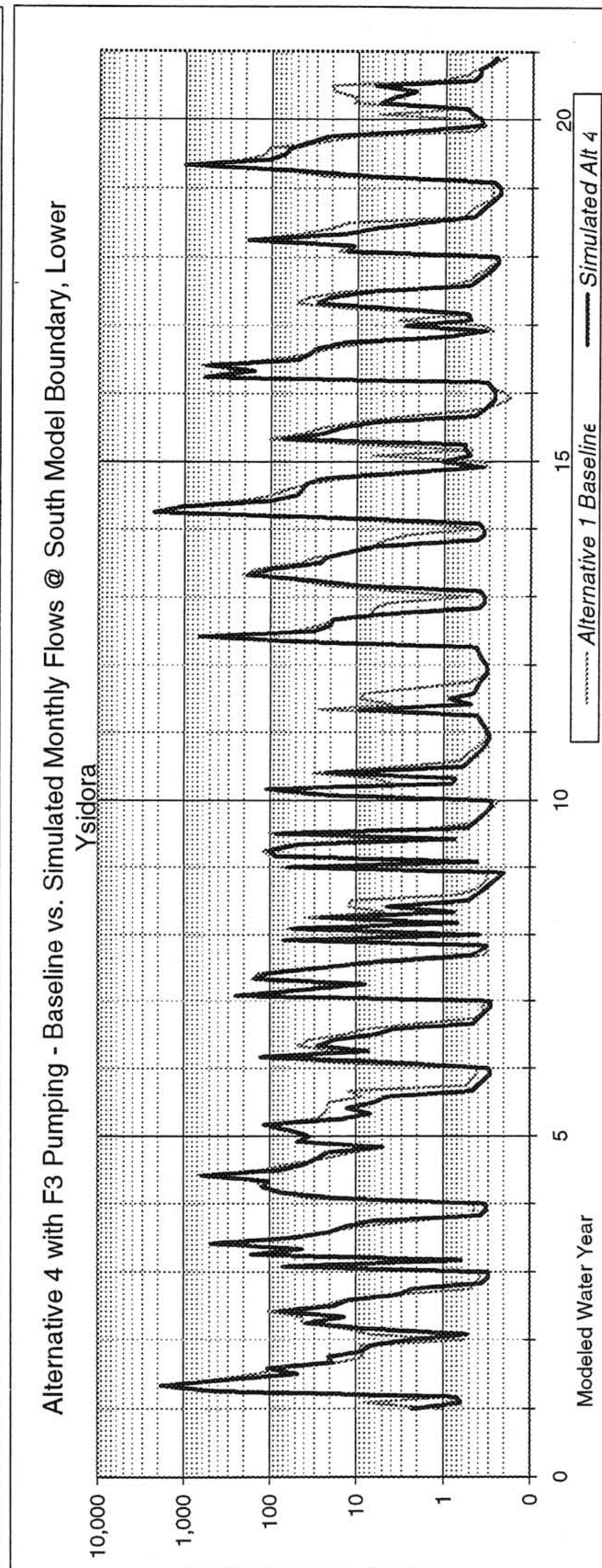
Figure 7-23 shows baseline ground-water level data compared to model simulated results for Alternative 4 for all three sub-basins without reservoir release and with reservoir release to show the contribution of the reservoir to the Upper Ysidora sub-basin. The reservoir release reduces the time shift observed in Alternatives 2 and 3 because the released water counteracts the increased pumping. Ground-water level highs occur in the summer during lower pumping and the lag time of infiltrated water from the recharge ponds reaching simulated monitoring well 10/4-7J1. Under Alternative 4, some lower water levels are observed in the Chappo (well 10/5-23L1) especially in the winter of MY 16, and appear to effect evapotranspiration values (Table 7-30). The minimal response at the Lower Ysidora monitoring well is considered a good indicator that there will be little to no ill effects on the estuary or salt water intrusion into the ground-water basin from implementation of Alternative 4. Simulated and baseline monthly streamflows observed at the Ysidora gage near Basilone Road and the Southwest boundary in the


Alternative 4 w/ F3 Pumping - Simulated Hydrograph @ Upper Ysidora Well 10/4-7J1
Water Level, feet msl
Simulated w/ Resvr Rel
Ground Surface Elev @ 92 ft msl
max ET Extc Depth @ 72 ft msl
Simulated no Resvr Rel
Alt 1 Baseline


Alternative 4 w/ F3 Pumping - Simulated Hydrograph @ Chappo Well 10/5-23L1
Water Level, feet msl
Simulated w/ Resvr Rel
Ground Surface Elev @ 50 ft msl
maxET Extc Depth @ 30 ft msl
Simulated no Resvr Rel
Alt 1 Baseline


Alternative 4 w/ F3 Pumping - Simulated Hydrograph @ Lower Ysidora Well 10/5-35K5
Water Level, feet msl
Simulated w/ Resvr Rel
Ground Surface Elev @ 25 ft msl
max ET Extc Depth @ 5 ft msl
Simulated no Resvr Rel
Alt 1 Baseline


Alternative 4 with F3 Pumping - Baseline vs. Simulated Monthly Flows @ Ysidora Gage
Monthly Stream Flow (cfs)
10,000
1,000
100
10
1
0
0
5
10
15
20
Modeled Water Year
Alternative 1 Baseline
Simulated Alt 4


Alternative 4 with F3 Pumping - Baseline vs. Simulated Monthly Flows @ South Model Boundary, Lower Ysidora
Monthly Stream Flow (cfs)
10,000
1,000
100
10
1
0
0
5
10
15
20
Modeled Water Year
Alternative 1 Baseline
Simulated Alt 4

Lower Ysidora sub-basin are shown in Figure 7-24. The model predicts that Alternative 4 will have minimal impact on streamflow at these areas.

Alternative 4 model run is summarized in the water budget presented in Table 7-30. The Model provides calculated numbers for underflow, stream flow out of the model area, and evapotranspiration. Measured and estimated model input data provides water volumes for streamflow into the model domain, diversion to and release/spill from Lake O'Neill, ground-water pumping, and recoverable water from precipitation.

TABLE 7-30
ALTERNATIVE 4 -- AVERAGE ANNUAL WATER BUDGET FOR MY 1 - 20 (AF/WY)

		Alt 1 -Baseline		Alt 4 - F3 Pumping	
		Average Annual	*Median Annual*	*Average Annual*	*Median Annual*
Inflow:	Subsurface Underflow	830	810	1,340	1,360
	Santa Margarita River Inflow	55,860	30,740	55,860	30,740
	Lake O'Neill Spill and Release	1,080	1,060	2,060	2,150
	Fallbrook Creek Bypass[1]	1,930	1,370	1,930	1,370
	Minor Tributary Drainages[1]	2,120	1,720	2,120	1,720
	Waste Water Discharge[1]	0	0	0	0
	Direct Precipitation	710	500	710	500
	Total Inflow:	62,530	36,200	64,020	37,840
Outflow:	Subsurface Underflow	230	220	220	220
	Santa Margarita River Outflow	50,080	24,420	47,200	19,200
	Ground-Water Pumping	5,550	5,870	14,050	14,800
	Evapotranspiration	2,790	2,700	2,590	2,480
	Diversions to Lake O'Neill	1,500	1,500	2,530	2,610
	Total Outflow:	60,150	34,710	63,590	39,310
	Net change in GW and SW Storage:	2,380	1,490	290	1,810
Water Exchange within Model Domain					
	Net Infiltration from Recharge Ponds	4,010	4,010	12,080	11,760
	Net Stream Recharge to GW	3,240	3,330	2,410	3,240

[1] Table revised on 10/2/03 in memo sent to Larry Carlson.

Though the net stream recharge to ground water is lower in Alternative 4 compared with the baseline, the average annual flow between the stream and ground water is greater. The average simulated annual seepage from all reaches of the stream to the ground-water aquifer is 8,400 AFY for Alternative 4, compared with 6,238 AFY under baseline conditions. During this same Model run, the average simulated annual gaining to all reaches of the stream from the ground-water aquifer is 5,991 AFY for Alternative 4, compared with 3,036 AFY under baseline conditions. There are more gaining sections of the stream during summer months under alternative 4 compared with the baseline, due to the higher water table during some of the summer months.

Evapotranspiration is approximately 200 AFY less on an annual basis for all three sub-basins under Alternative 4 compared with Alternative 1. It may be necessary to curtail pumping during observed critical months, though simulated water levels to not indicate any prolonged low water level conditions.

7.2.4.5 Expected Additional Yield

The annual ground-water yield and maximum surface diversion expected from the construction of Alternative 4 facilities are listed below in Table 7-31. The maximum annual surface diversion required to provide a median annual ground-water yield of 14,800 AFY is 26,500 AF. Of this amount, the unused portion of Permit 15000 would require a maximum annual diversion rate of 21,000 AF, after attributing for diversions under the existing license and pre-1914 water rights. The median annual ground-water yield attributed to Application 21471B, Permit 1500, would be 6,000 AFY. The location of the point of diversion for the unused portion of Permit 15000 would be at the identical location of the existing point of diversion.

7.2.4.6 Capital and Operation and Maintenance Costs

Cost estimates are given for Alternative 4 in terms of capital cost, annual operation and maintenance (O&M) cost, and unit cost per additional volume of water achieved from constructing the project. The estimates reflect year 2000 costs and are based on budgetary quotes from equipment suppliers and local contractors, construction bids for similar projects, unit cost databases published by McMahon (1995) and R.S. Means (2000), and other sources. The cost estimates reflect the level of accuracy that allows for an evaluation and comparison of project alternatives. Verification of certain assumptions is recommended to refine the cost estimates to the pre-design level.

TABLE 7-31

ALTERNATIVE 4 – ANNUAL GROUND-WATER YIELD AND MAXIMUM SURFACE DIVERSION

WATER RIGHT	ALTERNATIVE 1 (AFY)	ALTERNATIVE 4 (AFY)
Maximum Existing License Yield	4,000	4,000
Maximum Pre-1914 Rights Yield	1,100	1,100
Maximum Alternative Riparian Water Right Yield	3,200	3,700
Minimum Additional Ground-Water Yield (AFY)	N/A	6,000
Total Annual Project Yield	**8,300**	**14,800**
Maximum Surface Water Diversion (AFY)	N/A	21,000

The total capital cost estimate for Alternative 4 is $ 47.7 million. The cost estimate includes project planning, design, management, and construction of the project facilities. The project facilities under Alternative 4 include replacement of the existing sheet pile diversion weir with an Obermeyer spillway, new sluice gates at the river diversion, and relocation of the existing diversion headgate. The estimate also includes the cost to enlarge the capacity of O'Neill Ditch from 60 cfs to 200 cfs and the cost to construct new ground-water recharge Pond Nos. 6 and 7 with flow control and continuous flow measuring capability. The estimate for Alternative 4 also includes the cost of constructing an off-stream storage reservoir, pump station, and a pipeline to convey surplus river diversions from the ground-water recharge pond system to the proposed reservoir site. The amortized capital cost of Alternative 4 is $4.2 million and assumes an amortization period of 30 years for all project facilities and an 8 percent interest rate.

The annual O&M cost estimate for Alternative 4 is $128,300. Operations costs include labor and equipment needed to patrol the project area, monitor conditions, and operate the systems. Maintenance costs cover labor and equipment to maintain and make repairs to the mechanical and electrical components of the system, remove accumulated sediment and maintain the condition of O'Neill diversion ditch, and clean and maintain the ground-water recharge ponds. O&M costs for the off-stream storage reservoir system includes an estimate for the annual power requirement to operate the pump station that will deliver water to the reservoir.

The unit cost per additional volume of water achieved from constructing the Alternative 4 project facilities is $730 per AF. The unit cost is based on the sum of the amortized capital cost of constructing the project ($47.7 million) and the annual operations and maintenance cost ($128,300) divided by 6,000 AF of additional water achieved from constructing the project. Table 7-32 summarizes the cost estimate to construct the facilities proposed in Alternative 4.

TABLE 7-32
COST ESTIMATE FOR ALTERNATIVE NO. 4 – OFF-STREAM RESERVOIR STORAGE

Item	Cost
Obermeyer Diversion Dam Items	$621,000
O'Neill Ditch Enlargement Items	108,000
Recharge Pond Nos. 1-5 (additional flow structures)	200,000
New Recharge Pond Nos. 6 and 7	673,000
Off-Stream Reservoir Storage	
Mobilization and Demobilization	1,300,000
Dam Construction	19,000,000
Pump Station	1,700,000
Pipeline	4,000,000
Appurtenant Facilities	1,000,000
Subtotal (Off-Stream Reservoir Storage)	**27,000,000**
Subtotal (all items above)	**28,602,000**
Contingencies and Unlisted Items @ 25%	7,151,000
Subtotal	**$35,753,000**
Planning, Engineering, and Design @ 15%	5,363,000
Project Management and Administration @ 10%	3,575,000
Subtotal	**$44,691,000**
Ground-water Wells (6 @ $500,000 each)	3,000,000
Total Estimated Capital Cost	**$47,691,000**
Amortized Capital Cost [1.]	4,236,000
Annual Operation and Maintenance Cost	128,300
Total Estimated Annual Cost	**$4,364,300**
Unit Cost [2.]	**$730**

1. Capital costs amortized over 30 years at 8 percent interest.

2. Unit cost based on 6,000 AF per year increase in ground-water yield.

8.0 CONCLUSIONS AND RECOMMENDATIONS

Review of the existing water rights and diversion and recharge facilities on Camp Pendleton highlight the need to maintain and repair the existing facilities as well as improve and expand the diversion capabilities in order to secure a dependable water supply into the future. The maintenance and repair projects outlined in Chapter 6 will provide the Base with the ability to divert and recharge water to the ground-water aquifer as prescribed under their pre-1914 and 4,000 AF licensed appropriative water rights. The same maintenance and repair projects that return the existing facilities to their original design capacity will also allow the Base to divert water to Lake O'Neill as allowed under the pre-1914 water right. Additionally, water will continue to recharge the Base's aquifers and be extracted for use within the basin under their riparian water right. Finally, Alternatives 2 through 4 outlined in Chapter 7 provides the Base with three different projects that may be used to perfect Permit 15000 and provide Camp Pendleton with a dependable supply of water well into the future.

The legal right to divert and store water from the Santa Margarita River is a tangible and valuable asset in water short Southern California. On-going development in the region will continue to threaten the source of water that supplies the southern portion of Camp Pendleton with its domestic, military, and agricultural needs. The Base needs to take an active role in securing future appropriative supplies of water through Permit 15000 and maintaining existing water rights. The recommendations provided in this feasibility study provide the Base with the ability to become a self-reliant water producer, independent of the hydrologic and urban growth factors that control the surrounding water purveyors in Southern California.

The Base is in a unique geologic and hydrologic setting in Southern California. The streamflow of the Santa Margarita River fills the three highly transmissive floodplain alluvial sub-basins of the Lower Santa Margarita River basin. The geologic investigations have shown that the Base has not utilized the full ground-water capacity of these sub-basins, instead producing only a portion of what can be harvested from the Upper Ysidora, Chappo, and Lower Ysidora sub-basins. Investigation of different pumping distributions from month to month, as well as from a year to year basis, show that the Base can extract larger quantities of water needed to meet future demands. The analysis presented in this feasibility study allows the Base to fully utilize the natural geologic and hydrologic physical properties of the aquifer without causing harm to surrounding environmental needs.

The management tool that was developed to understand the intricate relationship between streamflow, hydrologic conditions, environmental demands, and ground-water pumping is the ground-water model presented in Chapter 4. The Model accounts for changes in hydrologic conditions on a month-to-month basis and allows for accurate quantification of the hydrologic resources when changes are made to the system. As shown in this report, the Model can quantify the impact of removing wastewater from the basin, adding additional water to the streamflow, or changing the quantity and location of pumping. The Model was developed to allow for the addition of a contaminant transport model to provide the Base with the ability to minimize the potentially adverse effects of aggravating the migration of existing plumes. The spatial resolution of the Model allows for it to be used as an adaptive management tool to prevent adverse impacts to riparian vegetation, thus eliminating costly mitigation measures that could prevent the Base from meeting its existing or future water demand. Although there are recommendations presented in the following section to improve the performance of the existing diversion facilities, a high priory should be given to maintaining the Model as a management tool to help protect the Base's water rights and secure the dependable supply of water into the future.

The Base is also in a unique situation that allows it an opportunity to take advantage of both recent and potential future agreements with other upstream water users. The presently unsigned water resource management agreement with the Rancho California Water District will supply an additional average annual volume of 2,500 AF of water to the Santa Margarita River. The maintenance and repair projects recommended in this report will allow the Base to exercise its water rights in the Santa Margarita River to the maximum extent possible. The recommended projects enable the diversion of these waters to Lake O'Neill and to percolation ponds while at the same time allowing for riparian and ecological needs to be met. Similarly, Alternatives 2 through 4 outline projects needed to provide a physical solution to the dispute with the Fallbrook Public Utility District for waters of the Santa Margarita River. These projects will allow the Base to meet all of its future needs and potentially satisfy the needs of others, thus potentially preventing costly future litigation. The maintenance and repair projects, as well as the recommended alternatives to expand the diversion facilities, will allow Camp Pendleton to sustain a viable inexpensive source of water into the future.

8.1 RECOMMENDATIONS

The results of this feasibility study indicate that the Base should implement the construction of the maintenance and repair projects discussed in Chapter 6 and further pursue the one of the four alternatives discussed in Chapter 7. The construction of the maintenance and repair projects will allow the Base to fully exercise its existing water rights to the Santa Margarita River and increase the efficiency of the existing diversion facilities. Further expansion of the recharge and recovery facilities described in Alternatives 2 through 4 will provide the Base with a long term dependable supply of water. It is recommended that the Base chooses a preferred alternative for perfecting Permit 15000 and pursue the environmental and regulatory analyses required under federal law.

Following construction of the maintenance and repair projects discussed in Chapter 6, the Base should implement a monitoring program to enhance the operation of the existing facilities. Infiltration studies and the monitoring of ground-water levels near the recharge ponds should be implemented to determine the maximum efficiency of each of the ponds. In addition, new maintenance procedures should be followed to maintain the highest maximum infiltration rates possible. A summary of the monitoring program and recommendations for future operating and maintenance procedures is provided in the following section.

Three maintenance and repair projects are recommended to rehabilitate the existing diversion and recharge facilities so that they meet the original project design capacity. Review of the historical records show that the inefficiency of the existing system prevents the Base from exercising its 4,000 AFY license and pre-1914 water right to the maximum extent possible. The projects that are recommended to return the existing facilities to their original design capacity include: replacement of the existing headwall and headgate; scraping and leveling of ground-water recharge ponds 1 through 3, and; installation of control and measuring weirs between recharge ponds. In addition, revamping the diversion facilities to their original project design capacity will decrease operation and maintenance costs due to the increased flow capacity and decreased sediment accumulation.

The replacement of the headwall and headgate structure will prevent the accumulation of sediment in front of the headgate. This project will maintain the invert elevation to the canal at the same elevation as the low flow channel, allowing the Base the flexibility to divert water to facilities as needed. The scraping of ground-water recharge Ponds 1 through 3 will increase the percolation rates in the ponds, allowing for greater quantities of water to be recharged and recovered for domestic use. The installation of control and measuring weirs between the ponds will allow for best management practices to be implemented, providing the maximum percolation rates. These three projects are necessary and mandatory to meet the maximum legal allotment provided by the Bases existing water rights.

The urban growth in the Upper Santa Margarita Basin also dictates the need to design and construct the recommended maintenance and repair projects and pursue an alternative to expand the existing facilities. As land surfaces become more impermeable as urbanization continues, the resulting streamflow events respond by becoming shorter in duration and higher in amplitude. The result of this phenomenon is that the Base will be forced with an even greater challenge of capturing its share of the Santa Margarita River and fulfilling its requirement to meet domestic, military, and agricultural demands.

The following recommendations are made to increase the reliability of the existing Santa Margarita River Recharge and Recovery Enhancement Program.

1) A new land survey of the existing facilities should be conducted in order to properly design and implement the maintenance and repair items described in Chapter 6. The land survey should include aerial topographic mapping supplemented by a field survey of the existing diversion structure, diversion headwall, O'Neill Ditch and the existing structures within the ditch, the existing ground-water recharge ponds, culverts between existing ground-water recharge ponds, the area of the proposed recharge ponds, and Lake O'Neill.

2) Design and construct the recommended Maintenance and Repair projects.
   a. Relocate headwall and install sluice way.
   b. Scrape ponds 1 through 3.
   c. Install control structures and monitoring devices in ponds and two new ground-water piezometers.

3) Use the Model as a predictive, investigative, and design tool to study potential hydrogeologic and environmental impacts prior to management decisions. Practical applications of the Model include pumping management scenarios, diversion system impacts to ground water, changing hydrogeologic conditions, etc. It is recommended that the Model be updated with future field data, thereby continually improving on its reliability.

4) Develop a complete and up-to-date cross-Division/cross-Department ground-water management and monitoring plan. During the data gathering phase of this project, many different departments on the Base held different information that affects the quality and quantity of the water resources and reserves. A joint management/monitoring plan could greatly reduce the investigative and operational costs associated with water basin management, by reducing and combining the overlapping concerns of different departments on the Base. This could potentially reduce detrimental impacts of contaminated sites on drinking water wells, potential salt water intrusion, reduce unnecessary or duplicate sampling and monitoring, and streamline the planning and development process. This would include developing a complete well and water quality inventory, determining the purpose of each well, and abandoning duplicate or potentially cross-contaminating wells. From this foundation and basin-wide understanding, both the quality and quantity of ground water can be enhanced.

5) Expand the ground-water flow model with particle tracking and contaminant transport models to study issues specific to each sub-basin:

Upper Ysidora:	Contaminant transport issues, residence time of infiltrated water, drinking water quality concerns.

Chappo:	Contaminant transport issues, drinking water quality concerns.
Lower Ysidora:	Salt water intrusion, study estuary impacts from changes in the hydrologic regime, irrigation water quality concerns.

6) Improve the model with field data measurements of gaining and loosing stream reaches, and streambed conductance. This would help to better define the relationship between surface and ground water.

7) Install three data loggers to measure water levels daily, with each data logger located in a central well in each sub-basin, to better quantify background ground-water flow under different pond infiltration, precipitation, and pumping conditions.

In order to increase the capacity of the existing diversion and recharge recovery program and reduce operation and maintenance cost associated with sediment removal, the following minimum recommendations should be followed.

8) Install new Obermeyer spillway gate system to reduce sediment accumulations and increase diversion capacity.

9) Enlarge or replace the portions of O'Neill Ditch that restrict flow including: the upper road crossing, restricted ditch areas above the turnout to the ground-water recharge ponds, the upper Parshall flume, and the turnout to the recharge pond system.

10) Install new ground-water production wells to lower the water table below the Recharge Ponds, thereby creating ground-water storage, increasing recharge, and minimizing mounding effects.

8.2 ESTABLISH A MONITORING PROGRAM

Based on the results of this study, it is clear that the efficiency of Camp Pendleton's recharge and recovery operations could be significantly increased and higher recharge pond infiltration rates could be achieved by implementing the above recommendations. In addition to implementing the above recommendations, a monitoring program should be established that would allow for a better understanding of the recharge and recovery capability of the system and a better understanding of factors that effect recharge and recovery operations. The implementation of a monitoring system represents a long term commitment to managing the ground-water yield of the basin and at the same time protecting the environment and ecological habitat on Camp Pendleton.

In addition to the information currently collected by Camp Pendleton (river diversions, evaporation and precipitation data), information and data should be collected to monitor flows between ponds, pond water levels, ground-water levels, and pumping from the ground-water basins. To the extent possible, these parameters should be monitored continuously. The additional data collected under the monitoring program should be utilized for additional studies and insight into the factors that effect the recharge and recovery operations.

8.3 PERFORM ADDITIONAL STUDIES

Wetting and drying cycles within the recharge pond system should be studied to evaluate their effects and to optimize pond infiltration. For example, the recharge pond system could be operated such that water first passes from Pond No. 1 into Pond No. 2, and then into Pond. No. 3. After filling, the system consisting of Pond Nos. 1, 2, and 3 could then be allowed to drain and dry while flow was transferred from Pond No. 1 into Pond No. 5, and then into Pond No. 4. Allowing flow to pass between ponds connected in series to achieve flooding and drying cycles, as opposed to stagnating water in one or two ponds for the entire diversion season could reduce biological activity in the water and on the pond bottoms, thereby reducing the frequency required for pond cleaning operations.

Methods of pond cleaning and maintenance should be evaluated. Disking tends to incorporate clogging materials further into the underlying soil forming a barrier to good percolation. Orange County Water District (OCWD) removes clogging layers from their recharge basins or by sand washing devices. Fresno Public Utilities Department is testing a method of "furrowing" the bottoms of ponds. The furrows are created by motor graders and consist of 10-foot wide troughs between 20-foot wide mounds, one foot in height. As pond water levels rise and fall, suspended sediments are believed to accumulate in the troughs, leaving unclogged mounds between the troughs for percolation, reducing the need for frequent pond cleaning.

Pond cleaning frequency should be evaluated. OCWD ground-water recharge basins are cleaned twice yearly to increase percolation rates. Wetting and drying cycles could also prove to reduce the frequency required for pond cleaning.

Suspended sediments entering the ponds should be monitored to determine their effects on clogging and to develop criteria for limiting sediment-laden water into the recharge pond system. OCWD utilizes a flocculent and a series of settling ponds to help coagulate suspended solid particles and reduce the sediment load diverted into their ponds.

Ground-water mounding in the area of the recharge ponds should be studied for a better understanding of the conditions under which mounding is produced and the affect of mounding on infiltration rates.

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